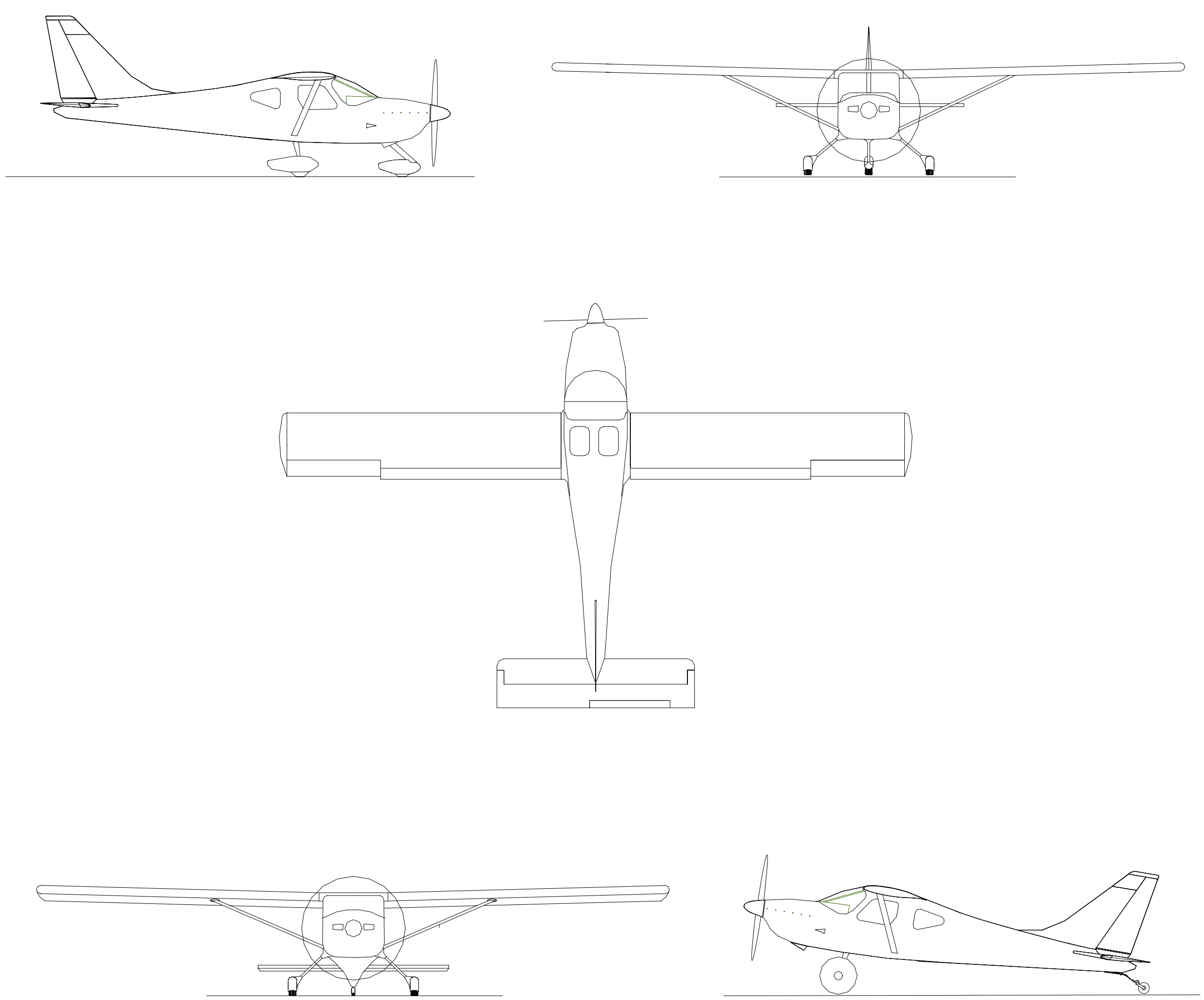
Sportsman Assembly Manual

vol. 1



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18701 - 58th Avenue, N.E.
Arlington, Washington 98223
Tel.: (360) 435-8533 Fax: (360) 435-9525

List of Revisions

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A	12/29/04	II	5, 24, 25, 56, 64, 96-97, 99-104
A	12/29/04	IV	44
A	12/29/04	V	19, 43, 72, 97, 98
A	12/29/04	VIII	52, 59, 98, 99, 154, 157
A	12/29/04	IX	2-8, 10, 11, 16, 19, 23, 42, 52-54, 58, 63-64, 71-72, 83, 114, 134-137, 158, 176, 178, 204, 213, 216, 221, 223, 224, 236, 240, 249 252, 258-259, 261, 264, 268, 270, 272, 274, 278, 284, 287-288, 317-318
A	12/29/04	X	2, 4, 9, 18-20, 24, 26, 28, 30, 37, 39, 57-59, 66, 70, 95, 107, 150, 154-158, 205, 209-212, 214, 219-220, 222, 226, 229, 237, 238-242, 244, 246-247, 251, 268, 287-296, 311, 313, 318-319, 323, 342, 392-396

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TABLE OF CONTENTS

Volume 1

SECTION I: INTRODUCTION

SECTION II: TOOLS AND TECHNIQUES

SECTION II: TOOLS AND TECHNIQUES (CONTINUED) PAGE:

SECTION II: TOOLS AND TECHNIQUES (CONTINUED) **PAGE:**

SECTION III: RUDDER ASSEMBLY

SECTION IV: HORIZONTAL STABILIZER ASSEMBLY

SECTION IV: HORIZONTAL STABILIZER ASSEMBLY (CONTINUED) PAGE:

SECTION V: ELEVATOR ASSEMBLY

SECTION V: ELEVATOR ASSEMBLY (CONTINUED) PAGE:

SECTION V: ELEVATOR ASSEMBLY (CONTINUED) **PAGE:**

SECTION VI: WING ASSEMBLY

SECTION VI: WING ASSEMBLY (CONTINUED) PAGE:

SECTION VI: WING ASSEMBLY (CONTINUED) PAGE:

SECTION VI: WING ASSEMBLY (CONTINUED) PAGE:

SECTION VII: AILERON AND FLAP ASSEMBLIES

SECTION VII: AILERON AND FLAP ASSEMBLIES (CONTINUED) PAGE:

Volume 2

SECTION VIII: FUSELAGE ASSEMBLY

Section VIII: Fuselage assembly (continued) Page:

SECTION VIII: FUSELAGE ASSEMBLY (CONTINUED) **PAGE:**

SECTION IX: SYSTEMS INSTALLATION

SECTION IX: SYSTEMS INSTALLATION (CONTINUED) Page:

SECTION X: FINAL ASSEMBLY

SECTION I: INTRODUCTION

WELCOME!

Welcome to the Sportsman family! We are confident that building your Sportsman aircraft will be a satisfying, enjoyable and fun project. We have done as much as possible to simplify construction of the Sportsman and to eliminate the need for expensive or exotic tools, for complicated jigging procedures and for specialized skills. The purpose of this *Assembly Manual* is to describe every assembly procedure clearly and concisely in a step-by-step manner.

Before beginning construction of your Sportsman, **we strongly urge you to read this section and the following "SECTION II: TOOLS AND TECHNIQUES" thoroughly. Pay particular attention to the "SAFETY PRECAUTIONS" in this section. Our experience of over twenty years in the kitplane industry has shown that time invested in studying the manual before starting work is richly repaid in increased efficiency and greater enjoyment down the road.**

AIRCRAFT DESCRIPTION

The Sportsman is a 2-4 place, high-wing, tractor-engine airplane that is designed to provide the highest possible utility and versatility. It can be built with either tricycle or conventional (taildragger) landing gear and was designed from the outset to accept floats, either straight or amphibious. The Sportsman features folding wings and an easily removable horizontal stabilizer that allow the airplane to be trailered home, reducing or eliminating hangar costs.

The Sportsman has a simple, rugged airframe of mixed construction. The wing, the horizontal stabilizer, and all control surfaces are made of sheet aluminum to minimize both weight and cost and to provide the fastest possible construction. All ribs and spars are pre-formed, as are leading and trailing edge bends. Pilot holes for rivets are pre-punched in the aluminum structure wherever possible to minimize the amount of measurement and lay-out needed to assemble the airframe.

The fuselage is a fiberglass composite shell with an internal steel tube cage around the passenger compartment. Most of the major components (the wings, the landing gear, and the engine) attach directly to the steel tube cage, which eliminates the need to fabricate load-bearing structure for these components in the fiberglass shell. Being able to bolt these components directly to a pre-welded structure also greatly reduces the requirements for tedious and exacting jigging procedures. Attach points are provided in the steel tube cage for both conventional and tricycle gear as well as for floats, so the airplane is easily converted among gear types.

The fuselage shell consists of left and right halves and a cabin roof, joined together by seam laminates. The forward part of the fuselage is essentially a fairing, providing smooth contours to reduce parasite drag; the aft fuselage is a structural member that carries the aerodynamic loads from the empennage. Loads are transferred between the steel tube cage and the fuselage shell by an array of reinforced areas in the shell and attach tabs on the cage.

The control system in the Sportsman is conventional. Dual sticks provide pitch and roll control, rudder pedals for both the pilot and the passenger provide yaw control, and a centrally-mounted lever actuates the large Fowler flaps. All of the primary controls are actuated by a system of cables and pushrods. A large elevator trim tab provides pitch trim.

Technical Support

With any project of this size, questions will almost certainly arise, and we want to assure you at the start that we will provide the best support possible. Our reputation for supporting our builders and standing behind our products is unequaled in the industry. If a question arises, please call our dedicated **Technical Support Line**, where a technician who has experience constructing the Sportsman airframe, as well as a wide range of aviation experience in general, will be available to help you. Refer to your purchase confirmation documentation for specifics of our technical support policy.

USING THE *ASSEMBLY MANUAL*

The *Sportsman Assembly Manual* begins with two general, introductory sections (this section and the following "SECTION II: TOOLS AND TECHNIQUES"). Sections describing the various sub-assemblies of the airplane follow the introductory sections in the recommended order of completion. All detailed descriptions of fabrication and assembly techniques appear in "SECTION II: TOOLS AND TECHNIQUES;" later sections will assume that you already know how to accomplish specific procedures.

Dimensions and Tolerances

Many dimensions are given throughout the *Assembly Manual*. All dimensions are in inches, mostly in fractional form as these are the easiest to measure using standard, English-system measuring tools. There are a few instances where we specify decimal dimensions; for these, use a rule graduated in 1/50ths of an inch. The fractional dimensions given have a tolerance of no more than ± 1/32". All decimal dimensions given have a tolerance of no more than ± .030".

For Sportsman builders in countries that use the metric system, we recommend procuring a set of English-system measuring tools (tapes and rules) and becoming familiar with their use rather than converting from English to metric measurements. Since English-size hardware is supplied in the Sportsman kit, and since you will be using English-size drill bits to drill all the holes, we feel that it is better to maintain consistency and use the English system throughout. Converting between systems is an unnecessary, time-consuming step that introduces one more opportunity for errors to occur.

Parts Lists, Tool Lists and Workspace Requirements

At the beginning of each assembly section is a list of parts used in the assembly. The parts in the parts list are assigned a key number by which they are referenced in the illustrations and the text. The key number is circled in the illustrations and enclosed in brackets in the text. Key numbers are for reference within the manual **only**. The complete, ten-digit part number is the number you should refer to when contacting the Order Desk to inquire about orders, order replacement parts, etc.

> **Note** These lists have two main purposes. First, they give you an idea of which parts are required for a particular sub-assembly of the aircraft. Second, they allow us to omit ten-digit part numbers from the text and illustrations, resulting in more easily readable instructions and clearer illustrations. What the manual parts lists are **not** intended for is taking inventory of your kit shipment(s). Special Kit Contents Lists included with each shipment are intended for this purpose. Due to different revision schedules, the manual parts lists and the Kit Contents Lists may not always agree, but any discrepancies will either be explained in Advance Notices of Revision (see below) or will be made good by supplemental parts shipments called "Addenda." **Please do not inventory your kit based on the manual parts lists.**

> **Note** Purchasers of any of our pre-finished steel part options will receive parts with part numbers such as "101-05000**P**03," where the "P" substitutes for the usual hyphen and indicates that the part is primed, plated or powder coated. The parts lists in the manual, however, will only list the standard, untreated part numbers. Construction procedures are identical in all cases.

The parts list is followed by lists of tools and additional materials not provided in the kit (such as scrap wood for simple jigs, household glue, anti-corrosion primer, etc.) needed to complete the assembly and a description of the workspace required for the assembly.

Illustrations

The *Sportsman Assembly Manual* makes extensive use of isometric line drawings of the various assemblies and exploded views of assembly details. As mentioned previously, parts shown in the illustrations are referenced by the key number that appears in the parts list at the beginning of the section. Detail drawings include a thumbnail sketch of the entire assembly with the location of the detail marked with an arrow.

Pre-punched holes in the parts are shown as holes in the illustrations. The locations of holes to be drilled by the builder are shown by small crosses.

Location References

Throughout the Sportsman Assembly Manual we make frequent use of terms that specify the location or orientation of a part or an assembly. Following is an alphabetical list of such terms with their definitions as used in this Assembly Manual:

AFT — used to denote a position or a direction relative to a reference point; means closer to the tail of the aircraft.

BOTTOM — used to denote a location; the lowest point.

FORWARD — used to denote a position or a direction relative to a reference point; means closer to the nose of the aircraft.

INBOARD — used to denote a position or direction relative to a reference plane; means closer to the longitudinal centerline of the aircraft.

LEFT — used to denote a position or direction relative to a reference point; corresponds to the pilot's left side when seated in the aircraft facing forward.

LOWER — used to denote a position relative to a reference point; means closer to the bottom of the aircraft when the aircraft is upright; often used as an adjective to differentiate between two similar objects.

OUTBOARD — used to denote a position or direction relative to a reference plane; means farther from the longitudinal centerline of the aircraft.

RIGHT — used to denote a position or direction relative to a reference point; corresponds to the pilot's right side when seated in the aircraft facing forward.

TOP — used to denote a location; the highest point.

UPPER — used to denote a position relative to a reference point; means closer to the top of the aircraft when the aircraft is upright; often used as an adjective to differentiate between two similar objects.

Warnings, Cautions, Notes and Hints

The following definitions apply to the **Warnings**, **Cautions**, **Notes** and **Hints** used throughout this Assembly Manual. **Warnings**, **Cautions**, **Notes** and **Hints** appear in the format shown here.

Warning A warning is used to alert you to a procedure, a practice or a situation that may result in personal injury or loss of life if not carefully followed or strictly observed.

Caution A caution alerts you to a procedure, a practice or a situation that, if not carefully followed or strictly observed, may result in damage to or destruction of a part.

Note A note alerts you to a step, a procedure, or an instruction that is considered important to emphasize.

Hint A hint is a recommendation for an easy way to accomplish a certain procedure.

Assembly Manual Revisions and Advisory Publications

ADVANCE NOTICES OF REVISION AND FORMAL REVISIONS

In order to keep you advised of pending *Sportsman Assembly Manual* changes in as timely a manner as possible, we will publish periodic **Advance Notices of Revision** (ANORs) for the manual. An ANOR consists of a simple list of items indicating places in the manual where changes will occur, with brief descriptions of the changes. When you receive an ANOR, we recommend that you pencil the outlined changes into your manual in order to insure that you are building according to the most current instructions.

ANORs are essentially a stop-gap measure to keep you informed between formal **revisions** to the manual. A formal revision consists of a set of replacement pages for the manual in which changes briefly outlined in the ANORs are fully developed with appropriate text and illustrations. When you receive a revision, discard the affected pages from your manual and replace them with the revised pages provided.

Any revision to the manual will be noted in the "LIST OF REVISIONS," which appears directly after the title page of this volume. The revision will be designated by a revision letter and date. The revised page will show the most current revision letter and date in the footer at the bottom of the page. Any page that shows no revision letter and date in the footer has never been revised and is the most current page available. A vertical revision bar in the outside margin indicates the area where each latest revision was made.

ADVISORY PUBLICATIONS

In addition to the *Assembly Manual* and its revisions, Glasair Aviation, LLC utilizes a variety of **advisory publications** to keep Sportsman builders and pilots apprised of important information. The publications include **service bulletins** and **service letters**; the specific definitions of these types of publications are discussed below. Any advisory publication that you receive should be read carefully and immediately, as it may contain vital information pertinent to construction you are currently undertaking or to operation of the completed aircraft. All advisory publications received should be retained in an organized fashion as part of the permanent record of the aircraft.

Advisory publications are numbered sequentially as they are issued. An important point, however, is that not all advisory publications apply to all kits. In order to avoid burdening you with irrelevant material, we will send you only those advisory publications that may pertain to your kit. Therefore, few builders will end up with complete sets of service bulletins or letters.

Service Bulletins

A service bulletin is a publication designed to alert builders and pilots to changes, recommendations, problems, or other information of a critical nature pertaining to either the construction of the kit or the operation of the completed aircraft. Service bulletins often prescribe actions to be undertaken by the builder or pilot.

Mandatory service bulletins concern problems with or changes in parts, assembly procedures or aircraft operations that are **directly related to the safety of flight**. Actions prescribed in mandatory service bulletins are **compulsory**, even if they affect an already completed aircraft or assembly.

Non-mandatory service bulletins concern non-flight-critical changes in parts, assembly procedures or aircraft operations. Undertaking the actions prescribed in non-mandatory service bulletins is **strongly recommended** to enhance ease of kit assembly and/or serviceability of the completed aircraft, but compliance remains at the builder's or pilot's discretion.

Service Letters

Service Letters are advisory publications of a non-critical nature concerning company policies, recommended operating procedures, aircraft systems, maintenance issues and so on. Any actions suggested in Service Letters are to be undertaken solely at the builder's or pilot's discretion.

All of the above information can be found on our website ***www.newglasair.com***.

Revisions to Advisory Publications

Revisions to advisory publications will be designated with a letter in the box marked "Revision" at the bottom of the page. The revised service bulletin/letter will supersede the previous service bulletin/letter of that number. Additional information on a subject covered in a previous service bulletin/letter will be published in a **service bulletin/letter supplement**. For example, "Service Bulletin 3, Supplement A," supplements the information published in "Service Bulletin 3."

Index of Advisory Publications

For your reference, we will periodically send out a list of service bulletins and service letters under the title **Index of Sportsman Advisory Publications**. This index also lists current ANORs and manual revisions. We recommend keeping a 3-ring Advisory Publications notebook in which you can organize service bulletins, service letters and the index.

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RECOMMENDED READING

Although "SECTION II: TOOLS AND TECHNIQUES" provides a fairly complete description of the various aircraft construction procedures needed to assemble the Sportsman, we recommend supplementing the information provided in that section with readings from the following list of books, which address the subject of airplane construction in greater detail. The handbooks listed are especially good for the amount of information they condense into a small package. We also recommend the various homebuilt airplane periodicals—especially *Sport Aviation* (which is sent to EAA members) and *Kitplanes.* In addition, browsing through some of the aircraft tool and supply catalogs, such as the Aircraft Spruce and Specialty catalog (800-824-1930), can provide a lot of insight into aircraft construction practices.

Bent, Ralph D., and James L. McKinley. *Aircraft Maintenance and Repair,* 4th ed. New York: McGraw-Hill Book Company.

———. *Maintenance and Repair of Aerospace Vehicles.* New York: McGraw-Hill Book Company.

———. *Powerplants for Aerospace Vehicles.* New York: McGraw-Hill Book Company.

Bingelis, Tony. *Firewall Forward: Engine Installation Methods.* Oshkosh, WI: EAA Aviation Foundation, Inc.

———. *The Sportplane Builder: Aircraft Construction Methods.* Oshkosh, WI: EAA Aviation Foundation, Inc.

———. *Sportplane Construction Techniques: A Builder's Handbook.* Oshkosh, WI: EAA Aviation Foundation, Inc.

Reithmaier, Larry, ed. *Standard Aircraft Handbook.* Blue Ridge Summit, PA: Tab Aero Books.

Standard Aviation Maintenance Handbook. Casper, WY: IAP, Inc.

U.S. Department of Transportation, Federal Aviation Administration. *Airframe & Powerplant Mechanics: Airframe Handbook.* Washington, D.C.: U.S. Government Printing Office.

———. *Airframe & Powerplant Mechanics: Powerplant Handbook.* Washington, D.C.: U.S. Government Printing Office.

———. *EA-AC 43.13-1A & 2A, Acceptable Methods, Techniques, and Practices: Aircraft Inspection and Repair—Aircraft Alterations.* Washington, D.C.: U.S. Government Printing Office.

Parts Not Supplied in the Sportsman Kit

The Sportsman kit supplies most parts necessary to build the airframe but not all parts needed to build the entire airplane. Additional parts and components you will need include an engine and its accessories, a propeller, cowling, avionics, and flight and engine instruments. Many of these, as well as various optional components that you might choose to configure your airplane just the way you want it, are available from Glasair Aviation, LLC. If you choose not to install components and options offered and supported by Glasair Aviation, LLC, you are responsible for finding sources of the components and working out the details of their installation.

Material Substitution

All the metal parts and raw metal stock supplied with your Sportsman kit are certified, aircraft-grade alloys—4130 chromium-molybdenum steel and 2024-T3 or 6061-T6 aluminum. **Substitution of materials with different grades or dimensions than those specified in the design and provided in the kit is strictly forbidden.** Additionally, in some applications, 6061-T6 aluminum stock is **not** an acceptable substitute for the 2024-T3 stock specified.

Similar restrictions apply to the composite fabrication materials. The fiberglass cloth supplied with your Sportsman kit has been treated with a chemical, called "sizing," to enhance its compatibility with the Sportsman's vinyl ester resin system. Fiberglass material obtained elsewhere, even though identical in all other respects, might be treated with a different sizing, making it difficult to achieve well-saturated laminates and resulting in structures with reduced strength. Substituting different resin for the supplied vinyl ester resin could also lead to construction difficulties and inadequate strength.

If you need to replace any parts or raw materials—either because of mistakes during construction or wear or breakage during service—we **strongly recommend** that you procure replacements directly from Glasair Aviation, LLC. If you insist on procuring raw materials from an alternative source, contact us first to confirm the material specifications.

GENERAL CONSIDERATIONS

Before beginning any construction, consider the following general instructions:

1. We suggest studying each of the individual assembly sections before beginning work on that assembly. By acquiring a thorough understanding of what is to be accomplished before beginning work, you will avoid surprises and help prevent costly and time-consuming mistakes. Often, questions that arise in reading any given step will be answered in subsequent steps.

2. Make sure all the tools and materials required are on hand.

3. Proceed in a stepwise manner paying close attention to the **Warnings**, **Cautions** and **Notes**.

4. After completing each step in the individual assembly sections, check the space marked "Completed." Also, when you have completed each major sequence of steps, sign and date the appropriate line on the Assembly Log pages at the end of this section. If you do this, you will always know where you are in the construction sequence and where you ended your previous work session. This will also provide some of the documentation required by the FAA (or other national authority) that you, yourself, accomplished the major portion of the work to assemble the Sportsman airframe. (Refer to the "FAA INSPECTION AND DOCUMENTATION REQUIREMENTS" information that appears later in this section.)

Suggestions for Kit Storage

Because most builders can work on just one part of the Sportsman airframe at any one time, the other parts must be stored until they are needed. Sheet metal, fiberglass and acrylic plastic (Plexiglas) components are subject to damage or deterioration if stored improperly. Heed the following suggestions for storing these parts.

Sheet Metal Parts

The sheet metal airframe components, such as the spars, ribs and skins, are subject to damage by deformation, by scratching and by corrosion. Take care, when storing these parts, not to pile heavier parts on top of them that might deform them, rendering them unusable. Store pre-bent skins on top of other components, for example, so that heavier parts do not tend to change the radius of the bends. Leave small components in their boxes or other packaging to protect them until needed. If a protective **plastic** coating is present on sheet aluminum parts, leave it on until the parts are needed. Any protective **paper** used during shipment should be removed for storage, however, since it can retain moisture next to the metal.

> **Caution** Be very careful and take your time when removing the protective covering from aluminum sheets. If you pull too hard in the wrong direction, you could permanently crease or kink the sheet. To remove the covering, start from one end and then hold that end down while pulling the covering low and parallel to the surface. Do not pull the covering up perpendicular to the surface. Additionally, take care when picking up large pieces of sheet metal (like the elevator skins, for example) that have a joggle or a bend in one edge. If you allow the sheet to flex perpendicular to the bent edge, you will crease it, and such creases are difficult or impossible to remove.

When aluminum is alloyed with various other metals, its stiffness and strength is increased dramatically but its corrosion resistance is reduced. So, a thin coat or "cladding" of pure aluminum (which is much more corrosion-resistant than aluminum alloy) is often applied to the surface of aluminum alloy sheets. All of the sheet metal skins in the Sportsman are made from this "Alclad" aluminum alloy. Because pure aluminum is very soft, the surfaces of Alclad sheets are easily scratched. Scratches that penetrate just the protective cladding have little effect on the strength of the sheet, but they do reduce its corrosion-resistance.

Deeper scratches on sheet metal components provide places where stresses concentrate, which can reduce the strength of the parts and their tolerance to fatigue. Be very careful, therefore, to prevent scratches on sheet metal parts. If small scratches occur, remove them with a non-metallic scrub pad like Scotch Brite. Deeper scratches can be removed with wet, aluminum oxide sandpaper. Use 400 grit, followed by 600 grit, and final polish with Scotch Brite. To prevent scratches, store the parts in an out-of-the-way place where they are not subject to routine contact from other parts or from tools while you are working in your shop.

Caution In sanding aluminum parts, be certain to **avoid carborundum grit sandpaper**. This type of paper will imbed tiny carbon particles in the aluminum surface, which can cause dissimilar metals corrosion. For the same reason, **steel wool should never be used** on aluminum parts. We recommend only aluminum oxide sandpaper, and even that should be followed with Scotch Brite.

Keep sheet metal components in a dry place to help prevent corrosion. Aluminum parts that are continuously damp, especially if in contact with dissimilar metals, can be ruined by corrosion in a very short time. Do not store metal parts in close proximity to corrosive chemicals, such as battery electrolyte or powerful cleaning compounds. Even the vapors from such chemicals, if confined to a closed space, can induce corrosion of metal parts.

The same storage and handling precautions apply to finished aluminum airframe components. Once you have finished the empennage components and the wings, for example, find a place to store them where they are safe from damage while you are working on the fuselage.

Fiberglass and Composite Parts

Fiberglass airframe components, individually, do not have the structural integrity of a completed assembly. Until bonded together into an integral structure, fiberglass parts are free to bend and adapt to any shape to which they are subjected. If stored for an extended period in a deformed condition (especially at higher temperatures), "sets" can occur in the fuselage halves and other fiberglass parts, which will complicate assembly of the parts. Proper storage is mandatory, therefore, to keep the parts from warping or taking on sets.

The best place to store the parts is in the shipping crate itself. All the parts are held in place with nylon strapping. Cut these straps to relieve any tension or pressure on the parts. If the parts cannot be stored in the crate, make sure the parts are stored in an un-deformed condition.

> **Note** If parts do become warped they can be corrected by applying pressure over a period of time in a direction opposite the set. Careful application of heat is also helpful.

Also, protect the unfinished interior surfaces of fiberglass components from long-term exposure to direct sunlight. Over time, the ultraviolet light in sunlight can cause the plastic resin in unprotected fiberglass parts to deteriorate, which can seriously weaken the parts. The exterior surfaces of all fiberglass components supplied for the Sportsman kit are finished with a durable white gel coat, which provides excellent protection from the harmful effects of ultraviolet light. After the airframe has been completed, therefore, and the interior surfaces of airframe components are no longer exposed, the potential for damage from sunlight is greatly reduced.

Acrylic Plastic Components

Protect acrylic plastic parts (the windshield and the cabin windows) from contact with sharp metal or fiberglass parts that could scratch them. Leave as much as possible of the protective covering on these parts until airframe assembly is complete. If the parts cannot be left in their original packaging, protect them from damage with sheets of corrugated cardboard, sheets of soft plastic foam, or clean old blankets. Acrylic plastic components can become warped if stored in a deformed condition, especially if subjected to elevated temperatures.

Fiberglass and Resin Storage

Store raw fiberglass cloth in such a way that it will be kept clean and free of water absorption. Moisture can easily damage the sizing of the cloth, which will affect the strength of the finished laminate. Glass cloth that is dirty or that has absorbed moisture will retard resin saturation, resulting in a defective laminate. Do not use fiberglass products that have been wet or are dirty.

We recommend storing fiberglass products in a closed package in a clean environment. Also, to reduce exposure of fiberglass cloth to possible contaminants, set up a separate cloth-cutting table in a clean area of your shop and restrict its use to handling fiberglass products only.

Each Sportsman kit is shipped with 1 gallon of vinyl ester resin. The shelf life of the resin is only about three months once promoted so use carefully! While 1 gallon of resin will be sufficient for some builders, not every builder will be the same or add the same accessories. Additional resin can be ordered by contacting our parts department.

Warning Because all of the chemicals used in the Sportsman are toxic to some degree (some worse than others), store them out of the reach of children. Refer to the "SAFETY INFORMATION," which appears later in this section, for additional precautions in storing and handling chemicals.

Kit Building Sequence

We recommend building the aircraft in the sequence outlined in this manual, starting with the rudder and then proceeding to the horizontal stabilizer and elevator assemblies. Then, fabricate the wing panels, the flaps and the ailerons. Once all of the flying and control surfaces have been completed, proceed to fuselage construction and then to final assembly. This sequence is not mandatory, but it is usually easier to store the completed tail surfaces and wing panels while working on the fuselage than vice versa. The other advantage to using the recommended sequence, especially if you are an inexperienced builder, is that you start on the smaller, less expensive components and proceed to larger components only after your skill level has increased. If you are an experienced builder, or lucky enough to have unrestricted shop space or a hangar you can move completed components to, you can devise your own schedule for component completion and even work on several sub-assemblies concurrently. Within a given sub-assembly, however, we **strongly urge** you to follow the prescribed assembly sequence. It is all too easy to skip ahead without fully appreciating what difficulties you may encounter later.

SAFETY PRECAUTIONS

Warning For personal safety, please read and heed the following safety precautions. Some of the materials and processes discussed below may be unfamiliar to you, but we believe it's important that you acquaint yourself with potential hazards before you encounter them. All the materials and processes discussed here will be fully explained in "SECTION II: TOOLS AND TECHNIQUES." Refer back to this "SAFETY PRECAUTIONS" section when you begin working with a new material or process.

Eye and Skin Contamination

Because of the corrosive nature of the chemicals used in the Sportsman airframe, care must be taken with them, especially with the MEKP catalyst. The MEKP catalyst is a strong oxidizing agent.

MEKP CATALYST

MEKP (methyl-ethyl ketone peroxide) is harmful or fatal if swallowed and harmful if inhaled. MEKP is a severe eye irritant. One drop of MEKP splashed in the eye **will cause blindness** unless the eye is washed within **four seconds** after contamination. Use of safety glasses is **strongly** recommended when catalyzing resin. Keep an eyewash bottle filled with clean water close at hand. In case of eye contact with MEKP, immediately flush the eye with plenty of clear water and see a physician.

MEKP is flammable. Keep MEKP catalyst away from fire and protect from direct sunlight, heat and sparks. Do not add MEKP to hot materials. Prevent contamination with foreign materials, especially readily oxidizable materials, accelerator (DMA) or promoter (cobalt).

Store MEKP in the original closed container in a cool location. When the container is emptied, it must be destroyed and not be reused for any purpose. Failure to observe these precautions may result in explosive decomposition.

Catalyzed Resin

Contact with fingers and hands poses no serious problem, but avoid prolonged contact. Tight-fitting latex medical gloves can be used to avoid any contact with the skin.

Vapors and Dust Particles

Avoid breathing the fiberglass particles while sanding or filing fiberglass. Use a good quality particle mask, available at most hardware stores.

The strong vapor smell of the resin before it cures is from the styrene in the resin as it evaporates away. Always laminate in a well-ventilated area. High concentrations of styrene in small, enclosed areas may cause nausea. Avoid breathing these vapors when high concentrations exist. We recommend wearing a vapor respirator (available at most hardware stores) for protection. We also recommend that you complete the fiberglass work on your airplane in an area separate from your living quarters because of the vapors present. A small fan is useful to carry styrene vapors away when working in a confined space, such as the tail cone. Because styrene vapors are heavier than air, try to work on an elevated bench or table; use a fan to move the air along the floor, away from the work space.

Flammability

The materials used in fiberglass construction are highly flammable, especially the acetone and catalyst. Keep them away from direct sunlight, heat, sparks and open flame. Keep track of all materials and store them in a cool, clean, well-ventilated area. Make sure all containers are sealed when not in use.

When resin gels and then exotherms, enough heat may be generated to cause a fire. None of the lay ups on the Sportsman pose a problem because they are not thick enough. The only time this could be a problem is when a large batch of resin is used in a container, coupled with high temperatures and a high catalyst percentage.

Do not throw away catalyzed resin before it has gelled, exothermed and cooled. If you have a pot of uncured resin left over after a laminating procedure, let it gel in its container on a concrete floor before discarding.

Proper Resin Mixing Sequence

Never mix cobalt directly with MEKP catalyst. A violent reaction will occur which may result in fire or explosion. Resin is first promoted with cobalt and then DMA. This forms a master batch of promoted resin from which smaller quantities may be taken as needed. Just prior to use, the promoted resin is catalyzed with MEKP catalyst. The proper resin promotion procedures are explained in "SECTION II: TOOLS AND TECHNIQUES."

Lead Toxicity

Lead is used for the control surface counterweights in the Sportsman. Lead is a poison that can enter the body either through inhalation or ingestion. Repeated exposures to lead over time can result in accumulation in the body. The effects of exposure to lead include loss of appetite, weakness and tiredness, insomnia, muscle and joint pain, frequent headaches, tremors, numbness, dizziness, vomiting, poor memory, irritability, and seizures. Overexposure to lead can damage the reproductive systems of both men and women. Birth defects, miscarriages, or stillbirth can occur if either the mother or the father were overexposed to lead.

Although it is highly unlikely that fabricating the control surface counterweights will result in overexposure to lead, it is wise to observe the following precautions: After handling lead, scrub your hands thoroughly before eating, drinking, or smoking. Clean your work area thoroughly after working with lead, carefully bagging any shavings or filings for disposal. Brush your clothing and shoes to remove lead shavings before going into your home from your workshop. Since lead poses a special risk to children (whose nervous systems are still developing), banish children and pregnant women from your workshop when working with lead. Store lead in an out-of-the-way place (preferably in a sealed and marked container) where you won't come into routine contact with it. Keep lead out of the reach of children.

A Final Word About Safety

We feel it's vitally important that you be aware of the potential hazards associated with aircraft construction from the beginning. However, the preceding catalog of dangers can sound rather overwhelming, and it's worth emphasizing that the experience of building your Sportsman will be safe and enjoyable as long as you follow the few, simple precautions outlined above. Like flying itself, building an airplane can be extremely safe as long as safety isn't taken for granted.

Note The following three sections outline inspection, documentation, registration and certification requirements for amateur-built experimental aircraft in the United States according to the regulations of the Federal Aviation Administration. Although national regulations in countries other than the United States are often very similar to the U.S. rules, there are also significant differences. It is the builder's responsibility to acquaint him/herself with these regulations, and we strongly recommend that this be done **early** in the construction process, if not prior to kit delivery.

FAA Inspection and Documentation Requirements

The FAA requires that certain documents and records be kept, including records of pre-cover inspection, during construction of a homebuilt aircraft. These requirements are detailed in FAA Advisory Circular 20-27D, which is available (free of charge) from:

U.S. Department of Transportation
Utilization and Storage Section M-443.2
Washington, D.C. 20590

This is a brief outline of the major points covered in AC 20-27D, but we strongly encourage you to procure and review a copy of the circular early in your construction schedule. First, the builder must keep copies of invoices, receipts and shipping documents for materials and kits used in construction of the aircraft. The FAA inspector will want to see these documents when inspecting the finished aircraft prior to issuance of an airworthiness certificate.

The builder must also keep a log of the construction and inspection of the aircraft as it is built. The Assembly Log at the end of this section is designed to help satisfy this requirement, but you should carefully study AC 20-27D to ensure that you meet all FAA logging requirements.

The FAA no longer performs so-called "pre-cover inspections" of the interior structure of homebuilts. However, pre-cover inspections performed by some knowledgeable person (such as the builder himself or an EAA designee) are still required and must be recorded in the construction log. As additional evidence of pre-cover inspection, many builders photograph the construction process as they build, and we strongly endorse this practice.

The FAA will perform a final inspection of the aircraft before flight. In addition to inspecting the aircraft itself, the FAA will inspect the above-mentioned documents and records. If the aircraft passes the inspection, and the necessary documents and records are in order, the inspector will issue a limited airworthiness certificate for a specific test period and area.

The flight history of the aircraft during the specified test period must be recorded in a flight log. Record the length of each flight, the tests performed and the outcome of the tests. Document any problems encountered during test flights and the steps taken to resolve the problems.

After the flight test period has been flown off, the builder should present the construction and flight logs and the old limited airworthiness certificate to the FAA for issuance of an unlimited airworthiness certificate. If all the records are in order, the FAA will not inspect the aircraft at this time.

If you have any questions concerning registration and certification we suggest contacting the local FAA General Aviation District Office (GADO) or Flight Standards District Office (FSDO).

Aircraft Registration Procedures

The Federal Aviation Regulations (FAR) require that all U.S. civil aircraft be registered before an airworthiness certificate can be issued. FAR Part 47, Aircraft Registration, prescribes the requirements for registering civil aircraft. The basic procedures are as follows:

1. Before an amateur-built aircraft can be registered, the builder must first obtain an identification number that will eventually be displayed on the aircraft. About six months before you anticipated first flight, request assignment of an identification number by writing to:

   FAA Aircraft Registration Branch
   Attn.: Central Records
   Department of Transportation
   P.O. Box 25504
   Oklahoma City, OK 73125

   Your request must include the following information: the manufacturer of the airplane (**your** name!), the make (Sportsman), the model number (GS-2), the serial number (your Sportsman kit number), your name, address, telephone number and signature. You must also enclose a check for the $10.00 fee.

   If you want a personalized "N" number assigned to your aircraft, specify five choices in order of preference. Alternatively, you can telephone the FAA in Oklahoma City at (405) 954-3116 to find out if a particular number is available. A personalized identification number costs an additional $10.00, so a check for this amount must be included with your letter of request. There is no extra charge for a random identification number. Within a few weeks of receiving your application, the Aircraft Registry will send you a form letter giving your assigned number, a blank Aircraft Registration Application (AC Form 8050-1) and other registration information.

2. Before you can get an Airworthiness Certificate, you must have an Aircraft Registration Certificate. So, about four months before your first flight, send the following information to the Aircraft Registry:

    a) The letter you received with your identification number assignment.

    b) A completed Aircraft Registration Application, FAA Form 8050-1.

    c) A completed Affidavit of Ownership—Amateur-Built Aircraft, FAA Form 8050-88.

    d) A completed Eligibility Statement for Amateur-Built Aircraft, FAA Form 8130-12.

AIRWORTHINESS CERTIFICATION

After one hour of taxi testing has been logged on the finished aircraft, it is time to submit your Application for Airworthiness Certificate and to request an inspection by the FAA. Contact your local FSDO to request an inspection.

So as not to waste the FAA inspector's time (and possibly evoke his or her ire!), you should be absolutely certain that the airplane is ready when you call for the inspection. We recommend having an independent inspection performed by a knowledgeable person, such as an EAA designee, before calling for the FAA inspector. Often, builders are so close to their projects that they inadvertently overlook deficiencies that are obvious to an unbiased observer.

Remedy any deficiencies uncovered by your independent inspector before the FAA inspector arrives, or else the Airworthiness Certificate could be denied. **Keep in mind that the primary objective of the inspections is not just to verify compliance with the law, but to ensure safety**.

In addition to inspecting for acceptable workmanship and construction practices, the FAA inspector will check the airplane for the minimum required instrumentation (see FAR 91.33), instrument range markings, ELT installation, pilot and passenger restraints, properly marked "N" number and the appropriate, permanently installed placards.

The placards required for certification of an experimental, amateur-built aircraft are:

1. The word "**EXPERIMENTAL**," in 2" high block letters, displayed near each entrance to the cabin.

2. A permanently installed, fireproof **identification plate** that is indelibly stamped or engraved with the information required by FAR 45.13. The data plate must be located on the exterior of the aircraft, either just aft of the entry door or on the fuselage near the tail surfaces, and must be legible to a person standing on the ground.

3. A Passenger Warning Placard, permanently installed in the cockpit in full view of all the occupants with the words:

   PASSENGER WARNING—THIS AIRCRAFT IS AMATEUR BUILT AND DOES NOT COMPLY WITH FEDERAL SAFETY REGULATIONS FOR "STANDARD AIRCRAFT"

Also, have the following documents ready for the inspector:

1. An Application for Airworthiness Certificate, FAA Form 8130-6.

2. Enough data (such as photographs or a three-view drawing) to identify the aircraft type. (The three-view drawings at the beginning of this Assembly Manual would suffice.)

3. An Aircraft Registration Certificate, AC Form 8050-3, or the pink copy of the Aircraft Registration Application, AC Form 8050-1.

4. A statement setting forth the purpose for which the aircraft is to be used. In "governmentese," your purpose is most likely to be: "Operating an amateur-built aircraft." (Other possibilities include "Exhibition" and "Air Racing.") The statement should also state the estimated duration of the test period and the areas over which the test will take place. Call your GADO or FSDO for guidance.

5. A notarized statement that the applicant, a) fabricated and assembled the major portion of the aircraft for educational or recreational purposes and, b) has evidence to support the statement available to the FAA upon request. This is where photographs of construction in progress will provide a good supplement to your Assembly Log.

6. Weight and balance data on the finished aircraft.

7. An aircraft log book with evidence of inspections, such as log book entries signed by the builder, describing all inspections conducted during construction of the aircraft. This will substantiate that the construction has been accomplished in accordance with acceptable workmanship methods, techniques, and practices. The Sportsman Assembly Manual with completion of each section signed off in the Assembly Log will suffice.

If no deficiencies are found in the aircraft, and if all the documents are in order, you will be issued a Limited Duration Experimental Airworthiness Certificate and Operating Limitations that will permit you to begin flight testing.

The regulations and paperwork required to get your Sportsman airborne can be daunting in their number and complexity. In general, we would advise you to establish a relationship with your local FSDO early in the construction process and to maintain it through final airworthiness certification. Things are likely to go much more smoothly if you do.

Going for the Gold

Anyone willing to undertake the rewarding experience of constructing his or her own airplane will strive to do the very best job possible. This is important for many reasons, such as function, integrity, cosmetic appearance and safety.

For those aspiring to be considered for one of the prestigious workmanship awards presented at major EAA events, air shows and fly-ins, we've included, on the following page, a reproduction of a typical custom-built judge's evaluation sheet, which was provided by EAA headquarters. Knowing in advance what the judges look for and how they score an aircraft may give you a better idea of where to concentrate your efforts.

Not every Sportsman builder needs to compete for an award. The extra work required to produce an award winner compared to just a nice airplane may not be worth the effort for many builders and has little effect on the flight characteristics or utility of the airplane. If you choose to "go for the gold," however, we wish to arm you with as much ammunition—and as much encouragement—as possible.

CUSTOM BUILT JUDGING **FORM A**

REGISTRATION NO.__________________ **CATEGORY**: PLANS____________
DESIGN NAME_______________________ KITS____________
CLASSIC____________

OPTIONAL INFORMATION: **ENGINE**:
OWNER'S NAME ______________________ MAKE _____________
ADDRESS ____________________________ HP RATING _____________
____

1. OVERALL APPEARANCE .... 1-10 |___|
   Quality of workmanship, neatness, consistency
2. FUSELAGE .... 1-10 |___|
   Quality of workmanship, sound construction practice, innovation and improvements, access for maintenance
3. MAIN LIFTING SURFACES .... 1-10 |___|
   Quality of workmanship, fit and finish, sound construction practice, innovation and improvements
4. EMPENNAGE/PITCH & YAW SURFACES .... 1-10 |___|
   Quality of workmanship, sound construction practices, innovation and improvements, neatness, consistency, fit and finish
5. LANDING GEAR AND BRAKES .... 1-10 |___|
   Quality of workmanship, sound construction practice, innovation and improvements, safety provisions
6. COCKPIT OR CABIN .... 1-10 |___|
   Utilization of instruments and controls, evidence of forethought and planning, safety provisions, neatness, consistency, innovations and improvements, workmanship
7. POWER PLANT AND PROP .... 1-10 |___|
   Safety provisions, sound practice, workmanship, access for maintenance and preflight, innovations, improvements
8. FINISH .... 1-10 |___|
   Consistency and attention to detail
9. PRESENTATION .... 1-10 |___|
   Documentation, builder's log, photo presentation
10. EXECUTION AND INNOVATION .... 1-10 |___|
    Difficulty, theme, judges discretion
11. DOCUMENTATION AND COMPLIANCE WITH FARs YES_____ NO_____

TOTAL .... |___|

POINTS:						
10	Perfect	6	Definitely Above Average	3	Functional
9	Excellent	5	Slightly Above Average	2	Crude
8	Very Good	4	Average	1	Unairworthy
7	Good				

Judge's Remarks: Judge No._______

SAMPLE

THE ADVENTURE BEGINS!

Enough preliminaries—let's roll up our sleeves and get to work! Your Sportsman awaits . . .

GLOSSARY

ACCELERATOR —a chemical added to resin along with the catalyst to accelerate catalysis; not needed when working at higher ambient temperatures; in the case of the vinyl ester resin used in the Sportsman, this chemical is dimethylaniline (DMA). See also "CATALYSIS" and "RESIN."

ACID ETCH — a conversion coating process in which an acidic solution is wiped or sprayed on the surface and then washed off with sprayed water. See also "ALODINE TREATMENT" and "CONVERSION COATING."

AFT — toward the tail of the aircraft. See also "FORWARD."

ALCLAD — a type of sheet aluminum in which an alloy core is clad in a thin layer of pure aluminum to enhance corrosion resistance; used for all Sportsman wing and control surface skins.

ALODINE TREATMENT — a metal preparatory treatment that can be applied after acid etching for increased corrosion resistance and enhanced primer adhesion. See also "ACID ETCH."

BIAS — the orientation of the weave pattern of fiberglass cloth to load paths, measured in degrees from the longitudinal axis of the piece.

BIDIRECTIONAL CLOTH — fiberglass cloth in which the proportion of warp fibers to fill fibers in nearly equal. See also "FILL," "UNIDIRECTIONAL CLOTH," and "WARP."

BLIND RIVET — a rivet that can be both inserted and peened from one side of the work surface; commonly called a "Pop" rivet, after the popular brand manufactured by USM Corporation.

BUCKING — the process of peening the interior end of a standard rivet. See also "BUCKING BAR."

BUCKING BAR — a metal die used in driving bucked rivets. See also "BUCKING."

BUTT LINE — a reference line left or right of and parallel to the aircraft centerline; also called a "BUTTOCK LINE."

CABLE CLAMP — a nut-tightened clamping device that is used to hold components temporarily in desired locations on control cables.

CATALYSIS — the chemical process by which resin cures. See also "CURE."

CATALYST — the chemical that causes resin to cure; this is methyl ethyl ketone peroxide (MEKP) in the case of the vinyl ester resin used in the Sportsman. See also "CURE" and "RESIN."

CHAMFER — a slight bevel in the edge of a part.

CHORD — a straight line from the leading edge to the trailing edge of an airfoil section.

CHORDWISE — in a direction parallel to the chord line of an airfoil.

CLECO — a pin fastener or sheet fastener, which is a type of clamp used in sheet metal work that holds two or more sheets together temporarily by means of a spring-loaded, expandable shank inserted through holes in each piece; "Cleco" is a trade name of the Aerospace Fastener Division of Monogram Industries, but it has become virtually a generic term industry-wide and has therefore been used throughout the text.

CLECO SIDE-GRIP CLAMP — a clamp that temporarily holds two or more sheets together at the edges by means of two spring-loaded, parallel jaws; "Cleco" is a trade name of the Aerospace Fastener Division of Monogram Industries, but it has become virtually a generic term industry-wide and has therefore been used throughout the text.

COBALT – see "PROMOTER."

CONAP – see "PROMOTER."

CONVERSION COATING — a process for preparing a metal surface to enhance primer adhesion.

COUNTERSINKING — the process of drilling out a hole with a beveled bit so that a rivet or screw head can fit flush with a surface.

COVE — the interior of a C-sectioned spar, that is, the area between the flanges. See also "FLANGE" and "SPAR."

CURE — the chemical state of catalyzed resin in which it reaches its full hardness and strength. See also "RESIN."

DBM (DOUBLE-BIAS MAT) CLOTH — a fiberglass cloth made of two uni-directional layers oriented on opposite 45° biases and a so-called 'mat' backing of multi-directional fibers. DBM produces stronger secondary bonds than standard bi-directional cloth and is therefore used in seaming the Sportsman fuselage shells together, as well as in other applications.

DEBURRING — the process of removing the sharp burrs of metal left behind after drilling or shearing.

DIMPLING — the process of introducing a slight inward deflection around the edges of a hole drilled in thin aluminum sheet; functionally equivalent to COUNTERSINKING.

DMA — see "ACCELERATOR."

EXOTHERMIC REACTION — a chemical reaction (e.g., the curing of resin) that releases energy in the form of heat.

FIBERGLASS — the trade name for glass fibers (consisting mainly of silicon, calcium and aluminum dioxides) woven into various types of cloth. See also "BIDIRECTIONAL CLOTH" and "UNIDIRECTIONAL CLOTH."

FILL — the direction on a piece of fiberglass cloth with the lesser percentage of fibers and, therefore, of strength. See also "WARP."

FLANGE — with regard to ribs and spars, the surfaces that are parallel to the skins they support. See also "WEB."

FOAM CORE — plastic foam used as a substrate onto which fiberglass laminates are applied to produce stiff, lightweight structures; also used to refer to the construction method using such foam cores. See also "LAMINATE."

FORWARD — toward the nose of the aircraft. See also "AFT."

GEL COAT — a durable, opaque, pigmented finish on the exterior surface of fiberglass parts. The white gel coat used on all of the Sportsman's fiberglass components is a two-part, catalyzed material that is applied to the mold before the part is laid up to become an integral part of the laminate.

GEL TIME — the time it takes a batch of resin to begin gelation. See also "GELATION."

GELATION — the chemical process by which resin begins to solidify after catalysis. See also "CATALYSIS" and "RESIN."

GREEN CURE — the point at which a laminate becomes hard enough to be cut with a knife; usually reached from 15—45 minutes after gelation, depending on temperature. See also "CATALYSIS" and "CURE."

HAT SECTION — an informal term used throughout the manual for the skin stiffeners used in the Sportsman wing, so called because of their cross-sectional shape. See also "STIFFENER."

HOLLOW-SHANK RIVET — see "BLIND RIVET."

INBOARD — toward the center of the aircraft in a spanwise direction. See also "OUTBOARD" and "SPANWISE."

JIG — a temporary structure built to hold parts of an assembly in the proper position during fabrication.

JOGGLE — an offset flange bent into the edge of a sheet (as, for example, on the trailing edges of the elevator skins) to add torsional stiffness and to provide a riveting surface.

LAMINATE — one or more layers of fiberglass cloth impregnated with cured resin; or the process of producing such a laminate. See also "FIBERGLASS" and "RESIN."

LAY-UP — one or more layers of fiberglass cloth being saturated with resin; or a synonym for the verb laminate. See also "LAMINATE" and "RESIN."

LEADING EDGE — specifically, the skin around the forward edge of the wing and tail surfaces; generally, the edge of a part nearest the nose of the aircraft. See also "TRAILING EDGE."

LEFT — the position or direction relative to the centerline of the aircraft corresponding to the pilot's left when seated facing the nose of the aircraft. See also "LEFT-SIDE."

LEFT-SIDE — left; used occasionally in the manual when the term "left" alone might be confusing. See also "LEFT."

MANUFACTURED HEAD — the head of a rivet (usually round or flush) that retains its original shape throughout the riveting process.

MILL FIBERS — very short, chopped strands of fiberglass resembling grayish lint. See also "FIBERGLASS."

NICOPRESS — a tool manufactured by the National Telephone Supply Company that allows full-strength cable splices to be made without complex manual splicing or swaging procedures. See also "SWAGING."

OUTBOARD — away from the center of the aircraft in a spanwise direction. See also "INBOARD" and "SPANWISE."

PASS DRILLING — the process of drilling a hole to final diameter through two or more contiguous pieces of material. See also "PILOT HOLE."

PILOT HOLE — an undersized hole drilled or punched through a piece of material for use as a drill guide for later drilling to final diameter.

PIN FASTENER — see "CLECO."

PLUMB — precisely aligned relative to one or more reference axes, most often the vertical axis.

POP RIVET — see "BLIND RIVET."

PROMOTER — a chemical added to resin before the catalyst to promote catalysis; necessary for resin to cure properly; in the case of the vinyl ester resin used in the Sportsman, this chemical is cobalt naphthenate (CoNap or cobalt). See also "ACCELERATOR."

PULL RIVET — see "BLIND RIVET."

PVA — polyvinyl alcohol; a green, water-based coating used as a mold release agent; may be found on the outer surface of factory-molded parts; can be easily removed with water.

Q-CELL — an inorganic micro-sphere (glass bubble); mixed with resin to form a lightweight, sandable sealing or filling paste for foam panels, cracks, etc. See also "RESIN."

REAMING — the process of deburring the interior circumference of a hole by means of a special hand or power tool. See also "DEBURRING."

RESIN — a chemical used to impregnate fiberglass cloth to produce laminates; in the Sportsman, vinyl ester resin is used. See also "FIBERGLASS" and "LAMINATE."

RIB — a structural member of a wing or tail surface that extends in a chordwise direction.

RIGHT — the position or direction relative to the centerline of the aircraft corresponding to the pilot's right when seated facing the nose of the aircraft. See also "RIGHT-SIDE."

RIGHT-SIDE — right; used occasionally in the manual when the term "right" alone might be confusing. See also "RIGHT."

RIVET SET — a die used with a rivet gun to drive rivets; each set is designed for a particular shape and size of rivet head.

ROOT — the location where a wing or tail surface meets the fuselage. See also "TIP."

SAFETYING — the process of securing aircraft fasteners (such as nuts, pins, turnbuckles, etc.) against unintended loosening, usually accomplished with wire or specially designed safety pins.

SHEAR — mechanical stress in a direction so as to cause two parts or two layers of a material to slide relative to each other; for example, a shear load on a bolt holding two sheets together is perpendicular to the longitudinal axis of the bolt See also "TENSION."

SHEET FASTENER — see "CLECO."

SHOP HEAD — the head of a rivet that is "upset," that is, the head that is deformed in the riveting process to secure the rivet.

SPANWISE — in a direction parallel to the span of the wing.

SPAR — a structural member of a wing or tail surface that extends in a spanwise direction.

SPRING CLAMP — see "CLECO SIDE-GRIP CLAMP."

STATION — a location reference specified by a distance from a datum point; on the Sportsman, wing stations are measured spanwise from the aircraft centerline, and fuselage stations are measured from an imaginary plane 58" forward of the cowling mounting flange joggle.

STIFFENER — a structural part that, when riveted to a sheet metal surface, provides increased torsional rigidity to that surface. See also "TORSION."

SWAGING — a process for attaching terminals to cable ends in which a sleeve on the terminal is compressed around the cable in a special press under such high pressure that the metal of the sleeve infiltrates among the strands of the cable, producing a splice as strong as the cable itself. See also "TERMINAL" and "TERMINAL SPLICE."

TENSION — mechanical stress in a direction so as to elongate a part; for example, a tension load on a bolt is parallel to the longitudinal axis of the bolt See also "SHEAR."

TERMINAL — a piece of hardware (such as an eye, clevis or turnbuckle shank) attached to a cable end to allow fastening the cable to another piece of hardware (such as a bellcrank, turnbuckle barrel or another terminal).

TERMINAL SPLICE — the attachment of a terminal to a cable end, usually either by NicoPressing or swaging. See also "NICOPRESS" and "SWAGING."

THIMBLE — a metal channel formed in the shape of a closed horseshoe, around which a cable end is wrapped to form a NicoPressed terminal eye splice. See also "NICOPRESS" and "TERMINAL SPLICE."

TIP — the end of a wing or tail surface furthest from the fuselage. See also "ROOT."

TORSION — motion in a twisting direction.

TRAILING EDGE — the edge of a part nearest the tail of the aircraft. See also "LEADING EDGE."

UNIDIRECTIONAL CLOTH — fiberglass cloth in which the ratio of warp fibers to fill fibers is very large. See also "FILL," "BIDIRECTIONAL CLOTH," and "WARP."

WARP — the direction on a piece of fiberglass cloth with the greater percentage of fibers and, therefore, of strength. See also "FILL."

WATERLINE — a horizontal reference plane running longitudinally through the fuselage.

WEB — with regard to ribs and spars, the surfaces that are perpendicular to the skins they support. See also "FLANGE."

WORKING TIME — the time after a resin is catalyzed but before it begins to gel, i.e., the time during which it can be applied successfully. See also "CATALYSIS," "GELATION," and "RESIN."

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ASSEMBLY LOG

Sign and date the appropriate line below as you complete each section.

Rudder Assembly

Preparing the Parts—Completed: (Steps 1 and 2)

Signature: ______________________________ Date: ______

Fabricating the Rudder Jig—Completed: (Steps 3 —5)

Signature : ______________________________ Date: ______

Preliminary Assembly of the Structural Framework—Completed: (Steps 6 — 10)

Signature: ______________________________ Date: ______

Preliminary Assembly of the Skins to the Structural Framework—Completed: (Steps 11 — 14)

Signature: ______________________________ Date: ______

Pre-Closeout Inspection Performed:

Signature: ______________________________ Date: ______

Final Rudder Assembly—Completed: (Steps 15 — 22)

Signature: ______________________________ Date: ______

Horizontal Stabilizer Assembly

Positioning and Drilling—Completed: (Steps 1 — 19)

Signature: ____ Date: ______

Pre-Cover Inspection Performed:

Signature: ____ Date: ______

Final Assembly—Completed: (Steps 20 —32)

Signature: ____ Date: ______

Elevator Assembly

Preliminary Assembly—Completed: (Steps 1 — 20)

Signature: Date:

Main Structure—Completed: (Steps 21 — 44)

Signature: Date:

Pre-Cover Inspection Performed:

Signature: Date:

Main Structure Riveting–Completed: (Steps 45 —60)

Signature: Date:

Trim Tab–Completed: (Steps 61 —71)

Signature: Date:

Pre-Cover Inspection Performed:

Signature: Date:

Trim Tab Riveting–Completed: (Steps 72 —77)

Signature: Date:

Elevator Hinges–Completed: (Steps 78 —84)

Signature: Date:

Elevator Assembly (continued)

Trim Tab Hinge—Completed: (Steps 85 —88)

Signature: Date:

Hinge Riveting—Completed: (Steps 89 —92)

Signature: Date:

Wing Assembly

Fabricate the Wing Jig—Completed: (Steps 1 — 3)

Signature: Date:

Assemble the Wing Spars—Completed: (Steps 4 —14)

Signature: Date:

Fabricate the Wing Jig—Completed: (Steps 1 — 3)

Signature: Date:

Assemble the Wing Spars—Completed: (Steps 4 —14)

Signature: Date:

Mount the Spars in the Jig—Completed: (Steps 15 — 16)

Signature: Date:

Mount the Ribs and Strut Beam Assembly to the Spars—Completed:
(Steps 17 —22)

Signature: Date:

Fit Up and Drill the Wing Skins—Completed: (Steps 23 — 33)

Signature: ______________________________ Date: ______

Install the Hat Section Stiffeners, Forward Spar Cap Strips and Lower Center Skin Stiffeners—Completed: (Steps 34 —40)

Signature: ______________________________ Date: ______

Dimple the Skins and Countersink the Forward Spar Flanges—Completed: (Steps 41 — 43)

Signature: Date:

Assemble the Aileron Hinges—Completed: (Steps 44 — 45)

Signature: Date:

Assemble the Aileron Bellcrank and Mount the Hinges and the Bellcrank—Completed: (Steps 46 — 50)

Signature: Date:

Fabricate and Mount the Aileron Pulley Brackets—Completed: (Steps 51 — 52)

Signature: Date:

Assemble and Mount the Flap Tracks—Completed: (Steps 53 — 54)

Signature: Date:

Assemble and Mount the Flap Bellcrank—Completed: (Steps 55 — 58)

Signature: Date:

Fabricate and Install the Flap Pulley Brackets—Completed: (Step 59)

Signature: Date:

Rivet the Ribs and the Leading-Edge and Lower Skins—Completed: (Steps 60 — 66)

Signature: Date:

Aileron and Flap Assemblies

Aileron Positioning and Drilling—Completed: (Steps 1 — 21)

Signature: ______________________________ Date: ________

Aileron Pre-Cover Inspection Performed :

Signature: ______________________________ Date: ________

Aileron Riveting—Completed: (Steps 22 — 35)

Signature : ______________________________ Date: ________

Flap Component Preparation—Completed: (Steps 36 —40)

Signature : ______________________________ Date: ________

Flap-Track and Deployment Arm Installation—Completed: (Steps 41 — 47)

Signature: ______________________________ Date: ________

Flap Skin Positioning and Drilling—Completed: (Steps 48 — 57)

Signature: ______________________________ Date: ________

Flap Pre-Cover Inspection Performed:

Signature: ______________________________ Date: ________

Flap Main Structure Riveting—Completed: (Steps 58 — 65)

Signature: ______________________________ Date: ________

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Fuselage Assembly

Component Preparation—Completed: (Steps 1 — 7)

Signature: Date:

Fitting Fabrication—Completed: (Steps 8 —12)

Signature: Date:

External Structure—Completed: (Steps 13 — 32)

Signature: Date:

Internal Structure—Completed: (Steps 33 —85)

Signature: Date:

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Systems Installation

Rudder Control Assemblies Installation—Completed: (Steps 1 — 8)

Signature: ____ Date: ________

Control Stick Assembly Installation—Completed: (Steps 9 —10)

Signature: ____ Date: ________

Flap Handle Assembly Installation—Completed: (Steps 11 — 12)

Signature: ____ Date: ________

Fuselage Control System Pulleys Installation—Completed: (Steps 13 — 20)

Signature: ____ Date: ________

Rudder Control Cables Installation—Completed: (Steps 21 — 22)

Signature: ____ Date: ________

Elevator Pushrod and Control Cables Installation—Completed: (Steps 23 — 25)

Signature: ____ Date: ________

Mounting the Wings to the Fuselage—Completed: (Steps 26 — 35)

Signature: ____ Date: ________

Mounting the Flaps to the Wing—Completed: (Steps 36 — 37)

Signature: ____ Date: ________

Mounting the Ailerons to the Wing—Completed: (Steps 38 — 39)

Signature: ____ Date: ________

Flap Control Cables Installation—Completed: (Steps 40 — 43)

Signature: ______________________________ Date: ________

Aileron Control Cables Installation—Completed: (Steps 44 — 46)

Signature: ______________________________ Date: ________

Control Cable Retainers Fabrication and Installation—Completed:
(Steps 47 —48)

Signature: ______________________________ Date: ________

Preliminary Fuel Tank Installation—Completed: (Steps 49 — 58)

Signature: ______________________________ Date: ________

Wing Plumbing, Wiring and Other Miscellaneous Stuff—Completed:
(Steps 59 —65)

Signature: ______________________________ Date: ________

Main Gear Leg Installation—Completed: (Steps 66 — 68)

Signature: ______________________________ Date: ________

Main Gear Wheel and Brake Installation—Completed: (Steps 69 —75)

Signature: ______________________________ Date: ________

Nose Gear Installation (Optional)—Completed: (Steps 76 — 89)

Signature: ______________________________ Date: ________

Tailwheel Installation (Optional)—Completed: (Steps 90 —102)

Signature: ______________________________ Date: ________

Brake System Plumbing—Completed: (Steps 103 — 106)

Signature: Date:

Fuselage Fuel System Plumbing—Completed: (Steps 107 —112)

Signature: Date:

Manual Elevator Trim System Installation (Optional)—Completed:
(Steps 113 — 118)

Signature: Date:

Miscellaneous Fuselage Plumbing and Wiring—Completed: (Steps 119 —123)

Signature: Date:

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Final Assembly

Firewall Installation–Completed: (Steps 1 — 6)

Signature: Date:

Firewall Forward–Completed: (Step 7)

Signature: Date:

Interior Installation–Completed: (Steps 8 — 28)

Signature: Date:

Fuselage Fairing Installation–Completed: (Steps 29 — 46)

Signature: Date:

Gear Fairing Installation–Completed: (Steps 47 — 73)

Signature: Date:

Wing Pre-Closure Inspection Performed:

Signature: Date:

Final Wing Assembly–Completed: (Steps 74 — 102)

Signature: Date:

Door Installation–Completed: (Steps 103 — 128)

Signature: Date:

Top Deck Installation–Completed: (Steps 129 — 146)

Signature: Date:

Instrument Panel Installation—Completed: (Steps 147 — 158)

Signature: Date:

Window Installation—Completed: (Steps 159 — 163)

Signature: Date:

Control Surface Balancing and Fairing Installation—Completed: (Steps 164 — 176)

Signature: Date:

Final Control System Rigging—Completed: (Steps 177 — 186)

Signature: Date:

Miscellaneous Final Assembly Details—Completed: (Steps 187 — 194)

Signature: Date:

Systems Check-Out—Completed: (Steps 195 — 202

Signature: Date:

Fastener Inspection and Safetying—Completed: (Steps 203— 216

Signature: Date:

Weight and Balance—Completed: (Steps 217 — 222)

Signature: Date:

SECTION II: TOOLS AND TECHNIQUES

This section of the *Assembly Manual* describes the tools and construction techniques required to build the Sportsman. It describes metal fabrication, riveting, fiberglass laminating and other fabrication procedures. Refer to this section frequently when fabricating the individual assemblies described later.

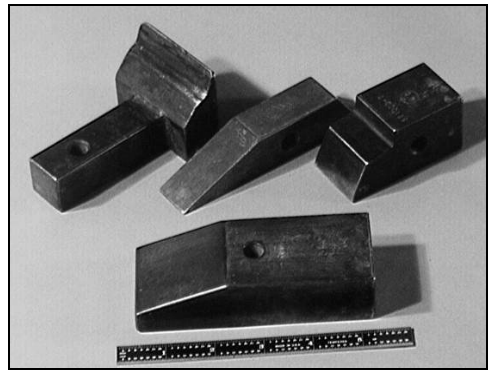


Figure 1: Bucking Bars

None of the procedures described here is difficult to learn, especially if you have some experience using basic hand and power tools. If a particular procedure is new to you, however, practice on scrap material to develop your skill before risking damage to the airframe components. To help you with this, we have supplied a **sheet metal practice kit** (P/N 075-00001-01) in your Sportsman kit. The kit consists of small pieces of aluminum sheet of various thicknesses so you can practice procedures such as riveting, dimpling and countersinking.

Besides studying the techniques described here, also refer to the publications listed under "RECOMMENDED READING" in "SECTION I: INTRODUCTION." This is your opportunity to learn as much as possible about aircraft fabrication in order to build the best Sportsman that you can. If nothing else, studying the various aviation mechanic's handbooks and shop manuals will give you an appreciation of how much of the Sportsman assembly work has already been done for you!

TOOLS REQUIRED TO BUILD THE SPORTSMAN

This tool list is not meant to be exhaustive; as you work on your Sportsman, you will undoubtedly think of other useful tools to procure. You may already have some favorite tools not listed here that you find indispensable. If you live in a normal household, you will probably already have many of the tools on the "*General Purpose Tools*" list; if you are an experienced airplane homebuilder, some of the more specialized tools will also be familiar. Brief descriptions of the less common or less familiar tools needed to assemble the Sportsman are provided here; for more detailed descriptions of the tools and their proper use, refer to the various Techniques sections, which follow the tool list. Some, if not most, of the tools on the "*Sheet Metal Tools*" and "*Special Tools*" list will be unavailable at your local hardware store. We will be stocking some of these tools; for the rest, contact the suppliers listed below to order catalogs.

Sources for Special Tools

Options Catalog, Glasair Aviation LLC
18701 - 58th Ave., N.E.
Arlington, WA 98223
(360) 435-8533
Fax (360) 435-9525

Aircraft Spruce and Specialty
Box 424
Fullerton, CA 92632
(800) 824-1930
Fax (714) 871-7289

U.S. Industrial Tool and Supply
15101 Cleat St.
Plymouth, MI 48170
(800) 521-7394/4800
Fax (313) 455-3256

Wicks Aircraft Supply
410 Pine St.
Highland, IL 62249
(800) 221-9425
Fax (618) 654-6253

Clinton Aircraft Tool & Supply, Inc.
3399-3405 Harrison Rd.
East Point, GA 30344
(404) 766-3222
Fax (404) 766-3809

Avery Enterprises, Inc.
Hicks Airfield
2290 W. Hicks Road
Hangar 54-1
Fort Worth, TX 76131
(800) 652-8379
Fax (817) 439-8402

Cleveland Aircraft Tool and Material
1804 First St.
Boone, IA 50036-4417
(515) 432-6794
Fax (515) 432-7804

General Purpose Tools

1. Tape measure, 16' (both decimal and fractional graduations recommended)
2. 12" steel decimal/fractional ruler
3. Dial or vernier caliper (optional)
4. Digital level, accurate to 1/2° (strongly recommended) or carpenter's level (acceptable)
5. Carpenter's framing square
6. Tr- square
7. Protractor
8. Straightedges of various lengths up to 10' (ruler, level and squares will work for shorter straightedges)
9. Plumb bob
10. Fine-point felt-tip marking pens ("Sharpie" brand works well)
11. 3/8" electric drill (cordless with a keyless chuck recommended) or air drill (high speed: 3000+ rpm). An air drill is best for drilling aluminum because of its high speed.
12. Small drill bit set (see also "*Sheet Metal Tools*")
13. Die grinder (recommended). This is a small, hand-held, air-powered tool that turns at a very high speed. It has a special chuck to hold rotary files, drum sanders or cut-off wheels and is very useful for a variety of grinding, sanding or cutting operations, especially in fiberglass construction.
14. Rotary files, drum sanders and fiber cut-off wheels for drill motor or die grinder (recommended)
15. Scroll saw (optional). Useful for cutting out small, intricately-shaped parts.
16. Assorted files

General Purpose Tools (Continued)

17. Assorted clamps: C-clamps, spring clamps, etc.
18. Portable work light. A fluorescent light is preferred because it generates less heat and is therefore less likely to burn fiberglass laminates (or you!).
19. Flashlight
20. Common hand tools: wrenches, screwdrivers, pliers, hammers, etc.

Sheet Metal Tools

1. Drill bits in the following sizes: #10, 11, 19, 21, 27, 30 and 40; letters D, F, O, U and V; and standard twist drills of 1/16", 11/64", 3/16", 1/4", 11/32", 3/8", 13/32", 7/16", 1/2" and 9/16". The number 30 and 40 bits (both 3" and 6" lengths) are most frequently used because they are the correct size to drill rivet holes for 1/8" and 3/32" rivets, respectively.
2. 3/32" diameter Clecos, 250 minimum. Clecos—also called "sheet fasteners," "pin fasteners" or "sheet holders"—are small, spring-loaded clamps that engage holes drilled in two or more parts to fasten the parts together temporarily. Special pliers that compress the spring are used to insert a Cleco into the hole. Our experience is that "Cleko-loc" or "Kwik-loc" brand Clecos work best.
3. 1/8" diameter Clecos, 200 minimum
4. 5/32" and 3/16" Clecos, about 15 of each

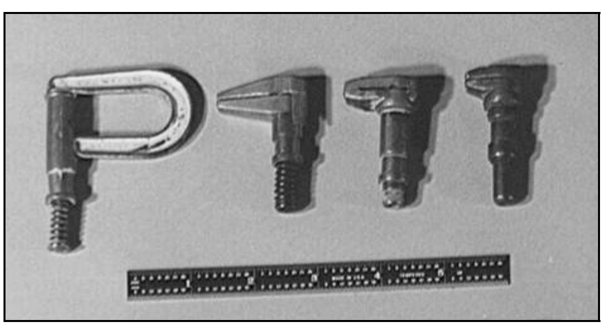


Figure 2: Assorted Side Grip Clamps

5. Cleco side-grip clamp fasteners, assorted grip lengths. These are small, spring loaded clamps that are operated by Cleco pliers and used to hold parts together before any rivet holes have been drilled. Ten to twenty of these should be enough.

Sheet Metal Tools (Continued)

6. Cleco pliers

7. Reamers are not required, but are nice to have when trying to obtain close tolerance holes. The standard sizes would be (3/16, 1/4, 5/16, 3/8, 7/16, and 1/2 inch diameters.) Purchase these on an as needed basis.

8. Metal-cutting hole saws in the following sizes: 1", 1-1/4", 2-5/8", 3" and 3-5/8"; or an adjustable fly-cutter

9. Machine stop countersink tool with 1/8", 3/32" and 5/32" pilots and 100° countersink bits. This tool holds a piloted countersink bit and has an adjustable, telescoping sleeve that controls the depth of the cut.

10. A 120° countersink cutter with a 1/8" or #30 pilot for installing flush-head blind rivets. This tool is available from Glasair Aviation LLC; order P/N 081-02001-01.

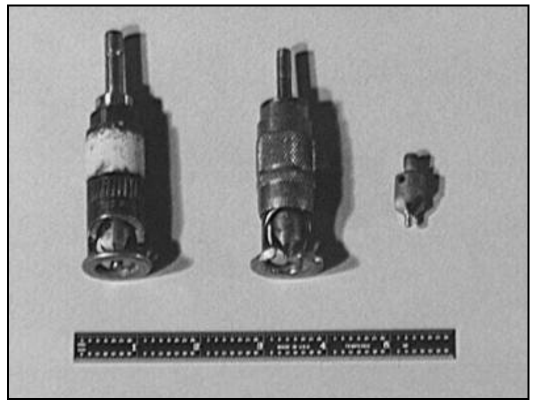


Figure 3: Stop Countersink Tools with Bit

Warning The 120°countersink cutter should be used **only** for the flush-head blind rivets used in installing the flap skin doublers in "SECTION VII: AILERON AND FLAP ASSEMBLIES." Use of this cutter for countersinking holes for standard, 100° flush-head rivets will compromise the strength of these rivets.

11. Rivet shaver (recommended). This is a bit that fits in a microstop cage and is typically used for shaving the heads of poorly set flush rivets but is also very useful for removing the broken mandrel ends that often remain protruding above the heads of Cherry AAPQ blind rivets after they have been pulled. A fine-tooth file will do the same job but requires more care and time.

Sheet Metal Tools (Continued)

12. Center punch. A hardened steel tool with a cone-shaped point, used to make a small divot in a piece of metal at the location where a hole is to be drilled. The divot keeps the drill bit from wandering when the hole is started. The simplest center punch is held in position with one hand and struck with a hammer. Also available are automatic center punches which have an internal spring-loaded hammer; the point of the tool is pressed against the work with one hand, which compresses the spring to cock the hammer mechanism. When the pressure reaches a certain point, the hammer is released to drive the point into the work.

13. 3/32", 1/8" and 3/16" pin punches. Used mostly for removing defective rivets.

14. Air compressor. Choose a compressor capable of generating at least 75 psi. A large air storage tank is preferable, especially if you are using an air-powered drill or a die grinder, as this will minimize the amount of time that the compressor is running while you are working.

15. 2X rivet gun. This size gun is appropriate for driving **all** the rivets used in the Sportsman, and we do not recommend the use of any other size gun.

16. 3/32" and 1/8" universal head rivet sets. One end fits the rounded, manufactured head of a universal head rivet; the other end is inserted into a rivet gun for driving the rivet.

17. Flush rivet set for countersunk rivets. Used in a rivet gun like the universal head sets, the flush rivet set has a large flat end to fit against the flat head of countersunk rivets.

18. Fluting pliers (optional). This is a useful tool for straightening ribs.

19. Rivnut installation tool, size 8-32. Rivnuts are female-threaded fasteners installed like a blind rivet—the installation tool mushrooms the interior portion of the rivnut collar against the inside surface of the skin, locking the collar securely in place. Required for installing the rudder base fairing, this tool is available from Glasair Aviation LLC; order P/N 081-01001-01.

Sheet Metal Tools (Continued)

20. Assorted bucking bars. A bucking bar is simply a heavy, smooth piece of steel that fits against the tail of a rivet when the head is being driven with a gun-mounted set. The vibrations of the rivet against the bucking bar cause the tail to spread out and flatten, forming the "shop head" of the rivet. Bucking bars are made in a variety of sizes and shapes to fit the various locations where rivets are to be driven. Our experience shows that three different styles of bucking bars are sufficient to complete all riveting on the Sportsman. Sources of these three styles are given below. However, the choice of an appropriate bucking bar for a particular riveting situation is not an exact science; individual riveters will find different styles most useful in different situations. That having been said, we recommend either of the following sets of three (or their equivalents):

   From Aircraft Spruce & Specialty, bar numbers TP-638, AT-721 or TP-647, and TP-760B-1.

   From U.S. Industrial Tool and Supply Co., bar numbers TP-638, TP-721 and TP-760B-1.

21. Blind rivet puller. A pliers-like tool used to form "blind" or "pull" rivets. Sometimes called a "Pop" rivet puller.

22. Sheet metal snips ("Prosnip" type aviation **offset** snips recommended); straight, left and right cutting. Choose snips with smooth rather than serrated blades as these require less work to smooth the edge after the cut has been made.

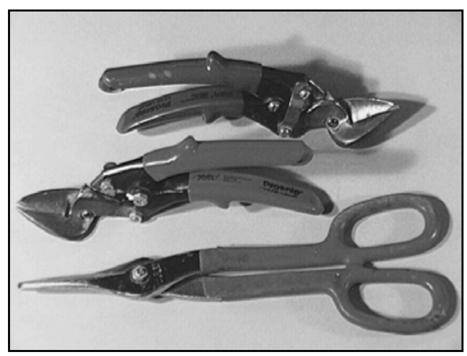


Figure 4: Offset and Straight Snips

Sheet Metal Tools (Continued)

23. (This tool deleted by previous revisions.)

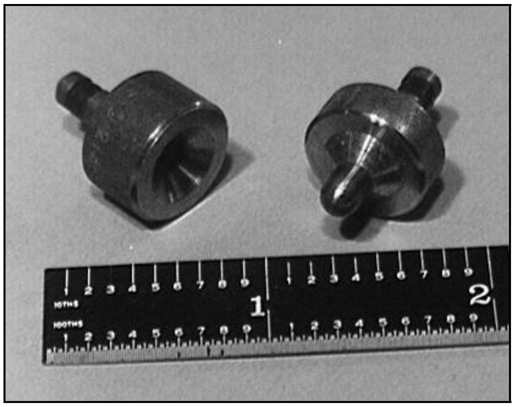


Figure 5: Dimple Dies

24. 3/32" and 1/8" dimple dies. These tools, consisting of matched male and female dies, are used to form thin sheet metal to accommodate countersunk rivets. The male die or punch is cone shaped to match the shape of the rivet head and has a small concentric pilot shaft that fits into the female die and matches the diameter of the rivet hole. The female die has a corresponding degree of countersink into which the male die fits. The sheet to be dimpled fits between the two dies; the dimple is formed by pressing the male die into the female die using either a rivet gun, a rivet squeezer or a bench-mounted riveting frame.

25. Chip chaser. This is a thin, hooked blade mounted in a handle. It is used to remove metal chips or shavings from between metal sheets that cannot be disassembled for cleaning.

26. Duck bill pliers (with the jaws taped to prevent damage to aluminum parts). Pliers with wide, flat jaws, used to straighten flanges on ribs and spars or to adjust bends in other metal parts.

Rivet squeezer (highly recommended). This is a pliers-like tool used to set rivets near the edges of sheets. It has a pair of sets that fit into the jaws of the tool, between which the rivet is compressed to form the shop head. A rivet squeezer is easier to use than a rivet gun and bucking bar and produces more consistent results.

Sheet Metal Tools (Continued)

28. #30 and 40 drill stops (optional). A device which fastens to a drill bit with a set screw to limit the penetration of the bit into the material. Helps prevent both damage to underlying structure and broken drill bits.

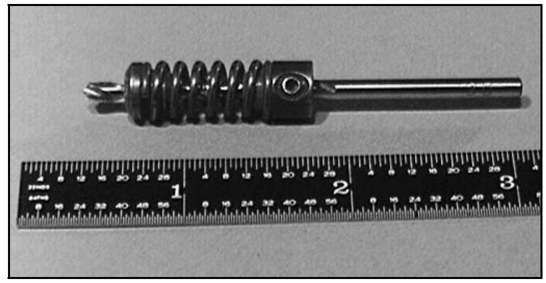


Figure 6: Drill Stop

29. Rivet cutter (optional). This is like a heavy-duty wire cutter and is used to shorten longer rivets to the correct length for a particular application. Usually has an adjustable stop to control the finished length of the rivet.

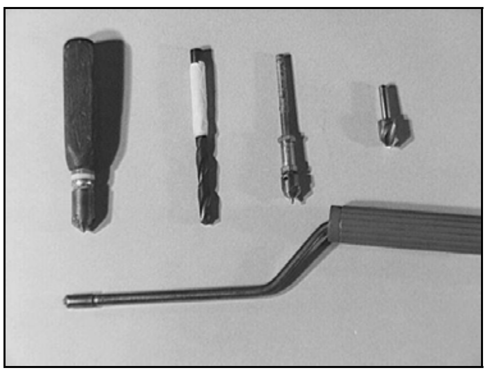


Figure 7: Hole Deburring Tools

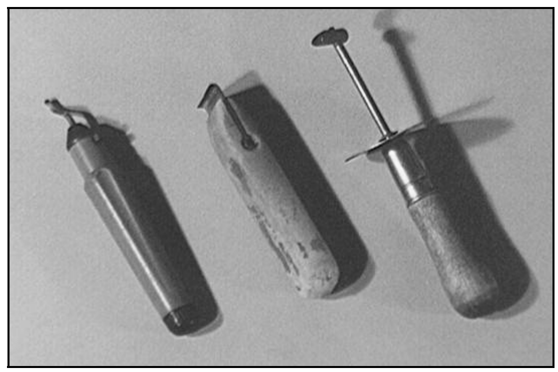


Figure 8: Edge Deburring Tools

30. Deburring tools for both edges and holes. An edge deburring tool is a hardened steel blade set in a handle and is used to remove the sharp burrs from the edges of metal sheets. A hole deburring tool removes the burr from holes drilled in aluminum. You can use a large drill bit or a countersink bit to deburr holes, but it is nice to have the tool mounted in a handle to expedite the operation.

Sheet Metal Tools (Continued)

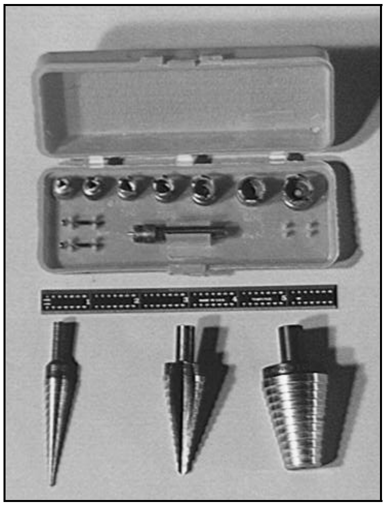


Figure 9: Blair Hole Cutter Set and Unibits

31. Blair hole cutter or Unibits (optional). A Blair hole cutter is a miniature hole saw; Unibits are special drill bits. Both tools make it easy to drill round, clean holes in thin aluminum sheet (a process that is difficult with standard drill bits for holes over about 1/4" diameter). The Unibits incorporate cutting steps of progressively larger diameter, so you can drill a number of different size holes with a single bit. We recommend a #1 Unibit (for holes from 1/8" through 1/2" diameters in 1/32" steps) and a #3 Unibit (for holes from 1/4" through 3/4" in 1/8" steps).

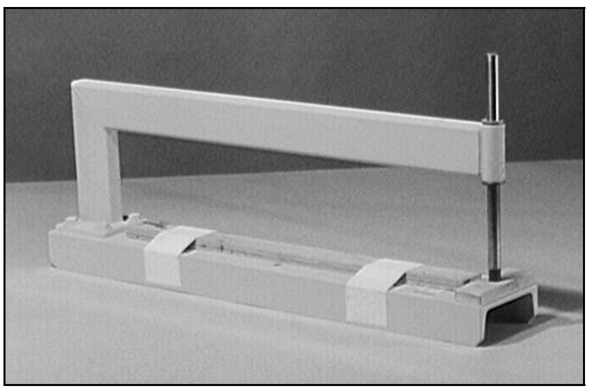


Figure 10: Riveting Frame

32. Riveting/dimpling frame (optional). This is a large, bench-mounted, C-shaped frame designed to hold rivet squeezer sets and dimple dies; the rivet is set or the dimple is formed by hitting the tool holder with a hammer. Since the sets and dies are held rigidly in the correct relationship to each other, it is relatively easy to achieve consistent, high-quality results. The frame has a throat depth of approximately 18" so, unlike the rivet squeezer, it can be used a considerable distance from the edge of a part.

Fiberglass Tools

1. Gram scale, 0-500 grams. Used to measure resin for laminating.
2. 5cc syringe, without needle. With the hole plugged, used like a graduated cylinder to measure promoters and catalyst.
3. Rubber squeegee. Used for laminating large flat surfaces.
4. 1" and 2" wide varnish brushes. Used for laminating smaller surfaces and convoluted shapes where a squeegee will not work.
5. Unwaxed mixing cups and mixing sticks (tongue depressors). Unwaxed cups are required to prevent contamination of the resin.
6. Heavy-duty scissors for cutting fiberglass materials.
7. Razor trim knife. This is just the standard utility knife or “box cutter.” Used to trim fiberglass cloth in the “green cure” condition.
8. 50, 60, 80, 180, 220, 320, 400, and 600 grit sandpaper and sanding blocks
9. Rotary cloth cutter (optional). Similar to a pizza cutter—a sharp, circular, steel blade that is rolled across fiberglass cloth. Since the cloth remains flat on the table (it should be on a wood or soft plastic surface to prevent damage to the blade), the cut is made without distorting or fraying the cloth. A rotary cloth cutter makes especially good curved cuts.

Special Tools

1. Paint spray gun

2. Right angle drill motor or adapter with bits for drilling in tight spaces where access with a regular drill is difficult or impossible

3. NicoPress crimping tool. The control cables in the Sportsman are secured at their ends by doubling the cable back on itself and crimping a copper sleeve over the doubled cable to form an eye. The NicoPress tool crimps the copper sleeves.

4. Cable tensiometer. Used to adjust control cables to the proper tension. (This is a very expensive tool; we recommend trying to borrow one from a local A&P or EAA chapter.)

5. Tubing cutter

6. Crimping tool for insulated electrical wiring connectors

7. Wire strippers

8. Soldering pencil. Use a low-wattage type (≤30W) to prevent damage to delicate electronic components. Avoid heavy soldering irons or guns.

9. Heat gun (hair dryer) for shrinking heat-shrink tubing in the electrical system and (optionally) on the control cables. Can also be used (carefully) to expedite curing of fiberglass laminates.

Safety Equipment

1. Fire extinguisher
2. Hearing protectors. Strongly recommended when riveting with a rivet gun.
3. Safety goggles or eye shield. Eye protection is needed when grinding metal on a bench grinder, when using a die grinder and when handling the MEKP catalyst for vinyl ester resin
4. Particle masks for protection from dust generated by sanding or grinding.
5. Paint spray respirator mask for protection from chemical vapors and solvent fumes.
6. Ventilation fan

Recommended Optional Tools

1. Bench grinder. In addition to its many other uses, a bench grinder with a Scotch Brite wheel can be used to deburr the edges of small parts.
2. Combination belt and disc sander. This is a very handy tool for finishing the edges of small metal parts.
3. Drill press
4. Band saw
5. Hot-melt glue gun. Used to temporarily hold parts together, especially for fiberglass lamination, in areas where they cannot be clamped. Hot glue can be removed easily using a heat gun; acetone will take care of any remaining residue.
6. Vise

Aluminum Sheet Metal Work

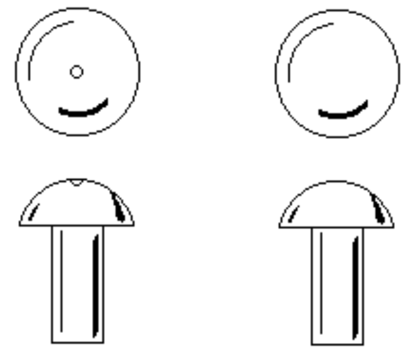
Since the entire wing, the horizontal stabilizer and all of the control surfaces are made from sheet aluminum (with some aluminum angle for reinforcement), aluminum sheet metal work obviously forms a major part of the Sportsman assembly project. If you have never worked on a sheet aluminum airplane before, you will find that it involves a relatively small number of easily learned skills performed repetitively. We provide a detailed description of the necessary metalworking skills in this section of the *Assembly Manual*; we will not repeat the detailed descriptions in later parts of the manual, but instead will assume you already know how to perform the procedures. Until you develop some facility with the various procedures, refer to this section often for review. We also recommend further study, using the publications listed in "Recommended Reading" in "Section I: Introduction."

Rivet Terminology

Before describing sheet-metal aircraft construction, here is a brief discussion of the various terms used to describe rivets. Most of the rivets used in the Sportsman are the round-headed variety known as "universal-head rivets." Some flat-headed, "countersunk" or "flush-head rivets" are also used. The end of the rivet formed by the factory during manufacture—the round head of universal-head rivets and the flat head of flush-head rivets—is called the "manufactured head" or, simply, the "head." The long, cylindrical part of the rivet is called the "shank." The end of the shank opposite the head is called the "tail." Driving a rivet, either with a rivet gun and bucking bar or with a rivet squeezer, causes the tail to spread out and flatten, forming the "shop head" of the rivet. The shop head, even after forming, can still be referred to as the "tail."

A special type of rivet is used in areas that are accessible from only one side for installation. These are called "blind" rivets—because the shop head is not visible during or after forming—or "pull" rivets—because the shop head is formed by pulling a solid "mandrel" or "stem" into the hollow rivet shank from the accessible side. These rivets are also frequently called "Pop" rivets, which is actually a proprietary trade name of a particular brand.

Warning All driven rivets used in the Sportsman must be the high tensile- strength "AD"-series rivets rather than the soft "A"-series rivets. Since we cannot always catch the mistake if our vendor ships the wrong rivets, it is your responsibility to verify that you are installing the proper, AD-series rivets. The two series of rivets can be distinguished by the head: the proper, AD-series rivets have a small dimple in the center of the head; the soft, A-series rivets have plain heads without dimples.



"AD"-series hard dimpled head	"A"-series soft plain head

Figure 11: Rivet Markings

Summary of Riveting Procedures

The following list provides a general summary of the steps used to rivet together two sheet aluminum components:

1. Straighten and deburr the parts, as necessary.
2. Mark centerlines on rib and spar flanges.
3. Align the parts and clamp them together.
4. Drill the rivet holes to size, installing Clecos as you go.
5. Disassemble the parts, deburr the rivet holes and remove drill chips and shavings.
6. Corrosion-proof parts that will be inaccessible after assembly.
7. Reassemble and clamp the parts together with Clecos.
8. Rivet the parts together.
9. Inspect your work and replace defective rivets, if necessary.

The rest of this section describes these procedures in detail.

Straightening and Deburring Parts

Most of the components of the Sportsman airframe are supplied in a fully formed condition ready for assembly. Some parts may require some minor adjustments and clean-up, however. Taking the time at this stage to accomplish minor adjustments will simplify assembly as work progresses.

Straightening

Use a try square to check the flanges of ribs for squareness to the webs. If the flanges are not quite square, use duck bill pliers (with the jaws taped to prevent damage to the flanges) to gently increase or decrease the angles of the flanges. It doesn't take much to accomplish this, so be careful and check your work frequently as you go.

> **Note** Some of the flanged parts in the Sportsman do not have their flanges perpendicular to their webs. The flanges on the rudder ribs, for example, must match the taper of the rudder, so you shouldn't expect them to be square.

Deburring

Use a deburring tool (recommended) or small, fine-toothed files to remove any burrs remaining on the parts from the manufacturing process. Use flat files on straight or convex edges; use half-round or round files on concave edges, such as the perimeters of lightening holes. Deburring the parts will make them more comfortable to handle, as well as eliminating stress risers which might lead to cracking from metal fatigue. Don't go overboard with this; a few strokes with a file or one pass with the deburring tool is all you need. This is where the advantages of the deburring tool become obvious; filing parts can be tedious.

Marking Rivet Lines on Rib and Spar Flanges

Before beginning to assemble the structural framework of major assemblies, rivet lines must be marked on rib and spar flanges. When the skins are positioned on the framework in preparation for drilling the rivet holes, these marked lines will be visible through the pre-punched pilot holes in the skins and can be used as guides to align the skins on the underlying framework. Such lines are often centered on the rib or spar flange and are thus most often called "centerlines" in later sections of the manual; however, in a few places the lines must be drawn slightly off-center at a specified distance from the flange edge.

Warning **A sharp instrument**, such as a scribe, an awl or an electric engraving pencil, **must never be used for marking metal parts**. Stresses will concentrate in the scratches or indentations made by such tools, leading to cracking of the part over time. Also, **do not use pencil** for marking aluminum. The graphite in pencil lead is a form of carbon, which will promote dissimilar metals corrosion.

Use a fine-point felt tip marker to mark the lines. (Our mechanics prefer the "Sharpie" brand pen.) It's not necessary to take great pains to measure the exact centerline of the flange and then use a straightedge for marking. You can just "eyeball" the location of the centerline and mark it freehand. To do this, hold the pen as you normally would between your thumb and forefinger. Place the point of the pen on the centerline at the far end of the flange while resting your middle, ring and little fingertips against the edge of the flange, as shown in Figure 12. Hold your hand in this position and draw the pen toward you along the flange; your fingers sliding along the edge of the flange keep the pen point on the flange centerline as you mark the line.

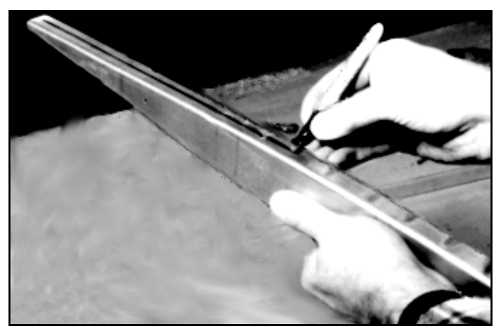


Figure 12: Marking a Centerline on a Rib

You can also use a marking pen mounted in a compass (the kind for drawing circles, not the magnetic kind!). Set the distance between the legs of the compass equal to the distance from the edge to the center of the flange. Slide the leg with the point along the edge of the flange while marking the centerline with the pen; the compass keeps the pen on the flange centerline while marking.

Clamping Parts Together

It is very important to hold sheet aluminum parts together tightly during the riveting process. If the parts are not held tightly together, the rivet will tend to expand between the parts, leaving a gap that reduces the strength of the riveted joint.

The usual method of clamping sheet metal parts in which holes have already been drilled is to use sheet holders, or “Clecos.” If holes are not available in the parts being joined, use small C-clamps or spring-loaded, side-grip clamps (Cleco clamps) to hold the parts together while riveting.

A Cleco consists of a small, cylindrical steel body which contains a plunger, a coil spring, a pair of locking wires and a spreader. When the plunger is depressed with a pair of Cleco pliers, the locking wires extend beyond the spreader, reducing the distance between the wires, which reduces the combined diameter of the two wires. The Cleco can then be inserted into the rivet hole. When the pliers are released, the spring pulls the locking wires back over the spreader, which expands the combined diameter of the locking wires to the diameter of the rivet hole. The Cleco's internal spring holds the parts tightly together by compressing them between the body of the Cleco and the hooks on the locking wires. Removing a Cleco is accomplished by reversing the installation process.

> **Caution** To avoid enlarging the rivet hole, be careful to compress the Cleco fully so that the diameter of the locking wires is reduced to a minimum. Also, refrain from twisting the pliers to install and remove the Cleco; twisting can deform the hole.

Cleco fasteners are available in all common rivet sizes and are color-coded according to the following table:

Fastener Size:	Cleco Color Code:	Drill Size:
3/32"	Silver	#40
1/8"	Copper	#30
5/32"	Black	#21
3/16"	Brass	#11

Table 1: Cleco Sizes

When clamping skins to a structural framework in preparation for drilling the rivet holes to their final size, the rib and spar flanges in the framework must be centered under the pilot holes in the skins, using the lines marked on the flanges as references for alignment. A handy tool for aligning the ribs is a "rib alignment probe," which you can make yourself. The probe is simply a length of aluminum or copper tubing with a small, 90° hook bent in one end (or you could use a wooden dowel with a hook screwed into the end). The probe can be inserted into the structure spanwise through the lightening holes in the ribs to push or pull the ribs into alignment, as necessary. The probe must be long enough to reach all the ribs in an assembly from a location that has not yet had the skins installed; usually about 4-5' long is sufficient.

Preparation of Rivet Holes

On the Sportsman, the sheet metal skins of the wing, the empennage and the control surfaces have undersized pilot holes already punched in them. After the internal structural framework (the spars and ribs) has been assembled and jigged, the skins are positioned and clamped to the structure. The pilot holes in the skin are then used as guides to drill the rivet holes to the final size.

It is very important that the rivet holes be of the correct size and shape and free from burrs. If a hole is too small, the protective coating will be scratched from the rivet when the rivet is driven through the hole; if a hole is too large, the rivet will not fill the hole completely. When such a rivet is bucked, the joint will not develop its full strength and structural failure may occur at that spot.

If flush-head rivets are specified, consider the thickness of the metal and adopt the method—either countersinking or dimpling—recommended for that thickness. (the section on "COUNTERSINKING AND DIMPLING," below, provides guidelines for choosing the correct method.) If the metal thickness requires dimpling, keep hammer blows or dimpling pressures to a minimum so that no undue work-hardening occurs in the surrounding areas.

DRILLING

Standard drill sizes for common rivets are shown in Table 2:

Rivet Diameter:	Drill Number:	Drill Diameter:
3/32"	40	0.098"
1/8"	30	0.129"
5/32"	21	0.159"
3/16"	11	0.191"

Table 2: Drill vs. Rivet Sizes

As mentioned previously, most of the aluminum skins for the Sportsman airframe have undersized pilot holes already punched in them. These holes are used as guides for drilling the rivet holes to their finished size. When drilling holes that do not have an existing pilot hole for guidance, lightly center punch the locations for the rivet holes before beginning the actual drilling. The center punch mark acts as a guide and lets the drill bit grip or bite into the metal with greater ease. Make the center punch mark large enough to prevent the drill from slipping out of position, but punch lightly enough not to dent the surrounding material. To prevent deforming thin sheets when making a center punch mark, back up the material with a thick sheet of metal or a bucking bar.

In order to drill accurately-sized rivet holes, it is essential to use sharp drill bits. Worn bits not only tend to make enlarged, out-of-round holes, but also are more likely to "walk" across the surface being drilled. Either discard or sharpen worn drill bits. Also, before beginning to drill, always test the drill bit for trueness by running the drill freely and watching the end of the bit. If the bit wobbles, it may be because of burrs on its shank or because it is bent or incorrectly chucked. Do not use a drill bit that wobbles or is bent; such a bit causes enlarged holes. **This cannot be over-emphasized: use straight, sharp drill bits**; don't attempt to hand sharpen them.

When drilling, hold the drill motor firmly with both hands. Always hold the drill at right angles to the work, regardless of the position of the hole or the curvature of the surface. Extend the index and middle fingers of the left hand against the metal to act as a guide in starting a hole, and as a snubber or brake for when the drill goes through the material. You can also use special drill stops that fasten to the drill bit to limit the bit's penetration through the material. Another technique for starting a hole is to use a long drill bit and pinch the smooth shank of the bit between your fingers, initially, to act as a guide.

Hint When drilling holes in sheet metal, you can position the drill bit at a right angle to the surface by aligning the bit with its own reflection in the material. Check from two different directions because this method cannot detect misalignments that are in the plane defined by the drill bit and your eye.

Use a right-angle drill or drill extensions and adapters when access is difficult with a straight drill. Never tip the drill sideways when drilling or when withdrawing the drill from the material because this causes elongation of the hole.

Edge Margins for Rivet Holes

For **universal-head** rivets in aluminum sheet, the **center** of the rivet hole must be at least **two rivet diameters** from the edges of all parts in the assembly. For **flush-head** rivets, the **center** of the rivet hole must be at least **2-1/2 rivet diameters** from the edges of all parts. For example, edge margins must be 1/4" for 1/8" universal-head rivets and 5/16" for 1/8" flush-head rivets.

Drilling a Line of Rivet Holes

When drilling a line of rivet holes in an assembly, it's best to first drill holes at the ends of the line and at several places along the line, while making sure that the parts are held in correct alignment. Insert Clecos into each of these first holes after drilling to "tack" the parts together and maintain alignment between them. Then go back and drill the intervening holes. This practice will help prevent warped assemblies caused by slight misalignments.

DEBURRING

When holes are drilled through sheet metal, small burrs are formed around the edges of the hole. The holes must be deburred before riveting. This can be done by hand using a drill bit larger than the hole by placing the point of the larger bit into the hole and twisting the bit through several revolutions between your fingers. (If you use this method, wrap the drill bit with tape to protect your fingers.) You can also use a countersink bit in an electric drill, using very light pressure.

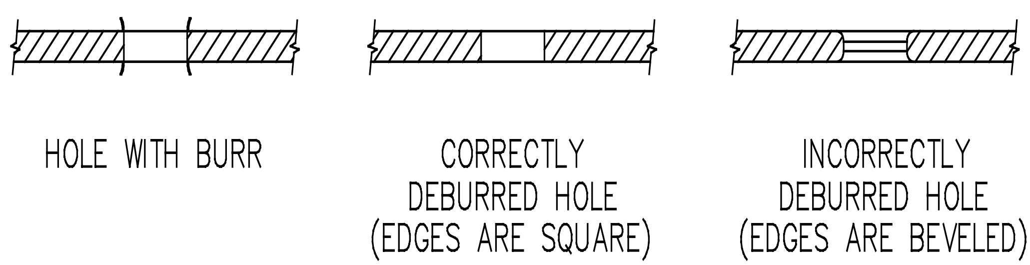


Figure 13: Deburring Rivet Holes

> **Note** Be careful to remove just the burr; do not enlarge the hole or bevel the edges of the hole. See Figure 13.

The usual sequence is to drill all of the holes at once and then disassemble the parts so that **both** sides of all holes can be deburred.

Note While the parts are disassembled, thoroughly clean away all chips that have accumulated between the parts. If drill chips or shavings prevent good contact between the parts, the rivet joint will not achieve its full strength.

Use an air nozzle or the exhaust from the air drill to blow the drilling chips off the surface; brushing the chips with your hand or a rag tends to scratch the aluminum cladding. A special tool, called a "chip chaser", can be used to remove drill chips from between parts that can no longer be disassembled.

Hint Before deburring rivet holes in exterior aluminum skins, remove narrow strips of the plastic covering along the rivet lines, leaving the major portion of the plastic for protection during construction. To remove the strips, run a hot soldering iron down both sides of the rivet line to melt through the plastic. Then you can peel off the plastic between the melted lines.

Caution Do **not** use any kind of knife or razor blade to score the plastic covering for removal along the rivet lines. Such tools will scratch the skin, possibly leading to later cracking.

COUNTERSINKING AND DIMPLING

All the Sportsman aluminum surfaces may be flush riveted. The manual details the procedures for universal head rivets. To use flush rivets in sheet-metal aircraft construction, the surface must be either countersunk or dimpled to accept the rivet head. The proper method for any particular application depends mostly on the thickness of the parts being riveted and the height of the rivet head. As a general rule, use the machine or drill countersink method when the thickness of the material is greater than the thickness of the rivet head; use the dimpling method on thinner material. Dimpling works best in material no more than .040" thick. Refer to Figure 14 and Table 3. **All Sportsman wing skins must be dimpled for 1/8" rivets, not countersunk.**

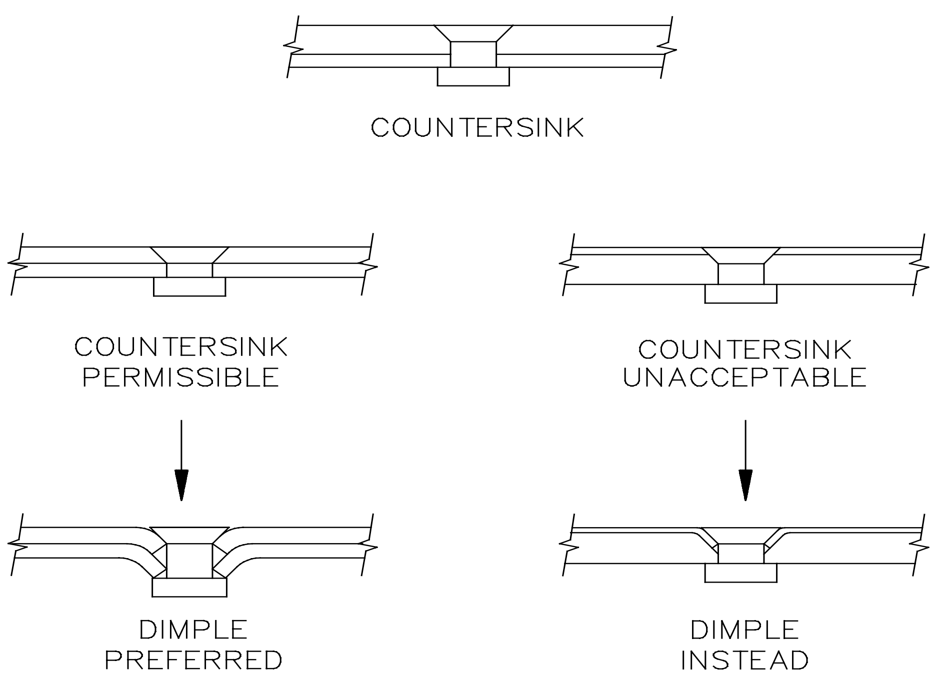


Figure 14: Countersinking and Dimpling

ACCEPTED METHOD	3/32" Rivet	1/8" Rivet
Dimple	.032" material	.040" material
Countersink	.040" material	.050" material

Table 3: Material Thickness for Countersinking vs. Dimpling

Note Table 3 gives the preferred method for **structural** applications. For other applications, you have greater leeway in deciding between countersinking and dimpling. For instance, when using 3/32" rivets to mount nutplates to .032" thick aluminum, it is normal and acceptable to countersink rather than to dimple the rivet holes.

Warning Flush-head (countersunk) rivets are specified only in locations on the Sportsman where they are desirable for drag reduction or, in some cases, for the clearance they provide for other parts. However, flush-head rivets do not offer the tensile strength of universal-head rivets of comparable size. You may flush rivet all the aluminum skins on you Sportsman, but use proper dimpling and countersinking techniques in order to gain full strength of the fasteners.

Countersinking

To countersink sheet metal for flush-head rivets, use a machine stop countersink tool, which cuts away the edge of the rivet hole to form a recess —called the "well" or the "nest"—for the rivet head. The countersink tool's cutter has a pilot that fits into the drilled hole to accurately position the cutter. It also has an adjustable stop to help ensure that the depth of the countersink will be accurate. Adjust the stop to the proper depth by practicing with a rivet on a piece of scrap material. (The head of the rivet must not extend more than 0.006" either above or below the surface of the metal, in most cases. A barely visible ring of cut metal around the rivet head is just right.) You can use the sheet metal supplied in the sheet metal practice kit for adjusting the countersink depth. (If you are countersinking .032" material for installing nutplates, use a thicker sheet for practice to get a true indication of the countersink adjustment.)

To cut accurate countersinks, hold the countersink tool at right angles to the material. Do not tip it. Tipping elongates the well and prevents the rivet head from seating properly. Oversized rivet holes, undersized countersink pilots, chattering caused by improper use of the countersink or by a countersink in poor condition, and a countersink not running true in the chuck of the drill motor are some causes of elongated wells.

Dimpling

To install flush rivets in thinner sheet aluminum (0.040" thick or less), the material must be dimpled to form the well for the rivet head. This is accomplished by using male and female die sets to press the metal immediately surrounding the rivet hole into the proper shape to fit the rivet head. The rivet must fit the well snugly enough to obtain maximum strength. The number of sheets which can be dimpled simultaneously is limited by the capacity of the equipment used, but generally two sheets of relatively thin material, such as the 0.020" Sportsman tail surface skins, can be dimpled simultaneously.

Note For thicker sheets that cannot be dimpled simultaneously, simply dimple each sheet separately. The resulting dimples will nest together properly for final riveting.

Both male and female dimple dies are machined accurately and have highly polished surfaces. The male die or punch is cone shaped to match the rivet head and has a small concentric pilot pin that fits into the female die and matches the diameter of the rivet hole. The female die has a corresponding degree of countersink into which the male die fits. The dimpling dies available from some sources (Cleveland Aircraft Tool and Material, listed in the "*Sources for Special Tools*" section, is one) are made so that their included angle is about 5° less than that of the rivet. This arrangement allows for spring-back of the metal and works especially well.

To dimple a hole, rest the female die on a solid surface, place the material on the female die, insert the male die into the hole to be dimpled, and then hammer the male die. Strike with several solid blows until the dimple is formed. Since the metal is stretched slightly during the dimpling process, the pilot hole of the female die should be smaller than the diameter of the rivet. After dimpling, the hole may be reamed to the exact diameter, using the appropriate drill bit, so that the rivet fits snugly. We recommend the use of a dimpling frame or a rivet squeezer to hold the dies.

Fitting a Dimpled Skin to a Countersunk Part

There are several places in the Sportsman where thin aluminum sheet is flush-riveted to an underlying thicker part; one example is the attachment of the wing skins to the forward spar flanges. In these instances, the thin sheet must be dimpled and the underlying thicker part must be countersunk. To achieve the maximum structural strength of each of these rivets, the countersink must be carefully adjusted to the proper depth of cut.

Use **scrap pieces** of aluminum to adjust your countersink, as follows:

A) Choose a piece of scrap aluminum the same thickness as the thin sheet you're working with. Drill an appropriately sized hole (#30 for 1/8" rivets; #40 for 3/32" rivets) through this piece and dimple the hole.

B) Drill the same size hole in another piece of thicker scrap (1/16" minimum), and countersink the hole. This piece simulates the underlying thicker part.

C) Fit the dimple formed in Step A into the countersink formed in Step B, and check the fit. If, when the dimple is pressed tightly into the countersink, the two pieces are held apart so that a gap exists between them, the countersink is too shallow. Refer to Figure 15. If the pieces fit tightly together without gaps but the dimple is loose in the countersink so that the pieces can shift laterally relative to each other, the countersink is too deep. If the dimple fits snugly in the countersink and the parts fit tightly together without gaps, the countersink depth is just right.

D) Adjust the depth of the countersink, if necessary, and repeat Steps B and C until you have achieved the proper countersink depth.

Now that your countersink tool is adjusted properly, you can use it to cut the countersinks in the rivet holes in the thicker part.

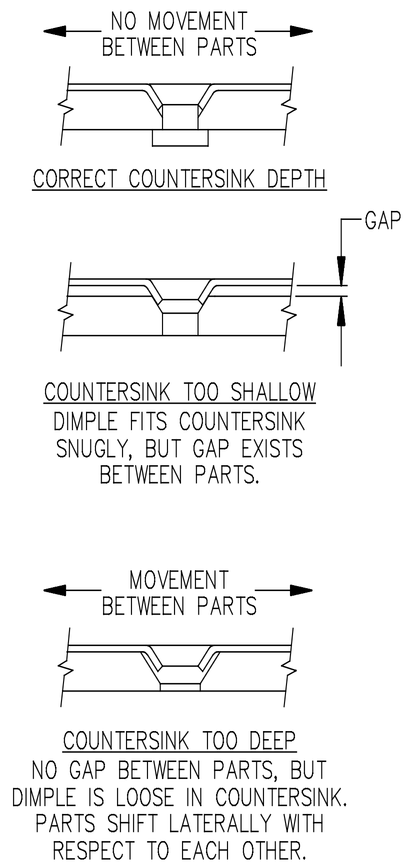


Figure 15: Countersink Adjustment

Note Since aluminum sheet of various thicknesses may be fastened to the same underlying part (as when fastening the various wing skins to the spar flanges), you must readjust your countersink tool, following the procedures described above, for each different sheet thickness. For example, you can use the same countersink adjustment for the rivet holes for the inboard leading edge wing skin and the inboard main wing skins, which are all .032" thick, but you must change the adjustment for the center leading edge wing skin, which is .025" thick.

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Determining the Proper Size of a Rivet

DIAMETER

Rivets used on the Sportsman range from 3/32" to 5/32" in diameter, with 3/32" and 1/8" being by far the most common sizes. The diameter of rivet to use in any particular application will always be specified in the manual.

LENGTH

The manual does not specify the length of rivets for particular applications, and so it is very important that you develop the ability to determine the proper length yourself. Rivets that are too long or too short for a given situation will not produce joints of full strength. The reason we do not call out specific rivet lengths is that small variations in material thickness, type of corrosion-proofing applied, parts fit, etc., can all produce differences in the optimal rivet length.

To determine the proper length of a rivet for any given application, the combined thickness of the material to be joined, or the "stack-up," must be known. This measurement is known as grip length. The total length of the required rivet is equal to the grip length plus the amount of rivet shank necessary to form a proper shop head, which is 1-1/2 times the diameter of the rivet shank . Referring to Figure 16 and the above information, use the formula A = B + C to determine the correct length of a rivet. (A is the total rivet length; B is the grip length; C is the material needed to form a shop head.)

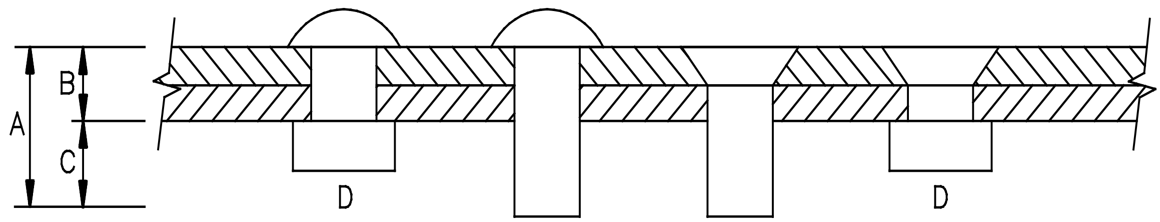

Figure 16: Determining the Proper Length of a Rivet

> **Note** The length of a universal-head rivet is measured from the underside of the head; the length of a flush-head (countersunk) rivet is measured from the upper surface of the head. Refer to Figure 3.

A slightly longer or shorter rivet may be used if, after driving, the shop head conforms to the specifications given in the next section. As a general rule, a rivet within 0.020" of the optimal length is acceptable. A rivet of the correct size can be obtained by trimming a longer rivet with a rivet cutter.

If the combined thickness of the material to be joined is not known, and the location of the hole is such that the thickness cannot be measured directly, you can easily determine the grip length of a rivet by using a homemade tool. Simply bend a tiny 90° hook into the end of a stiff piece of wire. Insert the wire into the rivet hole and pull the hook back against the metal around the lower side of the hole. Mark the wire at the upper surface of the hole (either use a pen or simply hold your thumbnail against the wire), then withdraw the wire from the hole and measure the distance from the hook to the mark. Remember, this just gives you the needed grip length; you must add 1-1/2 times the rivet diameter to the grip length to determine the required total length of the rivet.

Note Lengths of blind rivets will be specified in the text.

SPECIFICATIONS FOR PROPERLY DRIVEN RIVETS

After driving, the shop head should be a minimum of 1-1/2 times the diameter of the rivet shank in width and about 2/3 the diameter of the rivet shank in height. The minimum acceptable height of the shop head is 1/2 the shank diameter. See Figure 17 for examples of properly and improperly driven rivets.

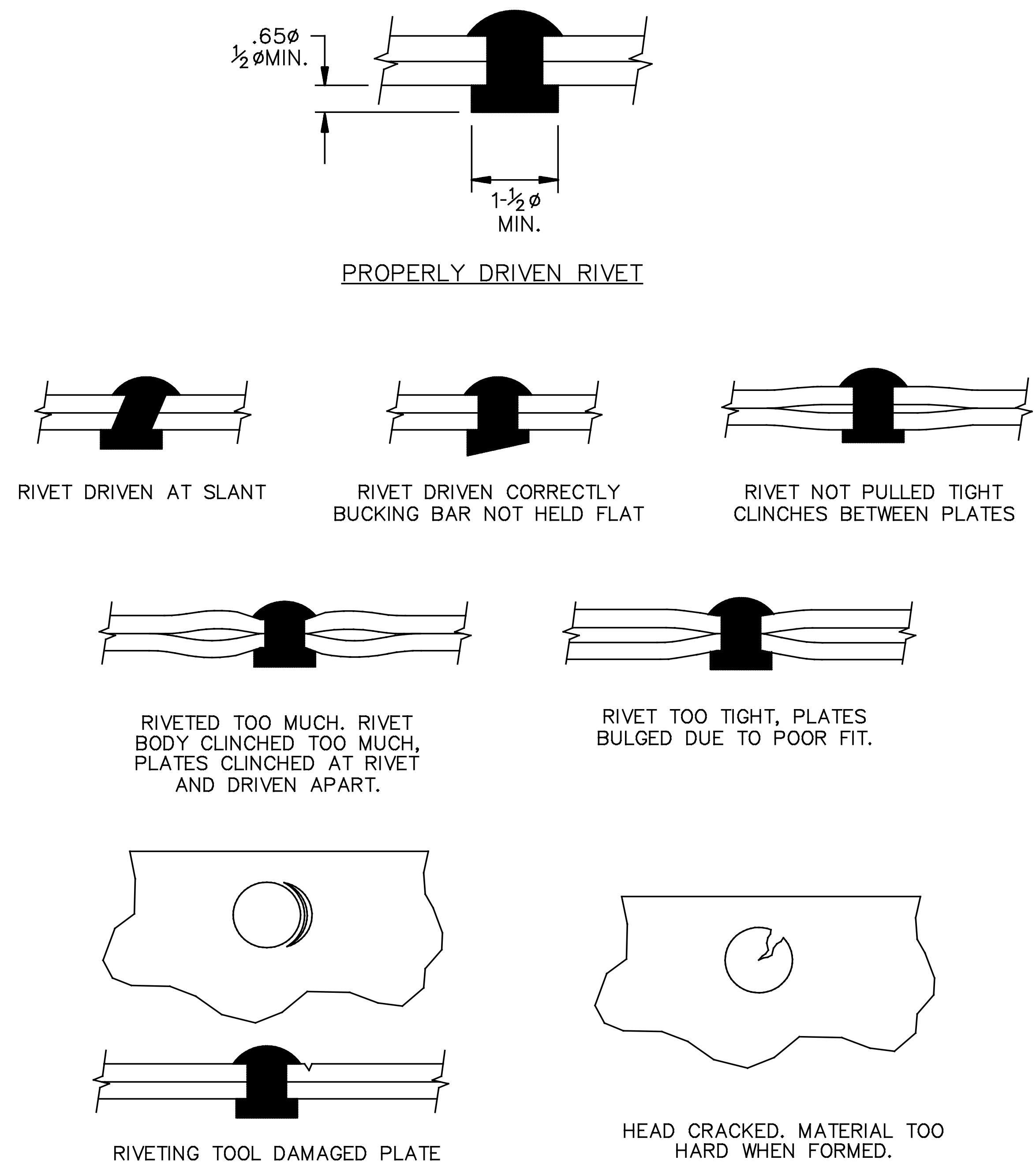

Figure 17: Properly and Improperly Driven Rivets

Installing a Line of Rivets

When driving a line of rivets in an assembly, start by driving a rivet at the center of the line and then one at each end. Then drive a rivet halfway between the center and the end on each side. Continue in this fashion, driving rivets at the centers of unriveted areas, until the entire line is finished. This practice tends to distribute any expansion of the material or any slight misalignments between the two parts along the entire length of the rivet line, resulting in a straighter assembly. If, on the other hand, you were to start at one end of the line and work your way to the other end, any slight misalignments or expansion would tend to be pushed along and to accumulate as you progressed. In this situation, you could force a curve into the assembly in order to get the rivet holes to line up as you go along, or you might be left with a bulge in the skin between the last two rivets.

The same principle applies to riveting the skins of the wings and control surfaces to their underlying structural frameworks. Begin with a rivet in one corner, then a rivet in the opposite corner, then a rivet somewhere in the middle. Establish a pattern in which you are always riveting approximately in the middle of the remaining unriveted area.

Driving Rivets

The essential tools for driving standard, solid-shank rivets are a compressor, a rivet gun, rivet sets and bucking bars. The rivet gun is used to deliver rapid, hammer-like blows that quickly drive the rivet when it is backed by a suitable bucking bar. Three basic types of rivets are used in building the Sportsman: universal round-head, countersunk flush-head and the blind pull type. For each type of rivet, different techniques and tools are required. The universal-head and flush-head rivets obviously require different rivet sets. The blind rivets require only a pull riveter to install them. When using pneumatic rivet guns, hearing protectors are highly recommended. A rivet squeezer may be used for forming the standard, solid-shank rivets in accessible areas, but accessibility is limited by the jaw depth of the squeezer. Installing rivets with a squeezer is much easier than with a pneumatic gun.

When riveting together material of different thicknesses, place the manufactured head against the thinner material wherever possible and form the shop head against the thicker material. This practice will minimize deformation of the material caused by riveting.

> **Note** Before driving any rivets, make sure that all holes line up perfectly, all shavings and burrs have been removed, and that all the parts to be riveted are securely fastened together.

Bucking

Two people, a "gunner" and a "bucker," usually work as a team when driving rivets. On some jobs, however, the riveter can hold a bucking bar with one hand and operate the rivet gun with the other.

Follow these general guidelines for bucking rivets:

1. Make sure the bucking bar has a flat, square face; otherwise, the rivet head will deform.

2. For the least distortion of the surrounding material, use as heavy a bar as practical.

3. Always hold the face of the bucking bar at right angles to the rivet shank. Failure to do this will cause the rivet shank to bend with the first blows of the rivet gun and will cause the material to be marred by the final blows.

4. The bucker must hold the bucking bar in place until the rivet is completely driven. If the bucking bar is moved while the gun is in operation, the rivet set may be driven into the surface of the material.

5. Position the bucking bar so that it clears surrounding obstructions, allowing the bucking surface to rest squarely against the tip of the rivet shank. Pad the bar with masking tape where it may contact the structure.

6. Avoid having the point of contact with the rivet too close to the edge of the bucking bar or it may slip off.

7. Do not bear down too heavily on the shank of the rivet. Allow the weight of the bucking bar to do most of the work. The hands merely guide the bar and supply the necessary tension and rebound action.

Failure to hold the bucking bar at right angles to the rivet can cause defective rivet heads. A rivet going “clubhead” (malforming), can be corrected by rapidly moving the bucking bar across the rivet in a direction opposite that of clubhead travel. This corrective action can be accomplished only while the gun is in action and the rivet is partially driven. If a rivet shank bends at the beginning of the bucking operation, place the bar in the corrective position only long enough to straighten the shank.

PNEUMATIC DRIVING

In pneumatic riveting, the pressure for forming the shop head of the rivet is applied with a rivet set and an air-driven hammer or gun. A rivet gun should be large enough to drive rivets in a reasonable length of time without distorting the structure. We have found that a 2X size rivet gun works well for all of the work on the Sportsman. Be sure to choose the proper rivet set to match the type and size of the rivet you are driving.

Always use a regulator on your rivet gun and adjust it for the minimum pressure needed to drive the rivet. Adjust the speed of the gun (strokes per minute) before starting to drive rivets. To do this, press the rivet set against a block of wood before pressing the trigger.

Caution Never operate the gun without resistance to the set; the vibrating action may cause the retaining spring to break, allowing the set to fly out of the gun. Also, free vibration may flare or mushroom the gun end of the set, causing it to bind in the barrel of the gun.

Hold the rivet set at right angles to the work to prevent damage to the rivet head or the surrounding material. Avoid using too many strokes without enough force because this may cause the rivet to work-harden and crack.

Hint Use masking tape on the rivet set and on the bucking bar. The tape on the set protects the rivet head from marring; the tape on the bar helps to keep the bar from slipping off the rivet.

Remove the bucking bar and check the shop head of the rivet; it must conform to the standards described above in "SPECIFICATIONS FOR COMPLETED RIVETS." If the rivet needs further driving, repeat the necessary procedures to complete the job. If the rivet has been driven too far (the shop head is less than 1/2 times the shank diameter in height), it must be removed and replaced. (See "REMOVING RIVETS" below.) In some cases, however, you may be better off leaving a rivet that has been driven too far rather than risk elongating the hole when removing the rivet.

We recommend practicing riveting on scrap material to get a feel for the proper techniques before attempting to drive rivets in any of the airframe components.

BACK RIVETING

For some assemblies in the Sportsman, especially where thick stack-ups of heavy material are joined by long rivets, it may be easier to "back rivet" instead of driving rivets in the conventional manner. In back riveting, the shank end of the rivet is driven with a flush set and a rivet gun, and the manufactured head is bucked. A bucking bar is used to buck flush-head rivets; universal-head rivets are bucked with a universal-head set held in a vise or a bottle bar (a special bucking bar recessed to hold a rivet set).

Hint For such thick joints, it helps to C-clamp the assembly tightly together while riveting.

SQUEEZE RIVETING

The squeeze method of setting a rivet produces the most uniform and balanced type of shop head. Each rivet is upset in a single operation; all rivets are formed with uniform pressure; and each rivet shank is sufficiently and uniformly expanded to completely fill each rivet hole. Squeeze riveters come equipped with pairs of end sets, each pair being designed for a particular type of rivet. Once the correct end set is selected and the squeezer is adjusted for a particular application, all the rivets will be driven uniformly, thus providing an efficient method of riveting. Access for squeeze riveting is limited by the jaw depth of the riveter, so this method can be used only near the edges of components.

The procedures for installing rivets by squeezing will vary depending on the type of rivet squeezer you are using, but, in general, follow these steps:

1. Carefully select and insert suitable sets to match the rivet being used. This is very important; it is impossible to buck the rivet properly unless the correct pair of sets is used.

2. Adjust the gap to conform to the length of the rivet being installed. The gap adjustment method varies with the type of squeezer: usually either a gap regulator controls the stroke of the jaw (adjusted by rotating the plunger that holds the moving set) or shims adjust the spacing between the sets.

3. Before using the squeezer on the work, test the accuracy of the gap adjustments on a piece of scrap material. The scrap must be the same thickness as the work to be riveted, and the rivets must be the same length and diameter.

4. If the parts to be riveted are small and easily handled, mount the rivet squeezer in a bench vise or a special clamp and hold the parts to be riveted in your hand.

Consult the instructions included with your rivet squeezer for specific details.

Blind Riveting

Blind rivets are used in areas of the Sportsman airframe that are accessible from only one side (the joint between the stabilizer skin and the leading edge ribs, for instance). These rivets are called “blind rivets” because the shop head is not visible during or after forming. They are also called “pull rivets” because the shop head is formed by pulling a solid mandrel into the hollow rivet shank from the accessible side.

Although the blind rivets supplied with the Sportsman kit may resemble the Pop rivets available at your neighborhood hardware store, there are important differences. All of the 1/8" pull rivets used on the Sportsman are aircraft-quality Cherry “Q” rivets, in which the stem fills the hollow shank of the rivet after pulling, providing much greater shear strength. On common Pop rivets, by contrast, the stem breaks off short during installation, leaving a structurally weak empty shank. There are a few places on the Sportsman where 3/32" pull rivets are specified. The rivets supplied for these applications are Cherry “N” rivets, in which the stem breaks off below the surface when pulling, leaving a partially hollow shank. Although these lack the shear strength of the Cherry “Q” rivets, they are still superior to common Pop rivets in that they are designed to positively retain the broken stem after installation.

Warning Do not use standard, hardware-store Pop rivets in the Sportsman airframe. Use **only** the rivets supplied with the kit.

Installing blind rivets is pretty straightforward. Holes are drilled and deburred in the same manner as for standard rivets except that greater care must be taken not to enlarge or elongate the hole. This is because a blind rivet will not expand as much as a solid shank rivet. Use the correct pulling tool and make sure that the proper pulling head is installed on the tool for the size of rivet being used. After the hole is drilled and the parts are clean and clamped securely together, insert the rivet fully into the hole, position the head of the pulling tool on the rivet stem (mandrel) and pull the rivet stem until it snaps. After pulling, the head must fit tightly against the metal. When a blind rivet is installed in an assembly with a thickness in the middle of the rivet's grip range, the mandrel will break off flush with the head. Otherwise, the mandrel will break off either above or below the head, depending on the thickness of the assembly. If the mandrel breaks off above the rivet head, simply file it down flush with the head.

Note In some places in the Sportsman where Cherry AAPQ-42 blind rivets are specified, the stack-up is technically too small for the optimal grip length range of the -42 rivets. -41 rivets are unavailable, however, so -42s must be used. This is not a problem; the rivet will develop full strength since the broken-off stem will fill the shank solidly after pulling. The only problem is that the stem will break off above the rivet head and will have to be shaved or filed down, as described above.

Replacing Defective Rivets

The design of riveted joints is based on the theory that the total joint strength is simply the sum of the individual strengths of each of a whole group of rivets. It is obvious that if any one rivet fails, its load must immediately be carried by others of the group; if they are unable to carry this added load, progressive joint failure then occurs. Consequently, an inspection must be made of **all** rivets before an assembly is put into service. This inspection consists of examining both the shop and manufactured heads and the surrounding skin and structural parts for deformities. A machinist's scale or a special rivet gauge can be used to check the condition of the shop head to see that it conforms to the specifications. The eye alone can detect deformities in the manufactured head. Use a straightedge to check that flush head rivets are neither protruding above the skin surface nor recessed too deeply below the surface.

Some common causes of defective rivets are improper bucking, rivet set slipping off or being held at the wrong angle, and rivet holes or rivets of the wrong size. Additional causes of unsatisfactory rivets are countersunk rivets not flush with the well; work not properly fastened together during riveting; the presence of burrs; and too much or too little driving. Whatever the cause, defective rivets must be removed and replaced.

Note Stop and inspect your work at important milestones before proceeding with further work that will make defective rivets inaccessible for replacement. When riveting the horizontal stabilizer skins, for example, inspect all rivets (and replace rivets as needed) after riveting the skins to the ribs and front spar, but before riveting the aft spar to the skins.

REMOVING RIVETS

When removing a rivet for replacement, be very careful to maintain the original size and shape of the rivet hole so that replacement with a larger size rivet will not be necessary. If the rivet is not removed properly, the strength of the joint may be weakened and replacement of rivets made more difficult.

When removing a rivet, work on the manufactured head. It is more symmetrical about the shank than the shop head, and there will be less chance of damaging the rivet hole or the material around it. The preferred method on the relatively light structure of the Sportsman is to drill through the rivet head and then to pull the tail out with a pair of flush cutting diagonal cutters, or to simply drill all the way through. On heavier structure, drill through the head and then drive out the remainder of the rivet with a pin punch. The dimple in universal and flush head rivets usually eliminates the need to center punch the rivet head, but you may center punch the head anyway to reduce the tendency of the drill bit to walk off the head. For blind rivets, use a small pin punch to drive the remains of the stem down into the rivet; the hole in the middle of the head then centers the bit for drilling.

Note On thin sheet metal, back up the rivet on the shop head side to avoid depressing the surrounding metal when center punching a bucked rivet or driving out the mandrel of a blind rivet.

Select a drill one size smaller than the rivet shank and drill out the rivet head. When using a drill motor, set the drill bit on the rivet head and rotate the chuck several revolutions by hand before pulling the trigger. This procedure helps the drill cut a good starting spot and reduces the chance of the drill slipping off and tracking across the metal. Drill the rivet to the depth of its head, while holding the drill at a 90° angle. Be careful not to drill too deeply because the rivet shank will turn with the drill and elongate the hole. The rivet head will often break away and climb the drill bit, which is a good signal to withdraw the drill. If the rivet head does not come loose of its own accord, insert a pin punch of the proper size into the drilled hole and rock it back and forth slightly until the head comes off.

Drive out the shank of the rivet with a pin punch slightly smaller than the diameter of the shank. On thin metal or unsupported structures, support the sheet with a bucking bar or a block of wood while driving out the shank, or pull out the shank from the back side with a pair of diagonal cutters. If the shank is exceptionally tight after the rivet head is removed, drill the rivet about two-thirds of the way through the thickness of the material and then drive out the remainder of the rivet with a pin punch.

The procedure for removing flush rivets is the same as just described. Be very careful to avoid elongation of the dimpled or countersunk holes. Drill the rivet head to approximately one-half the thickness of the top sheet.

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NUTPLATE INSTALLATION

Nutplates (also called "anchor nuts") are used in numerous places in the Sportsman in inaccessible areas where a regular nut cannot be used. As shown in Figure 18, installing nutplates is simple but requires following a specific sequence:

1. Drill the bolt hole through both parts.

2. Insert a bolt through the hole from the top side and thread the nutplate partially onto the bolt.

3. While the bolt holds the nutplate in alignment, use one of the rivet holes in the nutplate as a guide to drill the first rivet hole.

4. Insert a Cleco or a rivet through the first rivet hole to maintain alignment.

5. Drill the second rivet hole.

6. Remove the nutplate, deburr the rivet holes and countersink or dimple the holes on the top side. (If you dimple, as you should on thin material, then you will also have to dimple the flanges of the nutplate, or else it will not lie flat against the part when riveted.

7. Rivet the nutplate in place.

Note If the nut plate is to be mounted in a location that is inaccessible for drilling from the bottom side, insert the bolt through the hole from the bottom, thread the nut plate onto the bolt and drill the rivet holes from the top side.

Hint Special **nut plate jig** tools are available to simplify the installation of nut plates. The tools have a pin that fits into the bolt hole and two drill guides of the correct size and spacing for drilling the rivet holes. A different tool is needed for each size of nut plate.

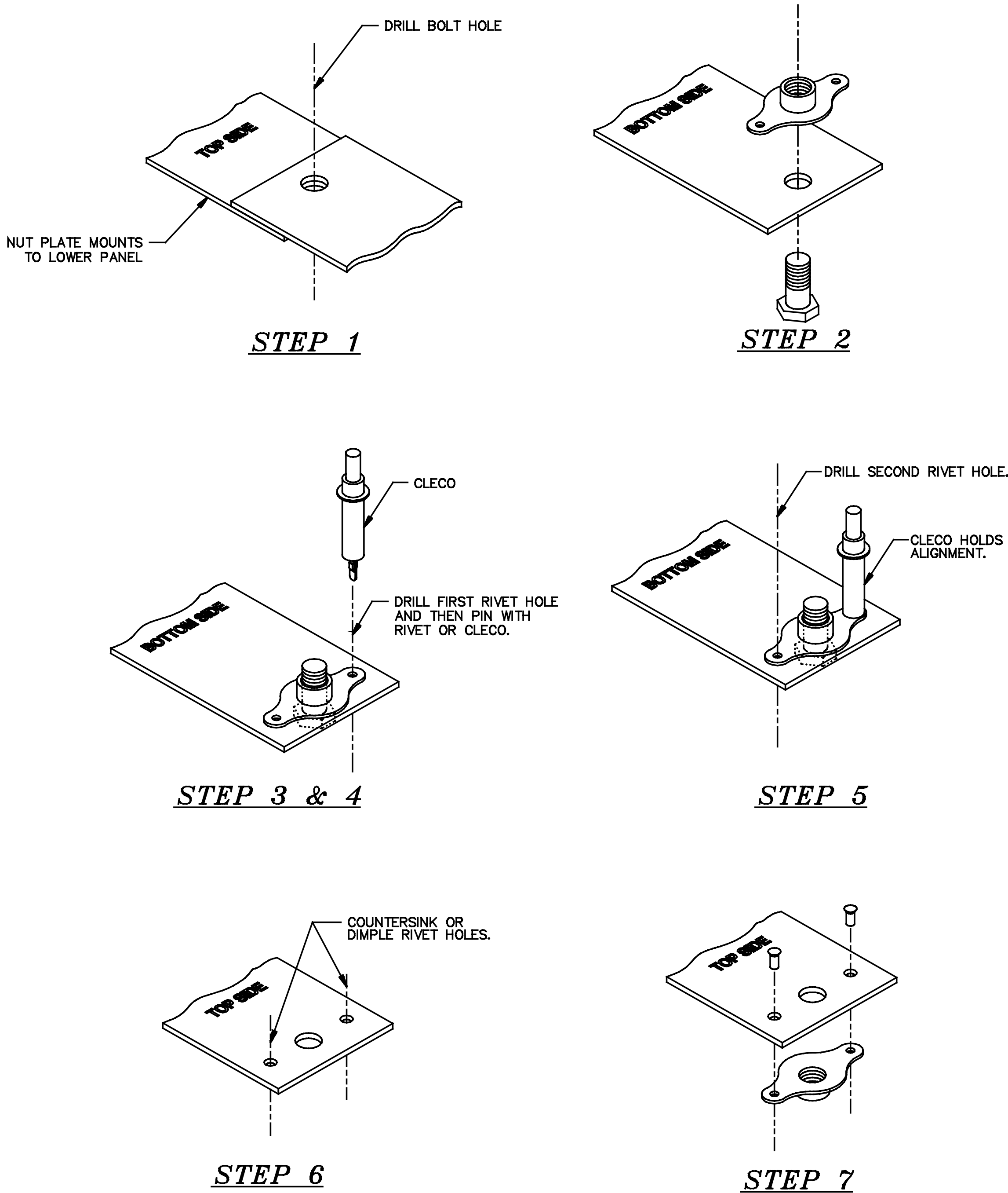


Figure 18: Nutplate Installation Procedures

FIBERGLASS LAMINATING

What Is Fiberglass?

Glass fiber is produced by drawing single fibers of special glass (largely silicon, calcium and aluminum dioxides) into very small-diameter strands. The glass itself has very high tensile strength, little corrosion resistance and is vulnerable to attack by both acids and alkalis. When the properties of glass fibers are properly complemented with the corrosion-resistance and toughness of resin, however, the end product is a strong, lightweight, corrosion-resistant material known by the generic name "fiberglass reinforced plastic" (FRP).

Fiberglass Construction in the Sportsman

The Sportsman fuselage halves are manufactured by laminating layers of bi-directional cloth on both sides of a foam core in a female mold. The foam sandwich construction combines exceptional stiffness with low weight. To assemble the Sportsman fuselage, you will seam the fuselage halves together (around the welded, steel-tube cage) using laminates of fiberglass seam tape. The cockpit cage will then be fastened to the fuselage with bolts and machine screws. You will also fabricate structural bulkheads and stiffeners at the aft end of the fuselage using pre-cure plastic foam-and-fiberglass laminate sheets and fiberglass cloth, both to reinforce the fuselage and to provide attach points for the horizontal stabilizer.

The resin supplied with your Sportsman kit is Dow Derakane 411-45 vinyl ester resin. This resin is well regarded for its high corrosion resistance (it is used to make underground fuel storage tanks), its ease of use and its low toxicity. A variety of other vinyl ester resins are used in the manufacture of the pre-molded parts of the Sportsman, but these are **not** recommended for use by the builder.

The majority of the fiberglass cloth supplied with the kit is 7781 9.5 oz. bi-directional E-glass (Mil. Spec. MIL-F-9084) with a CS-472 finish optimized for use with vinyl ester resin. This is the **only** bi-directional cloth recommended for use with the supplied resin. Substitution of any other cloth **cannot** be assumed to produce laminates of sufficient strength.

The DBM cloth supplied with the kit consists of 17 oz. double uni-directional cloth on the 45° bias with a 3/4 oz. mat backing.

> **Warning** Because of the careful match between the resin and the fiberglass cloth used in the Sportsman, **do not** substitute unapproved materials from other sources. Use only the materials supplied with your kit.

Before the vinyl ester resin can be used for fiberglass lamination, it must be promoted with cobalt naphthenate (cobalt) promoter and dimethylaniline (DMA) accelerator. Resin is promoted in one-gallon quantities, and then smaller quantities are taken as needed from the one-gallon batches of promoted resin. Finally, the resin is catalyzed with methyl-ethyl-ketone-peroxide (MEKP) catalyst just prior to use.

> **Warning** **Never** mix cobalt directly with MEKP catalyst. A violent reaction will occur that may result in fire or explosion. Store cobalt separately from the catalyst.

Each Sportsman kit is shipped with 1 gallon of vinyl ester resin. The Shelf life of the resin is only about three months once promoted so use carefully! While 1 gallon of resin should be sufficient for most builders to complete the most of the steps, not every builder will be the same or add the same accessories. Additional resin can be ordered by contacting our parts department.

Summary of Fiberglass Laminating Procedures

The following list provides a general summary of the steps used to apply a fiberglass laminate:

1. Promote the resin, if you don't already have a quantity of promoted resin on hand.
2. Prepare the surface where the laminate will be applied by sanding, if necessary, and cleaning with acetone.
3. Cut the cloth for the laminate.
4. Measure a sufficient quantity of promoted resin and catalyze it.
5. Saturate the cloth with the catalyzed resin, adhering it to the underlying structure and working out air bubbles.
6. Clean up and dispose of excess resin.
7. Trim the laminate in the green cure condition, if necessary.
8. Let the laminate cure.

The rest of this section describes these steps in detail.

Promoting Vinyl Ester Resin

Before vinyl ester resin can be catalyzed for lamination, it must be promoted. No noticeable change will occur in the resin upon promotion except for a change of color. Resin is promoted first with the cobalt promoter and then with the DMA accelerator. At high temperatures (80°-100° F), DMA is not required to cure the standard vinyl ester resin and may be left out of the promotion step to provide a longer working life for the resin.

If necessary, transfer the resin to a wide-mouth container so the promoters can be easily mixed into the resin. Use a clean plastic container that can be sealed, preferably with a closable spout. The amount of promoters used depends on the ambient temperature while you're working. See Table 4:

Chemical Component:	65-85° F	80-100° F
RESIN:	1 gallon	1 gallon
COBALT (purple in color):	5cc	3.6cc
DMA (orange-yellow in color):	3cc	0cc

Table 4: Resin Promotion

Use a graduated cylinder with metric markings or a plastic syringe without the needle to measure the cobalt and DMA. **Add the cobalt first** and mix thoroughly, scraping the sides and bottom of the mixing vessel. Then add the DMA, if needed, and mix again. You can use a paint stirrer on a drill motor to mix the promoters into the resin. This method introduces air bubbles into the resin, however, so you will want to wait until the bubbles have risen out of the resin before catalyzing it for use.

The minimum quantity of cobalt that can be used for promotion is 0.1% by weight. Since 1 gallon is approximately 3,600 grams, the minimum quantity of cobalt for a 1 gallon batch of resin is 3.6g. (You can assume that 1cc is equivalent to 1g.)

Note Be accurate when measuring the promoting agents. A small error will significantly alter the gel time.

The shelf life of promoted resin is 1 to 2 months, depending on storage conditions. Re-promotion with up to 100% of the original amount of cobalt and DMA, as listed in Table 4, is authorized if gelation is too slow.

Catalyzing Resin

GEL TIME

"Gel time" or "pot life" is the time it takes the resin to set up in the container after proper and thorough mixing with cobalt promoter, DMA accelerator and MEKP catalyst. Gel times can be adjusted significantly by varying the amounts of these materials. Gel times also will vary significantly with changes in ambient temperature and humidity.

"Working time" is the time after catalysis and before the start of gelation, when the resin can be applied successfully to the fiberglass cloth. Due to many variables affecting gel time, the working life can vary considerably from the gel time. The working life of the resin is shortened by high ambient temperatures, by warm resin temperatures and by direct sunlight. Large batches of resin and thicker laminates will also have a shorter working life, because a larger volume, due to its smaller ratio of surface area to mass, tends to retain rather than to radiate excess heat from the chemical reaction. High humidity will lengthen the resin's working life, as will brisk wind, unless the wind carries styrene fumes away from the surface of the resin, in which case wind will shorten the working life. Table 5 shows approximate gel times for promoted resin at various catalyst ratios and different ambient temperatures:

% Catalyst	Resin Amount	Catalyst Amount	50° F	60° F	70° F	80° F
.75%	100g	.8cc	1-1.5 hr.	50-60 min.	20-40 min.	15-20 min.
1.00%	100g	1.1cc	45 min.	30 min.	20 min.	10-15 min.
2.00%	100g	2.1cc	30-40 min.	20 min.	15 min.	10 min. or less

Table 5: Gel Times

Note Catalyst weighs approximately 1 gram per cubic centimeter; this is a useful conversion when catalyzing resin. For example, 1cc of catalyst (the approximate equivalent of 1g) is required for a 100g batch of resin catalyzed at 100%.

MIXING RESIN

Batch Size

Before mixing resin, the necessary batch size has to be determined, which depends on the size of the lay-up.

We recommend using resin in small quantities of 50, 100 or 200 grams. This is especially helpful when first becoming familiar with gel times and laminating techniques. Unless otherwise specified, start with a 50 gram batch to get a feel for how much resin will be needed for each step. Once this is determined, mix only enough resin in small amounts to complete the step. In time you will acquire a feel for how much resin to mix for a laminate, depending on the temperature, the size of the laminate and the number of layers.

There are several reasons for using small quantities of resin. If a large area is laid up all at once, the whole laminate will begin to gel at once. By using small batch sizes to divide the laminate into sections, the laminate will also gel in sections; after one area is saturated, the next area can be worked even if the previous area starts to gel. Small batch sizes allow enough time to do a good job before the resin begins to gel. Large batches of resin tend to cure faster than small ones because of the heat concentration of the larger mass of resin. Also, because less resin is left to gel in the container, smaller batches minimize the amount of resin wasted.

Determining the Mixing Ratio

Use the gel time's information, the ambient temperature and the size of the laminate to determine the ratio of catalyst for each batch of resin. If temperatures are high, use the minimum amount of catalyst. If temperatures are low and the lay-up is small, use the maximum amount of catalyst. When the conditions are indeterminate, always use the minimum amount of catalyst, allowing the slowest gel time and longest working life. As you gain experience with the particular conditions of your working environment and as your facility with laminating procedures increases, your judgment for determining the mixing ratio will improve. We have found that the most commonly used mixing ratio is a 1% catalyst ratio. This ratio works for most situations, but there are exceptions that will be up to you to determine.

Warning Do not under any circumstances use more than 2.0% catalyst in the mixture. Also, do not use less than the recommended minimum amount of catalyst (.75%) or the resin may never completely cure, resulting in reduced strength.

Measuring the Catalyst

Be accurate when measuring the catalyst. Small deviations will greatly alter gel time. Use a gram scale (available from Glasair Aviation LLC) to weigh the resin and a small plastic syringe, or graduated cylinder, to measure the catalyst. (Plastic syringes without needles are also available from Glasair Aviation LLC.) Syringes with a capacity of 3-5cc graduated in 0.1cc increments work fine for measuring the catalyst.

For small batches of resin, an alternative is to use a small plastic squeeze bottle (available from Glasair Aviation LLC) for dispensing the catalyst drop-by-drop. Included with the squeeze bottle is a calibration chart which displays the number of drops necessary to catalyze different size batches of resin at different percentages.

Warning Be **extremely** careful with the MEKP catalyst. Contact with the eyes must be prevented. Refer to the "SAFETY PRECAUTIONS" in "SECTION I: INTRODUCTION."

Mixing the Resin

Mix thoroughly and scrape the sides and bottom of the mixing vessel while mixing the catalyst into the resin. This mixing step should take approximately 30-60 seconds. Mix in such a way as to entrap the least possible amount of air. After mixing let the resin sit a couple of minutes to de-air. The best mixing container is and **unwaxed** paper tub. These are available in a convenient 8 oz. size in sleeves of 100 from Glasair Aviation, LLC; consult the Options Catalog. In lieu of **unwaxed** paper tubs, any clean metal or glass container is acceptable. However, **waxed** paper tubs are **unacceptable,** as the wax can contaminate the resin, and plastic containers are risky, because the resin may not be compatible with all types pf plastics.

Gelation Versus Cure

Upon mixing the promoted resin with MEKP catalyst, an exothermic reaction takes place—that is, a reaction in which thermal energy (heat) is released. The catalyzed resin will go through five sequential stages of hardness: gel, exotherm, cool, green cure, initial cure and cure. There are no rapid hardness changes except at the gel stage, when the resin begins to change from a liquid to a solid. Depending on the mixing ratio, temperature, batch size, etc., the gel time can vary anywhere from 10 minutes to 1-1/2 hours. To gain approximately 75% strength, the resin must cure for 16-24 hours. This is called "initial cure". To gain full strength, the resin must cure for 3-14 days at 74° F. "Green cure" is the stage at which the resin is hard or stiff enough to allow trimming excess cloth with a knife. Green cure is reached in anywhere from 15-45 minutes after gelation, depending upon temperature.

When resin begins to gel in a container, it will "curdle," developing a consistency similar to strawberry jam for approximately 2-3 minutes and then quickly solidifying. Just before the resin begins to gel, it will be unworkable on cloth, but there will still be enough time to save the brush with acetone solvent. When gelation begins, acetone loses its effectiveness to dissolve the resin, so be sure clean-up is accomplished before the resin gels.

While laminating, pay special attention to the elapsed time (i.e., the time from initial resin catalysis to the present). "Working time" is the time after catalysis and before the start of gelation. "Pot life" is the time specified in the "GEL TIMES" section under "*Catalyzing the Resin,*" above. Due to the many variables affecting gel time, working time will not always agree with quoted pot life times. A cooking timer is helpful to keep track of elapsed time.

Fiberglass Lamination

Fiberglass lamination is the process of impregnating the fibers of the fiberglass cloth reinforcement material with catalyzed plastic resin. While easily learned, fiberglass lamination is an art that requires some practice. The idea is to saturate the cloth with resin while removing any air bubbles present (which detract from the strength and corrosion-resistance of the laminate) without using so much resin that an unnecessarily heavy, resin-rich laminate results.

Hint The best guide for proper lamination is to compare the appearance of the cured laminate with the laminates in small factory-molded parts, such as the fairings or the wheel pants. Don't compare your laminates to the inside of the fuselage halves; they were manufactured with a special process that is difficult for you to duplicate in your workshop.

Standard Laminating Procedures

SURFACE PREPARATION

Secondary bonds are formed whenever a new fiberglass laminate is applied to a previously cured laminate (such as seam laminates applied to join pre-fabricated panels). To achieve satisfactory secondary bonds, proper surface preparation is required.

An independent engineering analysis has shown that prep sanding is the most important factor in ensuring adequate secondary bonding to laminates that have cured for longer than eight months. Joints made where no prep sanding was done sometimes failed at the new-to-old adhesive interface. Joints with prep sanding did not fail in the adhesive interface, but instead failed in the pre-cured piece or in the new lay-up. This indicates the joint overlap was stronger (in shear) than the pieces being joined (in tension).

Surface preparation by wiping with acetone also produced good results (joint stronger than pieces being joined). Dow Chemical literature warns that this practice should not be necessary, however, and can actually cause poor secondary bonding if the wiping rag itself contains any oil or contaminants.

Outside Surfaces of Molded Parts

Any surface that is smooth from being next to the mold must be sanded with 80 grit sandpaper when bonding is required. It is important to have a rough surface so the resin has something to 'bite' and bond to.

Note Be careful to restrict sanding to the surface only; do not sand through any of the fiberglass layers.

A green-colored coating called PVA may be present on the outside of the molded parts supplied in the kit. PVA is used to keep parts from sticking to the molds when new molds are being broken in. PVA may be barely visible, so check closely and remove any PVA with water and paper towels prior to sanding. Dry thoroughly.

Inside Surfaces of Molded Parts

When bonding to the inside surface of the composite shells (those surfaces not against the mold) or to other previously cured laminates, sanding preparation may or may not be required. For the vinyl ester resin system used in the Sportsman, exposure to air actually inhibits chemical curing of the exposed surfaces. Consequently, resin at the surface of a part that was exposed to the air while curing will remain slightly gummy for a period of time. Eventually (after approximately 8-12 months) the surfaces of such parts will cure completely, even when exposed to air. Soft, gummy surfaces do not require prep sanding, but hard, fully cured surfaces do.

To test whether the surface needs preparation, sand a small portion of the surface. If the sandpaper gums up quickly, preparation is not needed. If the sandpaper does not gum up, preparation is needed. Preparation entails sanding the entire area to be laminated with coarse sandpaper (60-80 grit) until it is dull or has no shine. Again, restrict your sanding to the surface only. Do not sand into fiberglass layers below the surface, thereby weakening the structure.

During manufacture of the Sportsman's main fuselage halves, a material called "peel-ply," which is a light dacron cloth, is laminated to the interior surfaces as the final layer. The panels are then vacuum-bagged and allowed to cure. This results in completely cured surfaces, since they are not exposed to the air. After the parts have cured, the peel-ply is removed, leaving a rough surface that is ready for secondary bonding. If your fuselage panels are less than a few months old, therefore, you can safely dispense with sanding before laminating to them; if your fuselage panels are more than a few months old, test them and prep sand, if necessary, as described above.

After the surface has been prepared properly, it must be kept clean and dry until laminating can begin. Dust, moisture, wax, fingerprints, traces of oil or other foreign material that comes in contact with the surface may prevent a good bond. If there is any chance the surface has been contaminated, wipe it with acetone (applied with a clean cloth) as a last step before laminating.

CUTTING THE CLOTH

Fiberglass cloth, like any other fabric, is woven from bundles of fibers. "Warp" is defined as the direction of the cloth weave with the greater percentage of fibers and the greatest strength. "Fill" is the direction of the cloth weave with the lesser percentage of fibers and less strength. The standard, bi-directional fiberglass cloth used in the Sportsman airframe has approximately the same percentage of warp and fill fibers, so it has roughly equal strength in both directions. To gain full structural advantage of fiberglass cloth, the orientation of its weave to load paths in the structure is important. Orientation to load paths is called "bias", which is measured in degrees from the longitudinal axis of the pattern.

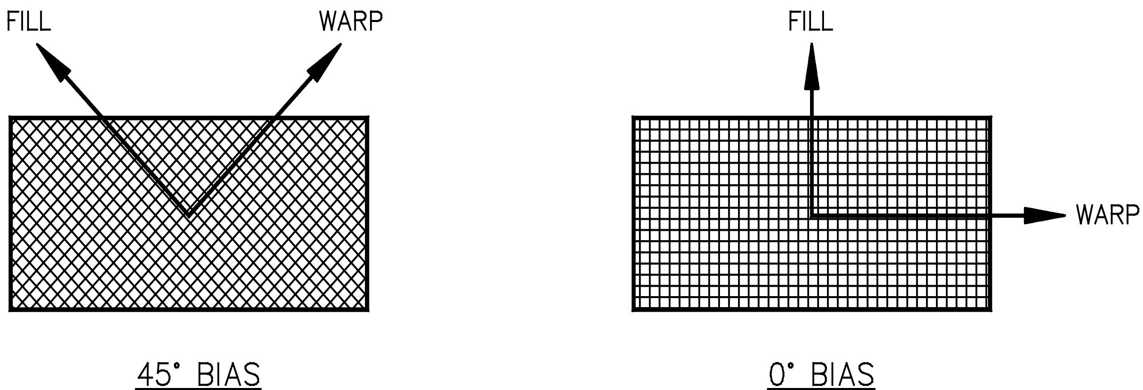
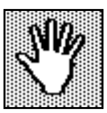


Figure 19: Cloth Bias

All bi-directional cloth used in the Sportsman airframe is cut on either the 45° or the 0° bias (see Figure 19). Cutting bi-directional cloth on the 45° bias has certain advantages related not only to strength. The edges of a piece of cloth cut on the 0° bias tend to unravel, making laminating more difficult, while cutting cloth on the 45° bias alleviates this problem. Also, cloth cut on the 45° bias conforms much more readily to the contours of compound curves. The instructions for particular steps in the Manual will tell you at what bias to cut the cloth.

To cut the bi-directional cloth supplied with the Sportsman kit, unroll a length and lay it on a clean, flat table, being careful not to distort the cloth by pulling it diagonally. Use a marking pen to lay out the pattern on the cloth while observing the specified bias. If a 45° bias is called for, lay out the pieces with their longitudinal axes at a 45° angle to the "selvage" edge—that is, the sewn edge—of the cloth. If a 0° bias is specified, lay out the pieces parallel to the selvage edge. Most of the long, narrow seams in the Sportsman fuselage are laminated with fiberglass seam tape, for which bias is not a consideration. Simply cut pieces of seam tape to the lengths specified.

Cut the cloth either with a pair of heavy-duty scissors or with a rotary cloth cutter ("pizza cutter"). The latter tool (available from Glasair Aviation LLC Aircraft) has a sharp, circular blade that is rolled across the cloth, which is supported on a wood or soft plastic surface to prevent damage to the blade. The rotary cutter works especially well for making curved cuts in fiberglass cloth; it also reduces fraying of the edges and helps reduce stretching of the cloth. If you are striving for a show-quality airplane, and if the laminate will be visible when the airplane is completed, cut the cloth in such a way as to remove any pen marks; the final laminate will be much more appealing to a judge.



Caution Be very careful to keep fiberglass cloth clean and dry during storage and handling. Any moisture or contaminants on the cloth—especially grease or oil—can inhibit adequate saturation of resin into the cloth, greatly reducing the strength of the laminate.

We recommend storing fiberglass products in a closed package in a clean environment. Also, to reduce exposure of fiberglass cloth to possible contaminants, set up a separate cloth-cutting table in a clean area of your shop and restrict its use to fiberglass work only.

SATURATING THE CLOTH

Proper Cloth Saturation

When fiberglass cloth is properly saturated with resin, the cloth looks wet and rich in color but is without puddles. The cloth pattern should still be visible on the surface and not glazed over. White or pale dry areas need more resin.

> **Note** Once the laminate begins to cure, it is too late to add or remove resin to "touch it up."

Minimizing Air Bubbles

Air bubbles in a laminate detract from its strength and corrosion-resistant properties. Air bubbles may be minimized by the following practices:

1. First, apply a thin coat of resin to the surface to be laminated. Then lay the cloth down, rolling the cloth into the resin. Application of cloth to dry surfaces tends to cause air bubbles.
2. When laying up a cloth layer, start in the middle of the piece and work to the outer edges. Use firm but not excessive pressure when brushing or squeegeeing the resin into the cloth. Excessive pressures may fragment existing air bubbles and make them more difficult to remove.
3. Always eliminate all air bubbles from one ply before proceeding to the next ply.

Saturation Techniques

On large, flat surfaces, use the squeegee technique. To start, apply a thin layer of resin to the area to be laminated. This will help saturate the first layer of cloth with resin. Lay the cloth down as neatly as possible, making sure it is centered on the seam or part with no wrinkles or folds present. Then brush on more resin, getting the entire lay-up wet. With a rubber squeegee, spread the resin out using medium pressure, raking across the surface of the cloth to remove any bubbles, air pockets, or excess resin. Be sure not to add too much resin, causing the laminate to float. Also, be careful not to shift the laminate on the part when raking, but still apply enough pressure to remove any excess resin.

On surfaces where the use of a squeegee is impossible, use a varnish brush. The majority of the surfaces on the Sportsman will use the varnish brush technique for saturating the cloth. To saturate the cloth using a brush, use a dabbing or stippling motion with the brush. First, wet the area to be laminated and apply the fiberglass cloth. Then apply the resin with the brush, being careful not to use too much because excess resin is difficult to remove with a brush. Once the cloth is wet, start removing the air bubbles using a rapid stabbing (same as dabbing or stippling) technique with the tip of the brush. The air will bleed through the cloth eliminating the bubbles in this manner.

Hint A standard varnish brush is more effective for laminating if you cut the bristles off to about a 1" to 1-1/4" length.

For large laminates consisting of long narrow strips (especially in inaccessible areas, such as the main fuselage seams), we recommend saturating the cloth on a smooth, clean table top, rolling or folding it as you go. Then, carry the saturated cloth to the seam and, starting at one end, unfold it into position. Use your fingers (protected by rubber gloves) to stick the cloth to the fuselage panels and to work out any air bubbles under the cloth.

When working on difficult or inaccessible laminates, let each layer become tacky to the touch before applying the next layer. For these difficult laminates, applying a new layer before the underlying layer becomes tacky can cause the underlying layer to shift position, introducing large air bubbles or wrinkles.

For most laminates, layers can be placed while the underlying layers are still wet. With this technique, there is no need to wet the area again because the surface will still be wet from the previous layer of cloth. This results in a lighter, less resin-rich laminate. If the previous layer has dried and cured, wet the area again to aid in cloth saturation.

Practice Laminate

If you are not experienced (or not current) with fiberglass laminating, we recommend practicing before starting work on the actual airframe parts. Even if you are experienced with fiberglass construction, it is helpful to practice with the actual materials used in the Sportsman to become familiar with their mixing procedures, gel times, saturation techniques that may differ from other resin systems, etc. Refer to previous topics in this section for detailed descriptions of the procedures discussed below.

Wax a 3'-square area of a Formica table top or an aluminum sheet on a flat workbench. Use a special mold release wax (available from Glasair Aviation LLC; order P/N 270-0205-001) or a good quality automotive paste wax. Apply at least two layers of wax, buffing between layers.

Note Avoid any silicon-based wax. Traces of silicon are extremely difficult to remove from the finished laminate and will inhibit the adhesion of secondary laminates, paint, etc.

Cut two 2'-square pieces of bi-directional cloth on the 45° bias and lay one of these pieces in the center of the waxed area, being careful not to stretch the cloth. Mix a 200 gram batch of resin and pour it onto the cloth. Use a brush or squeegee to spread the resin and then use a squeegee to work the resin into the cloth and to remove excess resin and any air bubbles. Be careful not to stretch the cloth when squeegeeing. Remove as much of the excess resin as possible without drying the laminate out excessively; there should be no white, dry areas in the laminate. Mix extra resin if necessary. When the first layer is saturated satisfactorily, lay the second piece of cloth over the first. Apply more resin and saturate as before.

Before the laminate has cured, compare its surface to the interior surface of the manufactured airframe components; the entire laminate should be evenly and thoroughly saturated with no excess resin pooled on the surface and no white areas of unsaturated cloth. Let cure.

When cured, peel the laminate off the work surface (it should release easily) and save it for use during kit construction. Small pieces will be cut from the laminate for use as supports to which other laminates will be applied to form such components as attach brackets or panel flanges. For use in these applications, the smooth side of the laminate, which was down against the waxed surface, must be thoroughly roughened with sandpaper to prepare a good surface for bonding.

Q-Cell and Mill Fiber Mixtures

"Q-cells" are very tiny, hollow glass spheres that resemble a fine, white powder. Q-cell mixtures are made up of Q-cells mixed into catalyzed resin. Q-cell mixtures are used primarily for sealing the porous surfaces of foam panels, filling holes and radiusing corners.

When mixing to use as a sealant for foam panels, add Q-cells to a batch of catalyzed resin until a **thin**, milkshake-like consistency is achieved. This is called a "wet mix". To seal foam bulkheads and the like, apply a thin layer of wet Q-cell mixture to the foam. Apply only enough to seal the foam. Use a squeegee to rake the mixture over the foam when applying.

To make a Q-cell mixture to use as filler, add Q-cells to a batch of catalyzed resin until a **thick** milkshake-like consistency is achieved. This is called a "thick mix". The consistency should be such that the mixture will hang on a tongue depressor held vertically; a real milkshake of this consistency would have to be eaten with a spoon.

"Mill fibers" are very short fiberglass strands. A mill fiber mixture consists of an appropriate quantity of fiberglass mill fibers mixed into catalyzed resin. These mixtures are used when strong adhesion bonding is required. To mix, add mill fibers to catalyzed resin until you achieve a consistency just slightly more liquid than paste. The mixture should be thick enough to stay on a wooden tongue depressor without running off, while still being fully saturated with resin.

Clean-Up and Disposal of Wastes

The best solvent to use with resin is acetone, which is available at most hardware stores. As noted in the "*Gelation Versus Cure*" section, acetone loses its effectiveness as a solvent when the resin, gel coat or primers begin to gel, so be careful to start clean-up before the resin starts to gel. Use acetone for cleaning resin from brushes, squeegees, etc.

Note If the resin begins to gel while still on the brush, the brush will be ruined unless immediately immersed in acetone.

Warning Acetone is highly flammable. It is harmful to the eyes and skin. Avoid inhalation. It is also poisonous if swallowed. Carefully read all safety precautions on the outside of the container.

Take care when disposing of catalyzed resin. An exothermic reaction is set in motion when catalyst is mixed into resin. Enough heat can be generated in this reaction to cause a fire, depending upon the depth of the resin in the mixing vessel and the amount of catalyst used.

Warning Do not throw away catalyzed resin until after it has gelled, exothermed and cooled. This will help prevent fires from starting in trash cans or waste bins.

We suggest letting the resin cure in its mixing cup on a concrete floor or some other place where it is not in contact with flammable materials and cannot be knocked over. After the mixture gels, exotherms and cools, discard the container.

Trimming and Drilling Fiberglass

Often a fresh laminate must be trimmed to meet the edge of the underlying structure. This is easiest to accomplish when the laminate is in the green cure condition, which is reached about 15-45 minutes after the resin begins to gel, depending on the temperature. In the green cure condition the resin has begun to cure but is still somewhat rubbery, and the laminate can easily be trimmed with a sharp utility knife. If you wait until the resin has reached initial cure (from 16-24 hours after gelation, or even just overnight), you will have to use a hacksaw blade, a cut-off wheel in a die grinder or sheet metal snips to trim the laminate. Trimming the laminate by any of these methods leaves a ragged edge that will then have to be smoothed with sandpaper. If you use a band saw or a saber saw to trim cured fiberglass laminates, the abrasive-type blades work the best and last the longest.

Drilling and countersinking holes in fiberglass structure is done using the same procedures used for other materials, except that the glass fibers tend to fray and intrude into the hole as it is drilled, reducing the hole diameter. This can be minimized by using a very sharp drill bit, but you may need to drill with a slightly oversize bit to allow easy insertion of the fastener.

Aircraft Fasteners

The following discussion is a brief description of the most common fasteners used in assembling the Sportsman. This information is intended to assist the builder in identifying the different hardware supplied with the kit and to provide some general guidelines for its proper use. If you are a first-time builder or an amateur mechanic, we strongly recommend procuring an aviation mechanic's general handbook for a more detailed discussion of this subject.

Bolts

With very few exceptions, the bolts used in the Sportsman are standard, general-purpose, aircraft-grade bolts designated AN3 through AN8. The "AN" number refers to the diameter of the bolt in sixteenths of an inch. The "AN" number is followed by a "dash number" that specifies the bolt's length. For bolts less than 1" long, the dash number is a single digit that indicates the length in eighths of an inch. Dash numbers for bolts 1" long and longer consist of 2 digits, in which the first digit specifies the whole inch portion of the length and the second digit specifies the fractional portion in eighths of an inch. An "H" between the "AN" number and the dash number indicates that the head of the bolt is drilled for safety wire; an "A" after the dash number indicates that the shank is undrilled; and no letter after the dash number indicates that the shank is drilled for use with a castle nut and a cotter pin. For example: an AN3H10A is a 3/16" diameter, 1" long bolt with a drilled head and an undrilled shank; an AN4-16 is a 1/4" diameter, 1-3/4" long bolt with a drilled shank.

A good tool to keep handy is a bolt gauge (available from aircraft hardware suppliers), which is designed to measure the most common sizes of AN bolts.

Nuts

Most of the nuts used in the Sportsman are of the self-locking variety, which uses a nylon insert as a means of safe tying the nuts. These can be used in any low-temperature application where there is no rotation in the components being fastened, which might tend to loosen the nut. In general, self-locking nuts used in high-temperature applications (such as in the engine compartment) are an all metal type (AN363). A letter "A" after the dash number indicates a non-metallic insert.

The nylon self-locking nuts used in the Sportsman are of two types: shear nuts and tension nuts. The shear nuts are designated AN364, are thinner, and may be used only when the only loads on the bolt are shear loads (that is, loads that are perpendicular to the length of the bolt). Tension nuts are designated AN365, are thicker, and may be used when tension loads (parallel to or in line with the length of the bolt) are applied to the bolt.

Other nuts used in the Sportsman (primarily on the control system components) are of the non-self-locking variety. These are either AN310 or AN320 castle nuts for use with drilled-shank bolts and cotter pins or AN316 nuts, which are plain nuts used as jam nuts to lock components such as threaded rod end bearings. Of the castle nuts, the AN310 are tension nuts and the AN320 are shear nuts. AN355 nuts are another type of castle nut used primarily on the engine installation.

Nuts are designated with a dash number which specifies the shank diameter (for bolts 1/4" diameter and larger) or the shank diameter and thread pitch (for bolts or screws smaller than 1/4") of the fastener on which the nut will fit. For example, an AN320-4 is a shear-type castle nut that fits a 1/4" bolt, and an AN365-1032A is a tension-type, self-locking nut that fits a #10 (3/16") bolt with 32 threads per inch.

Washers

Most of the washers supplied with the Sportsman kit are plain washers for use under hex nuts to provide a smooth bearing surface and to act as shims for obtaining the correct grip length of a nut and bolt assembly. AN960 washers are standard-diameter washers; AN970 washers have a larger diameter to provide a greater bearing area in some installations to prevent crushing the structure that the bolt passes through.

Washers are designated with a dash number that corresponds to the diameter of the bolt shank they fit. In addition, a letter "D" before the dash number indicates the washer is made of aluminum alloy rather than steel. Steel washers have no letter designation before the dash number. Use aluminum alloy washers under bolt heads and nuts on aluminum or fiberglass components. For AN960 washers, a letter "L" after the dash number indicates a thin washer. For example, an AN960-416 is a plain steel washer that fits a 1/4" (4/16") bolt, an AN970-3 is a large diameter steel washer for an AN3 (3/16" or #10) bolt, and an AN960D10L is a plain, thin aluminum washer to fit a #10 (3/16") bolt.

Installation Practices

AN bolts have a round "washer" surface machined on the underside of the head, which eliminates the need for a washer under the head when the bolt head contacts a steel surface. A washer under the nut on all types of surfaces guards against mechanical damage to the structure when the nut is tightened. On aluminum alloy structure, use aluminum alloy washers under both the head of the bolt and the nut unless their omission is specified. By observing this practice, any corrosion due to the contact of the dissimilar metals will attack the washer rather than the structure. Use steel washers when joining steel structure with steel bolts.

Be certain that the bolt grip length is correct. Grip length is the length of the unthreaded portion of the bolt shank. Generally speaking, the grip length should equal the thickness of the material being bolted together. Bolts of slightly greater grip length may be used, however, if extra washers are placed under the nut and/or the bolt head. Washers may also be used to adjust the position of castellated nuts with respect to drilled cotter pin holes in bolts. When using self-locking nuts, a **minimum** of 1-1/2 bolt threads must show beyond the nut when the installation is complete.

Torque Values

Use Table 6 as a guide in tightening nuts, studs, bolts and screws whenever specific torque values are not called out. The following rules apply when using the table:

1. To obtain values in foot-pounds, divide inch-pounds by 12.

2. Do not lubricate nuts or bolts except where specifically instructed to do so.

3. Always tighten by rotating the nut, if possible. When space considerations make it necessary to tighten by rotating the bolt head, approach the high side of the indicated torque range. Do not exceed the maximum allowable torque value.

4. Use maximum torque values only when materials and surfaces being joined are of sufficient thickness, area and strength to resist breaking, warpage or other damage.

BOLT, STUD OR SCREW SIZE		TORQUE VALUES IN INCH-POUNDS	
Coarse Thread	Fine Thread	Shear Nuts (AN 320, AN364)	Tension Nuts (AN310, AN365)
8-32	8-36	7-9	12-15
10-24	10-32	12-15	20-25
1/4-20		25-30	40-50
	1/4-28	30-40	50-70
5/16-18		48-55	80-90
	5/16-24	60-85	100-140
3/8-16		95-110	160-185
	3/8-24	95-110	160-190
7/16-14		140-155	235-255
	7/16-20	270-300	450-500
1/2-13		240-290	400-480
	1/2-20	290-410	480-690

Table 6: Torque Values

On all 3/16" and 1/4" bolts, over-torquing is the most common mistake. It is very easy to stretch or strip the threads on 3/16" bolts. A torque wrench is not a requirement for assembling the Sportsman but is recommended if you are not familiar with the approximate feel of the proper torque for the smaller hardware.

Hint To avoid over-torquing small fasteners, use short-handled tools and "choke up" on the handle. This minimizes the amount of torque you can apply.

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Control Cables

Cables are used throughout the Sportsman's flight control system. You'll need to master the following fairly simple splicing, tensioning and safe tying procedures.

NicoPress Sleeve Installation

The prettiest connections between control cables and terminal hardware are swaged splices, but unless you have special access to a very expensive swaging press, you'll probably want to make do with the NicoPress splices supplied with the Sportsman kit. This is no sacrifice in any but aesthetic terms—NicoPress splices are every bit as strong as swaged joints, which is to say as strong as the cable itself.

Figure 20 illustrates the process of making a NicoPress splice. The first step is to run the cable through the sleeve, loop it around the thimble, and feed the end back through the sleeve. Be sure to leave sufficient length extending beyond the sleeve—an inch or more is fine. If you're careful, it's easier to cut off excess when the splice is finished than it is to start over if you come up short. Also, before crimping the sleeve, remind yourself what kind of hardware will ultimately be connected to the terminal you're working on; if it's an eye or a particularly tight shackle, for example, it has to go through the thimble **before** you make the splice! You can save yourself a little cable and a lot of frustration by thinking ahead at this point.

With the thimble in place, slide a cable clamp over the loose end of the cable and push it tightly up against the sleeve. When you have pulled the loose end as tightly as you can around the thimble, tighten the cable clamp to hold the cable in place. Use the NicoPress pliers to make the first of three crimps in the center of the sleeve. Before you squeeze, make sure you've seated the sleeve firmly in the proper notch for the sleeve size you're using—the tool will have several notches, only one of which is right. Squeeze the handles until they are completely closed; incomplete crimping will result in a weak, unacceptable splice. After the first crimp, the second should be made beside the first on the side closest to the thimble or bushing. Finally, the third crimp should be made on the other side of the first. Remove the cable clamp before making the final crimp, because the sleeve lengthens somewhat when crimped.

Hint Clamp one handle of the NicoPress tool in a bench vise to make this an easier one-person operation.

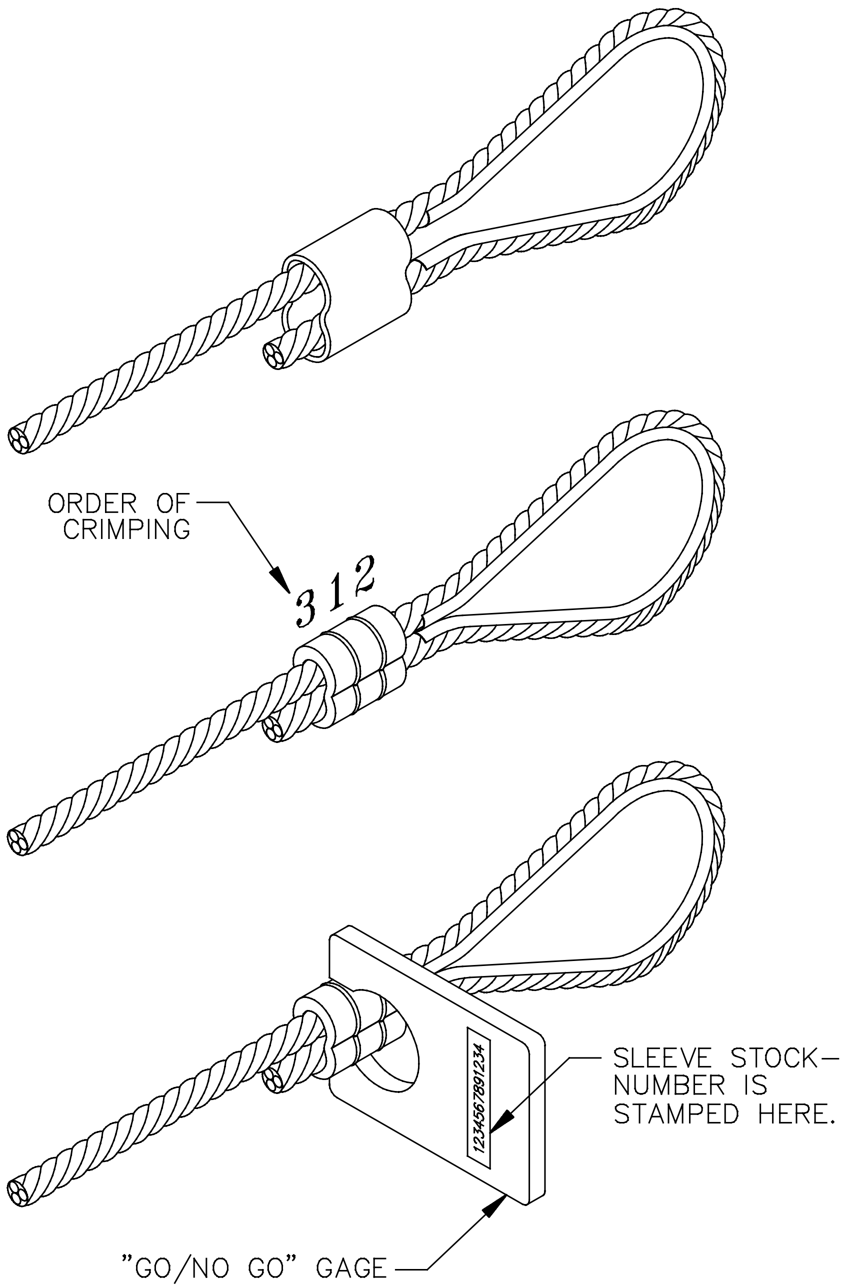

Figure 20: NicoPress Splicing

Hint Some builders like to clip the sharp points off thimbles before making a NicoPress splice. This allows the sleeve to be positioned more tightly against the thimble.

When all three crimps have been made, use the “go, no-go” gauge that comes with the NicoPress pliers to check the width of the crimps. The widest part of the crimped section should slide easily into the appropriate slot in the gauge. If it doesn’t, that means the sleeve was insufficiently compressed, and the splice will not be full strength as a result. Try crimping it again to make it fit the gauge, but be careful—the finished crimps should be round and smooth, and if the second crimping leaves the sleeve buckled or cracked, you’ll have to abandon the splice and start again.

At least 1/8" of cable should protrude beyond the end of the sleeve when the splice is completed. After you are satisfied with the splice, cut off any excess beyond that length using a cable cutter or a bolt cutter.

Caution When cutting excess off the end of a cable, be **extremely** careful not to nick the working cable with your cutters or chisel. Severing a single strand of the working cable is sufficient reason to discard it and start again.

For a cleaner-looking and safer splice, slip a short length of clear heat-shrink tubing over the cable before you slip the sleeve on. When the splice is completed, slide this tubing over the loose end of the cable until it's tight up against the NicoPress sleeve and shrink it down. This tubing will keep those razor-sharp strand ends away from you when you're connecting or adjusting the cables and at the same time—because of its transparency—will allow easier inspection of the terminal splices during pre-flight and annual inspections.

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ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76:

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

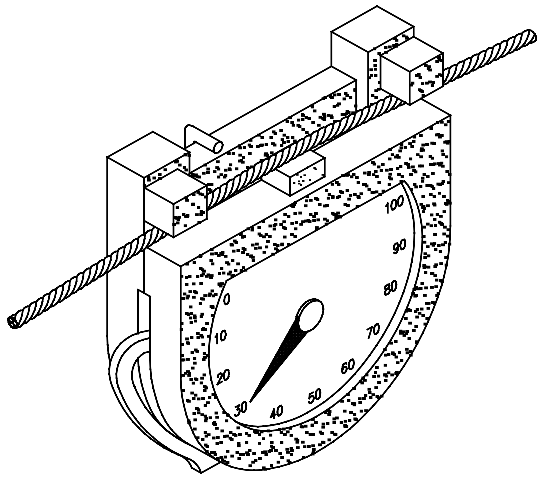
Tensioning

It's essential that proper tension be maintained in all control cables. Tension is adjusted by means of turnbuckles. To measure cable tension, you'll have to lay your hands on a tensiometer (shown in Figure 21), but unless you plan to build lots of airplanes, there's little reason to buy one. Any local A&P mechanic will have one you can probably borrow in exchange for the promise of a ride in your completed Sportsman!

The tensiometer works by measuring the force required to deflect the cable to a pre-determined extent. It does this by pushing a riser against the cable after it has been secured under two anvils. Different risers are used for different cable diameters, so be certain that you're using the right one. Pull the trigger to raise the riser, and then read the indicator. The dial reading is meaningless by itself but must be converted to pounds of tension by using the calibration table supplied with the tensiometer. A sample conversion problem is shown in the calibration table in Figure 8: the tensiometer, with a number 2 riser to measure the tension in a 5/32" diameter cable, indicates "30" on the dial, which converts to 70 lbs. of tension.

To determine the required tension for a control cable of a particular diameter corrected for ambient temperature, use the cable rigging chart shown in Figure 8. For example, assume that a 1/8" diameter, 7 X 19 cable is to be adjusted at an ambient temperature of 85° F. Follow the 85° F. line upward until it intersects the curved line for 1/8", 7 X 19 cable. From the point of intersection, extend a horizontal line to the right edge of the chart. The value at this point is the **maximum** tension (rigging load in pounds) to establish on the cable, which for this example is 70 lbs. To provide free control movement, the tension will generally be set at less than the maximum. Recommended 10-15 lbs less.

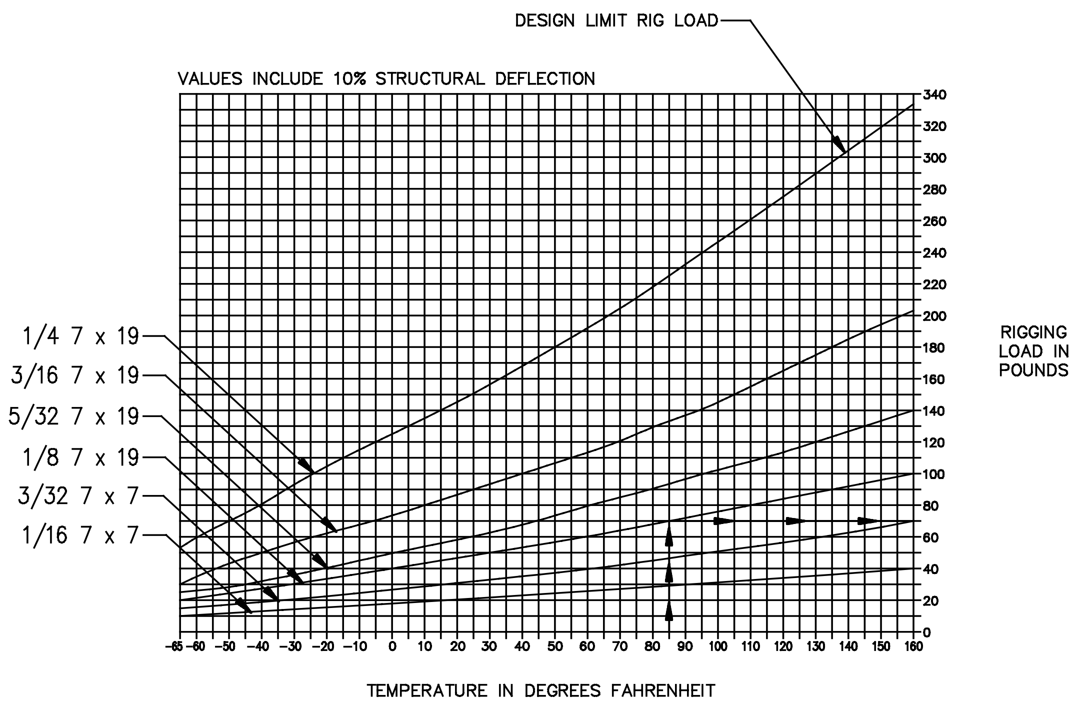
Cable tension is adjusted with turnbuckles installed along each cable run. The only trick in adjusting them is ensuring that the end shanks remain stationary when the center barrel is turned. A good way to do this is to bend a length of stiff music wire into a "U" shape, with the arms of the "U" about as far apart as the shanks of the turnbuckle. Insert one end of the "U" into the hole in each shank, and hold the "U" steady while tightening or loosening the barrel with a straight piece of music wire through its hole.



EXAMPLE

No. 1			RISER	No. 2		No. 3	
1/16	3/32	1/8	TENSION	5/32	3/16	7/32	1/4
12	16	21	30	12	20		
19	23	29	40	17	26		
25	30	36	50	22	32		
31	36	43	60	26	37		
36	42	50	70	30	42		
41	48	57	80	34	47		
46	54	63	90	38	52		
51	60	69	100	42	56		
			110	46	60		
			120	50	64		

CALIBRATION TABLE
SAMPLE ONLY



CABLE RIGGING CHART

Figure 21: Cable Tensiometer, Calibration Chart and Cable Rigging Chart

Safe tying Turnbuckles

Once the proper cable tension has been achieved, the turnbuckles must be safe tied to prevent loosening. Traditionally, this has been done with elaborate wrapping techniques using aircraft safety wire. However, the turnbuckles supplied with your Sportsman kit are a more modern variety designed to accommodate special locking clips. If you feel drawn to tradition, there's no reason you can't wire your turnbuckles; refer to any standard aircraft maintenance manual for directions. But for simplicity's sake, we recommend the clips.

The turnbuckle barrel and terminals are slotted lengthwise to accommodate the locking clips. After the proper cable tension has been achieved, the barrel slots are aligned with the terminal slots and the locking clips are inserted. The curved ends of the locking clips expand and latch in the vertical slot in the center of the barrel. Refer to Figure 22. Once locked in place, the clips are removed by prying them out of the center hole with a large, flat-blade screwdriver. This procedure destroys the locking clip, making it a throw-away item that can only be used once. Make sure the turnbuckle has had its final adjustment, therefore, before snapping the clip into place. Also, be sure to keep plenty of extra clips on hand.

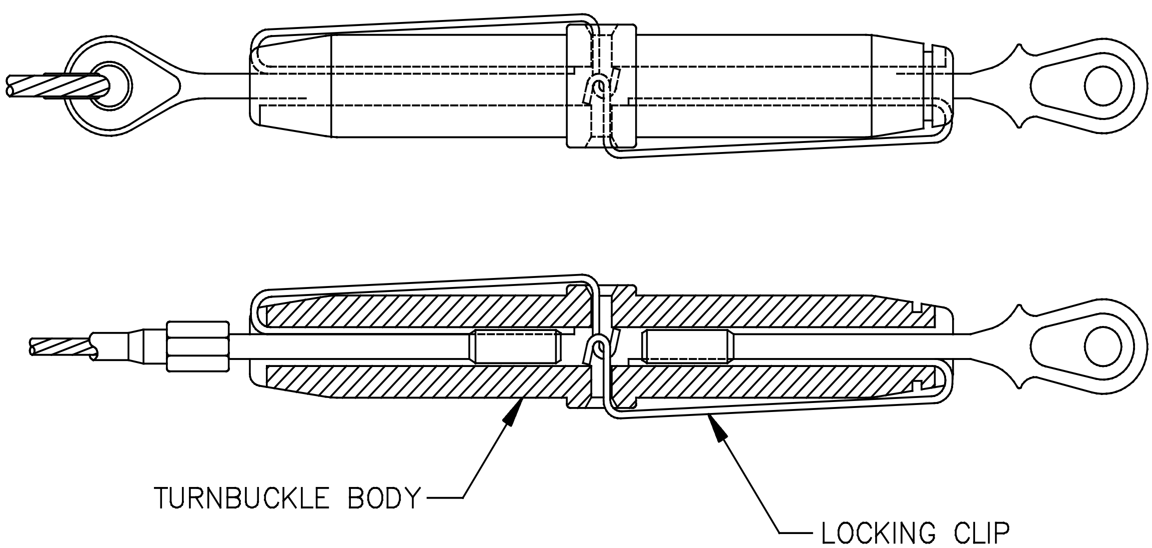


Figure 22: Safe tying Turnbuckles

TUBE FORMING PROCESSES

Tube Cutting

When cutting tubing, it is important to produce a square end free of burrs. Use a tubing cutter with any soft metal tubing, such as copper, aluminum or aluminum alloy.

To use a tubing cutter, place the tubing in the cutting tool, with the cutting wheel at the point where the cut is to be made. Rotate the cutter around the tubing (with the open side of the cutter leading), applying a light pressure to the cutting wheel by intermittently twisting the thumbscrew. Too much pressure on the cutting wheel at one time could deform the tubing or cause excessive burring. After cutting, carefully remove any burrs from inside and outside the tube. Use a knife or the burring edge (reamer) attached to the tube cutter.

When performing the deburring operation, use care not to reduce the wall thickness of the tubing or to fracture the end. A fine tooth file can be used to file the end square smooth.

Tube Bending

The objective in tube bending is to obtain a smooth bend without flattening the tube. Tubing under 1/4" in diameter usually can be bent without the use of a bending tool, although a tool results in neater bends. For larger sizes, a hand tube-bender is usually used. A hand tube-bending tool is available from the Glasair Options Catalog.

Bend the tubing carefully to avoid excessive flattening, kinking or wrinkling. A small amount of flattening in bends is acceptable, but the smallest diameter of the flattened portion must not be less than 75 percent of the original outside diameter. Do not install tubing with wrinkled, irregular or excessively flattened bends. Wrinkled bends usually result from trying to bend thin-wall tubing without using a tube bender.

Swagelok Fittings

All of the metal tubing assemblies on the Sportsman aft of the firewall terminate in Swagelok fittings. These fittings provide the same functionality as the flared tubing connections used with standard AN fittings, but they are much easier to install since they eliminate the need to flare the tubing. Each Swagelok fitting consists of four components, as shown in Figure 23: the nut, the back ferrule, the front ferrule and the body. Swagelok fittings are supplied completely assembled and ready for use. Disassembly before use is unnecessary and can result in dirt or foreign material getting into the fitting and causing leaks.

Swagelok tube fittings are installed in three easy steps:

1. Simply insert the tubing into the Swagelok tube fitting. Make sure that the tubing rests firmly on the shoulder of the fitting. Tighten the nut finger tight.

2. Before wrench-tightening, mark the nut at the 6 o'clock position.

3. While holding the fitting body steady with a back-up wrench, tighten the nut 1-1/4 turns. Watch the mark on the nut, make one complete revolution and then continue to the 9 o'clock position. By marking the nut at the 6 o'clock position as it appears to you, there will be no doubt as to the starting position. When tightened 1-1/4 turns to the 9 o'clock position, you can easily see that the fitting has been properly installed. You can verify proper installation by trying to fit the Swagelok Gap Inspection Gage into the gap between the nut and the fitting body. If the gage **will not fit**, the fitting nut is tightened sufficiently. (The Swagelok Gap Inspection Gage is 0.143" thick for the 1/4" and 3/8" fittings used on the Sportsman.)

Note For 3/16" and smaller tube fittings, only 3/4 turn from finger-tight is necessary to install the fitting.

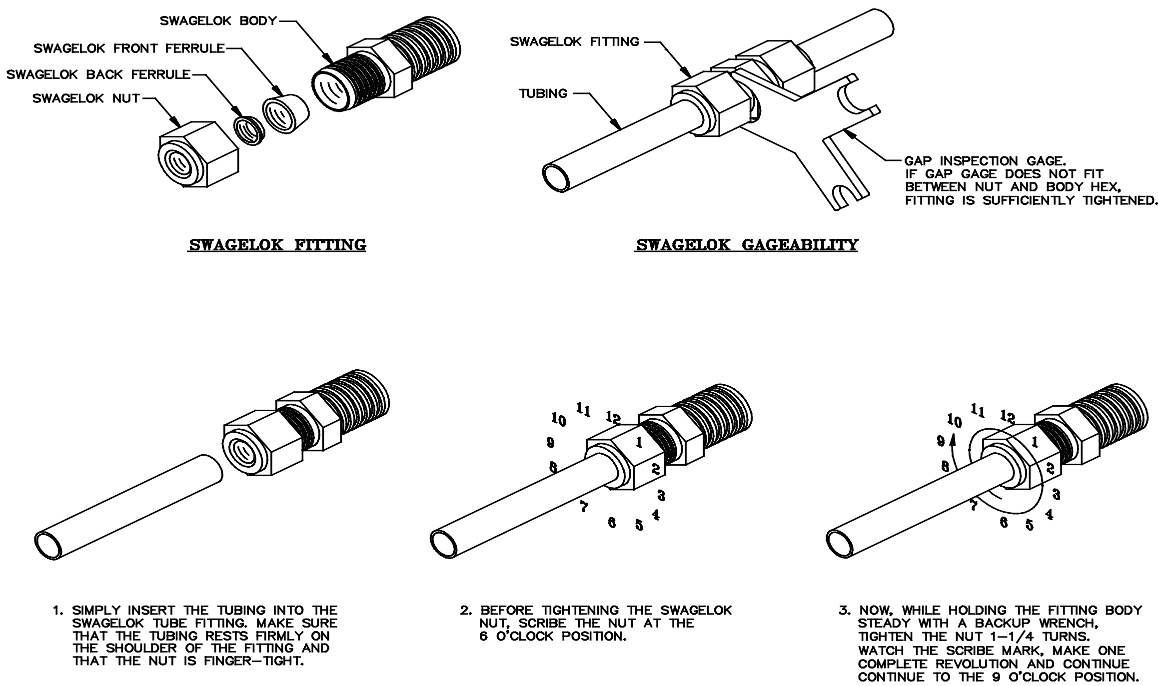


Figure 23: Swagelok Fitting Installation

Connections can be disconnected and re-tightened many times. The same reliable, leak-proof seal can be obtained every time the connection is remade. To do this, insert the tubing with pre-swaged ferrules into the fitting until the front ferrule seats in the fitting. Start the nut and tighten it by hand. Use a wrench to rotate the nut to its original position (an increase in resistance will be encountered at the original position). Then tighten slightly with the wrench. (Smaller tube sizes will take less tightening to reach the original position, while larger tube sizes will require more tightening. The wall thickness of the tubing will also have an effect on tightening.)

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ELECTRICAL WIRING AND CONNECTIONS

To a large extent, a trouble-free electrical system depends on the quality of the connections between the electrical cables and the various components of the system. Cables are connected to the components with crimp-on connectors, such as butt splices or ring-end terminals, or by solder joints.

Use crimp-on connectors rather than solder joints wherever possible. Solder joints are generally not used in aircraft unless the wire is well supported near the connection, such as in radio stacks, with connectors and cable supports attached to the radio stack framework, or in quick-disconnect plugs that utilize a strain-relief for the wire bundle. The reason is that solder makes a rigid connection that defeats the purpose of using multi-strand, flexible, aircraft quality wire. A rigid solder joint can weaken and break when subjected to continuous vibration. Where solder joints are necessary, be sure to support the wire near the joint to prevent the joint from flexing.

Crimp-On Connections

Crimp-on connections are easy to make: strip 1/4" of the insulation from the end of the wire, insert the wire into the connector so the insulation butts against the shoulder of the metal connector socket, and crimp the connector with the proper jaws of the crimping tool.

Note Use a firm tug on the connector to test its security.

Solder Connections

Solder joints, while also fairly simple, are somewhat more prone to error. Accordingly, here are a few suggestions for achieving good solder joints:

1. Use **only** 60/40 rosin-core solder. **Do not** use acid-core solder.

2. After removing 1/4" of the insulation from stranded wire, it helps to "tin" the separate strands together by twisting them tightly and applying a small amount of solder.

3. Before soldering, form a hook in the bare wire end and crimp it tightly around the terminal lug with a pair of needle-nose pliers. This mechanical connection adds to the strength of the solder joint and helps prevent movement of the joint while it cools.

4. When soldering, position the soldering pencil tip, as shown in Figure 24a, so that it contacts and heats both the wire and the terminal lug simultaneously. Apply the solder to the opposite side of the connection as shown in Figure 24b, allowing the heated connection rather than the soldering pencil to melt the solder. Hold the joint still while the solder cools. The finished solder joint should appear smooth and shiny, and the solder should appear to flow onto and blend into both the wire and the lug, as shown in Figure 24c.

5. If the finished joint is not smooth and shiny but rather is dull and grainy or chunky in appearance, it indicates that the joint was disturbed during cooling. Reheat the connection and, if necessary, add more solder.

6. Improper positioning of the soldering pencil tip so that it doesn't heat both the wire and the lug can also result in a faulty connection called a "cold solder" joint. The solder on such a joint will not appear to flow onto both the wire and the lug, but will tend to collect in rounded drops or blobs. Again, reheat the connection until the solder flows properly.

Use heatshrink tubing on all solder joints to protect against moisture and accidental short circuits. Clear tubing is preferable, since it aids inspection of joints.

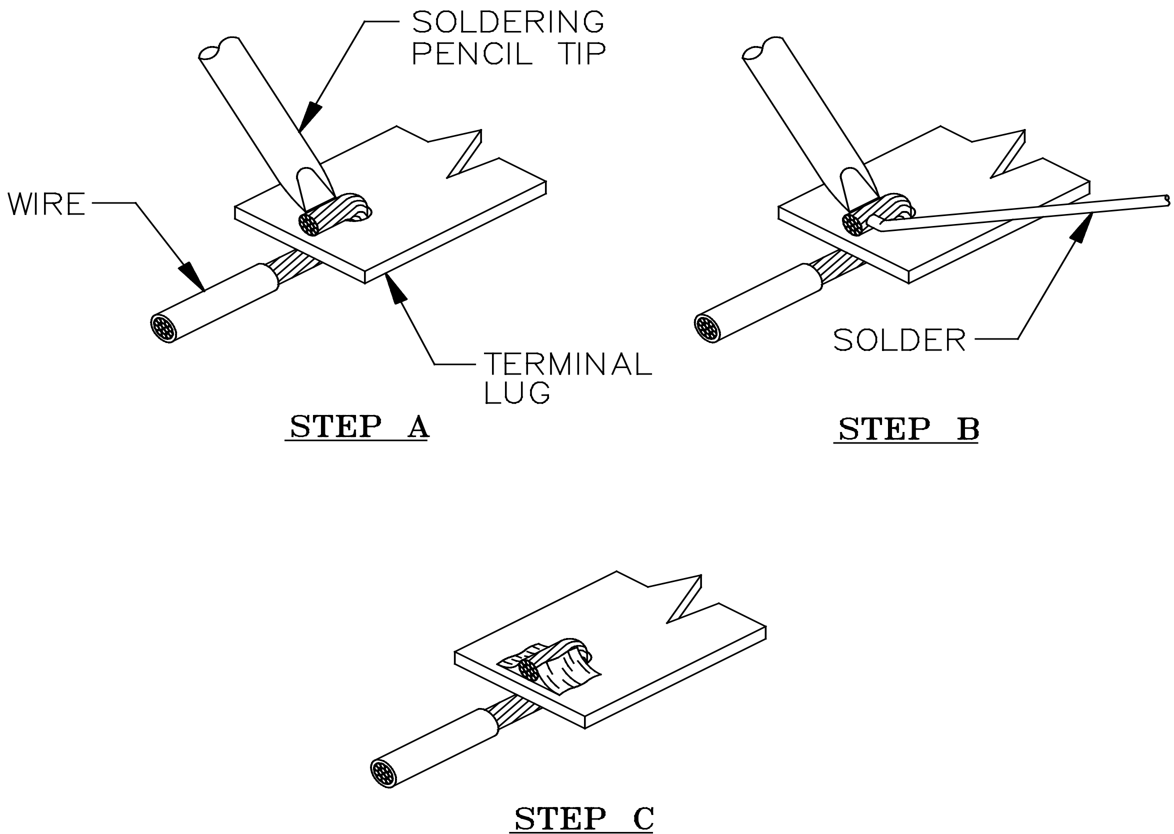

Figure 24: Soldering Procedures

Wire Routing

In routing the wiring for the electrical system, make extensive use of cable clamps, spiral wrap and wire ties to keep the wires clear of moving parts of the various systems, to prevent vibration from chafing the wires and to bundle the wire runs together for a tidy installation.

Warning Always route electrical wires above any fluid lines to help prevent short circuits or fires caused by fluid from a possible leak running down the wires.

Refer to the book, *Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair/Aircraft Alterations*, FAA publication number EA-AC43.13-1A & 2A, for descriptions of standard wiring procedures.

Note Wire ties, cable clamps, adhesive mounting pads for securing wire bundles to the airframe, heat shrink tubing, an assortment of crimp-on connectors, quick-disconnect terminals, terminal strips, spiral wrap (both regular and high-temperature) and other electrical components are all available from Glasair Aviation LLC. Consult our *Options Catalog* for details.

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Flexible Hose Assemblies

Flexible aircraft hoses are used in the fuel and oil systems of the Sportsman. Hoses forward of the firewall use braided Aeroquip hose and AN fittings. The hoses are easily fabricated by cutting raw hose stock to the correct length and installing the appropriate hose end fittings. We strongly recommend protecting fuel and oil lines in the engine compartment with fiberglass fire sleeves. When fabricating and installing flexible aircraft hose assemblies, observe the general rules depicted in Figure 25 and in the following list:

1. Install hose assemblies without twisting.
2. Never stretch a hose tightly between two fittings as this will result in over-stressing and eventual failure. When fabricating a hose assembly, provide about 5-8% slack.
3. Avoid tight bends in flex lines as they may result in failure. Never exceed the minimum bend radius specified for the hose.
4. Support all hose installations at least every 24". More frequent supports are preferable.
5. Carefully route and securely clamp hose assemblies to avoid abrasion, kinking or excessive flexing. Excessive flexing may cause weakening of the hose or loosening at the fittings. If some rubbing cannot be eliminated, protect the hose by wrapping with nylon spiral wrap (available from Glasair Aviation LLC).

Note For more information, such as minimum bend radii for different hoses, refer to EA-AC 43.13, Chapter 10.

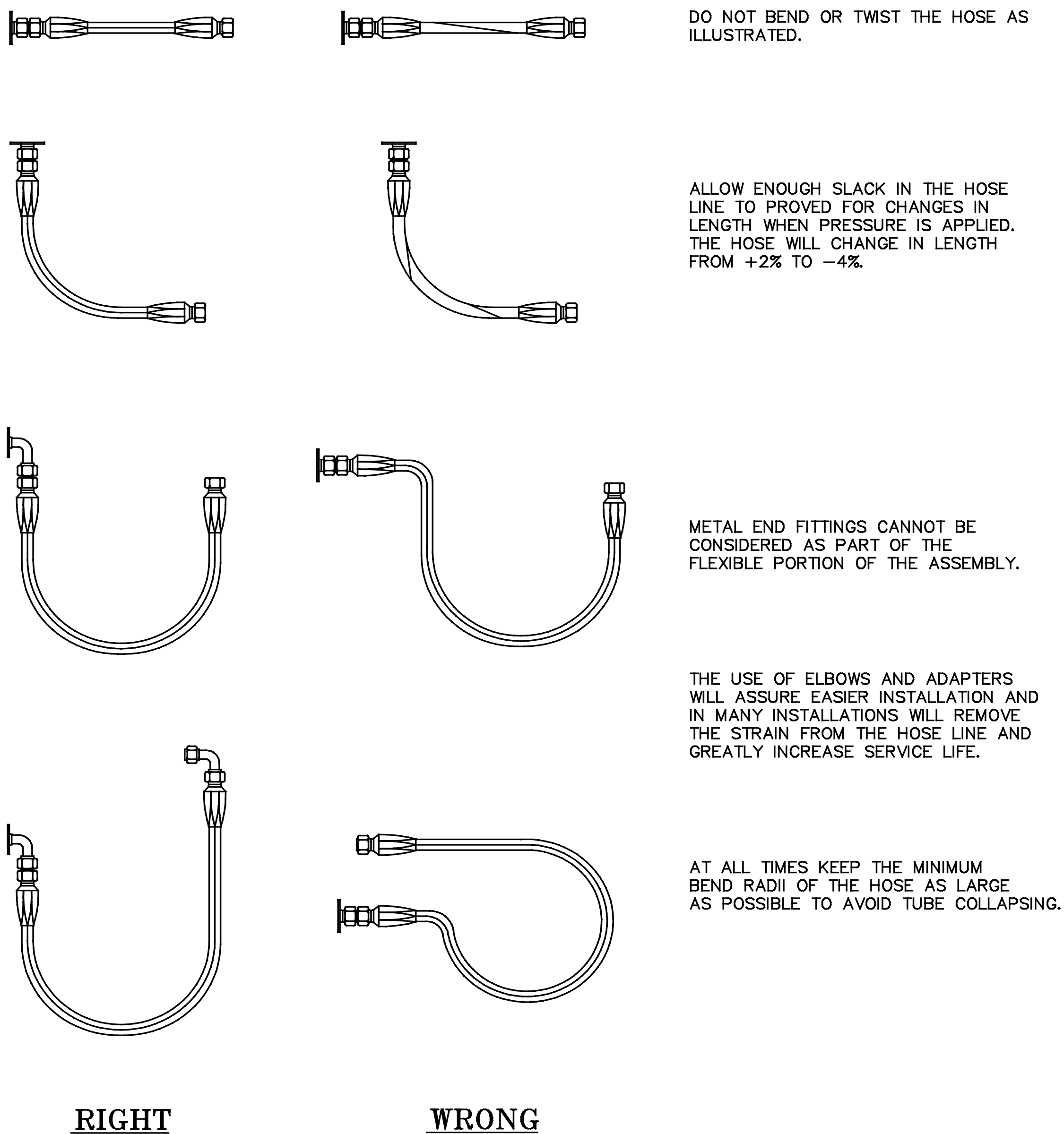


Figure 25: Proper Hose Installations

To size hose, temporarily fasten the hose ends onto the fittings between which the hose will fit. With a tape measure or piece of wire, measure the length needed. When measuring, make sure to allow sufficient length to conform to the slack and minimum bend radius requirements described previously.

Aeroquip Hose Assemblies

To cut Aeroquip hose and install the end fittings, refer to Figure 26 and follow these steps:

1. Cut the hose squarely to length. Use an abrasive cut-off wheel or a fine tooth hacksaw. To minimize wire braid fraying, tightly wrap the hose with masking tape in the area of the cut and saw through the tape. Remove the tape after cutting. Remove any excess wire braid with wire cutters.

2. Place the hose in a vise. Screw the socket onto the hose in a counterclockwise direction.

3. Using tape or a marking pen, mark the hose at the rear of the socket as a reference to detect any slippage of the hose within the socket.

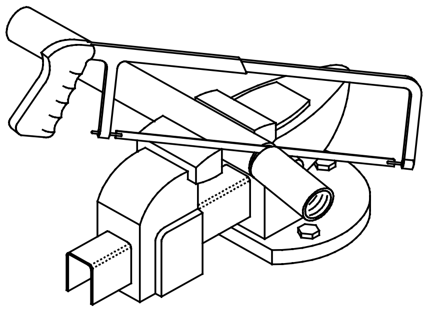
4. Lubricate the inside of the hose and nipple threads liberally with oil or light grease.

5. Place the socket in a padded vise. Carefully insert the nipple and engage the nipple and the socket threads while holding the hose in position with the other hand. Make sure that the hose does not push out of the socket by observing the reference mark made in Step 3.

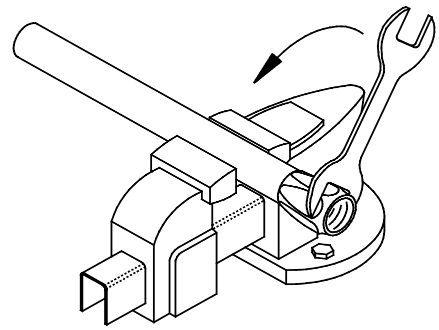
6. Complete the assembly using a wrench while continuing to hold the hose in position. Do not tighten the nipple against the socket, but leave a slight gap (.005" to .031"). The maximum allowable gap between the socket and the nut is .041".

7. Check for hose push-out by observing the hose position mark. No push-out should be evident.

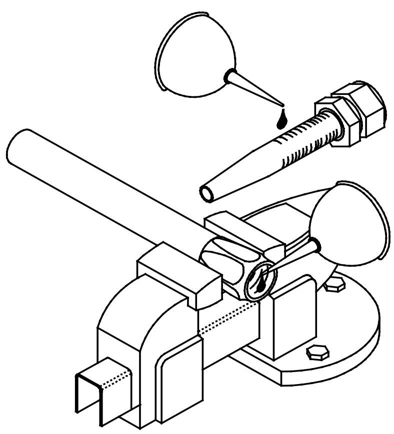
8. Always blow out or flush the hose assembly with solvent after completion. Visually inspect the inside of the hose for obstructions and contamination. A common problem resulting from improper fitting installation is a partially cut inner wall that makes a rubber flap inside the hose.



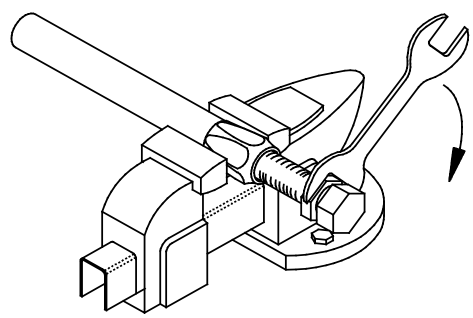
1. PLACE HOSE IN VISE AND CUT TO DESIRED LENGTH USING FINE TOOTH HACKSAW OR CUT OFF WHEEL.



2. PLACE HOSE IN VISE AND SCREW SOCKET ON HOSE COUNTERCLOCKWISE.



3. LUBRICATE INSIDE OF HOSE AND NIPPLE THREADS LIBERALLY.



4. SCREW NIPPLE INTO SOCKET USING WRENCH ON HEX OF NIPPLE AND LEAVE .005 INCHES TO .031 INCHES CLEARANCE BETWEEN NIPPLE HEX AND SOCKET.

Figure 26: Aeroquip Hose Assemblies

> **Hint** A useful tool for assembling aircraft hoses is a **hose assembly mandrel**. This tool threads into the hex nut of the nipple and has a smooth, cylindrical shaft that extends completely through the nipple, beyond its tapered end. The shaft guides the nipple into the hose as the nipple is threaded into the socket, preventing the nipple from tearing the inside of the hose.

If you don't want to fabricate your own hose assemblies, you can order them custom-fabricated to your specifications from several suppliers, some of which are listed here:

Herber Aircraft, (800) 544-0050

Sacramento Sky Ranch, Inc., (916) 421-7672; Fax (916) 421-5719

Aircraft Spruce and Specialty Co., (800) 824-1930; Fax (714) 871-7289

Interior Corrosion Protection

Corrosion of metal components is a potentially serious problem, and steps should be taken to prevent it. However, the degree of protection required depends to an extent on the environment in which the aircraft will be operated. Protection that is adequate for a plane based and primarily flown inland would not be sufficient for a floatplane or a plane based and flown near salt water. On the other hand, the level of protection required for the latter environments might be unnecessarily expensive and time consuming for the former. So, as the builder you will have to judge the sort of environmental demands you'll be placing on your airplane. The following information should help you to make and carry out an appropriate choice.

What Needs Protection?

Some of the steel parts in the Sportsman kit are cadmium plated at the factory and thus require no further anti-corrosion treatment. Many others, however, are untreated and must receive supplemental corrosion protection. The same is true of the aluminum components. The wing, stabilizer and control surface skins are Alclad; this means that the aluminum alloy, which has relatively low corrosion resistance, is clad in a thin layer of pure aluminum, which has excellent corrosion resistance. Therefore, Alclad parts are probably sufficiently corrosion resistant without further treatment for most land-based use. However, other important structural components such as ribs, spars, stiffeners and doublers are not all Alclad and require some extra surface protection, depending on where and how you'll be flying your airplane.

> **Caution** The Alclad coating is extremely thin. Any scratches that penetrate the coating allow corrosion to take root in the underlying alloy. For this reason, don't sand or buff any Alclad surfaces (except to prepare for painting) and be careful to avoid inadvertent scratches. If an Alclad surface becomes scratched, it must be treated as unclad metal and protected as described below.

At a minimum, you need to provide some extra corrosion protection, such as an alodine treatment, to the interior structure of the wings and empennage. If you anticipate floatplane operation, especially on salt water, then a comprehensive interior treatment, including application of a suitable primer, is strongly recommended for all ribs, spars, skins and fittings.

Methods for Corrosion-Protecting Aluminum

The recommended corrosion protection program for aluminum parts consists of three steps: cleaning, alodine treatment and priming. Ideally, these steps should follow one another directly. Letting a cleaned part sit overnight, for example, could, under certain conditions of temperature and humidity, allow oxidation that would necessitate re-cleaning.

CLEANING

The purpose of the cleaning step is to remove dirt, grease and oxidation that will inhibit the bonding of the primer to the metal. Such contamination doesn't need to be visible to mess up an otherwise good priming job. Therefore, you should make it a practice to clean **all** parts before proceeding to the alodine treatment and priming stages regardless of whether a part looks "dirty" or "greasy."

Aluminum cleaner is manufactured by a number of different companies and should be readily available in most areas through auto body supply houses.

The first step is to mix the aluminum cleaner, using the manufacturer's instructions. For most applications, you can use a mixture toward the more dilute end of the manufacturer's recommended range; however, if the parts you are treating have been stored for a long time outside their protective plastic coverings or have gotten unusually dirty for any reason, use a stronger dilution.

Note Don't worry about diluting more aluminum cleaner than you need for a particular job; there's no problem storing the dilute cleaner for future use. Just follow the normal storage precautions discussed above.

Apply the aluminum cleaner by wiping it on liberally with a paper towel. For parts that have just recently been uncovered, this is all that is necessary. For oxidized or otherwise contaminated parts, follow the toweling with a thorough scrubbing with a piece of Scotch Brite non-metallic scrub pad (very fine grade, #7448, preferred). When in doubt, remember that scrubbing will never do any harm.

Caution Be especially careful to remove any pencil or pen marks you may have made during assembly. These can require extra Scotch Brite scrubbing to remove, but it is essential to do so, because if allowed to remain they will bleed through the primer.

Caution Never use steel wool to clean aluminum parts. The tiny particles of steel left behind can be extremely difficult to remove completely, and any that remain could bring about dissimilar metals corrosion.

If you Scotch Brite a part, follow up with another paper towel application of aluminum cleaner. Allow the cleaner to lie on the surface of the metal for 1-3 minutes and then rinse the part thoroughly with clean water. However, do not allow the cleaner to sit long enough to dry on the part before rinsing.

Note It is not necessary to use distilled water for either mixing or rinsing the aluminum cleaner.

ALODINE TREATMENT

Like aluminum cleaner, alodine should be available through auto body supply houses. The purpose of alodine treatment is to provide microscopic roughening of a clean metal surface to aid the adhesion of the primer coat. It is essential, therefore that the part be, in fact, clean before alodizing. If a part has been cleaned but has been allowed to sit for a period of hours, it is safest to assume that it has picked up airborne dirt and grease and/or oxidized: clean it from scratch using the procedures outlined above and alodize it immediately afterwards.

> **Note** It is not necessary to let a part dry after rinsing off the aluminum cleaner; you can proceed directly to alodizing.

Mix the alodine solution according to the manufacturer's instructions. Apply the mixture liberally to the parts to be treated. For large surfaces like stabilizer or wing skins, the solution can most easily be applied with a sponge; use a brush for smaller or irregular surfaces like rib webs and flanges.

> **Note** Like the aluminum cleaner, the alodine can be stored diluted if so desired.

As with the aluminum cleaner, the alodine solution should be allowed to sit on the part for a few minutes without being allowed to dry. Rinse the part thoroughly with clean, cold water after 1-5 minutes have elapsed.

If you are going to apply primer for additional protection, let the part dry **thoroughly** before moving on. Air drying is fine if you are in no hurry, since oxidation is no longer a problem now that the part has been alodized. However, if you want to speed the process up, use a heat gun or blow dryer. **Do not** use compressed air, as the air stream from a compressor will likely contain small droplets of oil and water.

PRIMING

To date, the most popular primer choices have been either the traditional zinc chromate or epoxy. Both provide good corrosion protection, although epoxy is somewhat superior and is clearly preferable for airplanes that will be exposed to salt water or spray. The downside of epoxy for other applications is the inconvenience of having to measure and mix the resin and the hardener. For its part, zinc chromate is even more highly toxic than epoxy is, and its use is declining for that reason. The new water-based primers appearing on the market are safer environmentally, but be sure to check with the manufacturer about the corrosion-protection service history of a new product. Results vary widely with water-based products.

Caution Both the solvents used for pre-primer cleaner and the most popular primers themselves are powerful and potentially harmful chemicals. Follow all manufacturers' safety guidelines carefully. Good ventilation is absolutely essential, and the use of rubber gloves, goggles and a respirator is highly recommended.

For bare metal parts that will not be visible in the cabin area, we recommend applying a single coat of acid etch wash primer (PPG DX 1791/1792 yellow) on all parts.

For steel or aluminum parts that will visible inside the cockpit or baggage area such as the cage attach angles, rudder pedals, door latches, etc, we recommend either the same PPG mentioned above or a rattle can of primer formulated for metal or an epoxy based primer mixed and shot from a spray gun followed by a top coat of matching cage gray paint. The matching gray touch up paint is available from Glasair Aviation part number **027-00001-01**.

For the utmost corrosion-protection, dab a little primer in each rivet hole before riveting, especially if bare metal was exposed by drilling or deburring.

Methods for Corrosion-Protecting Steel

The recommended minimum corrosion-protection for steel parts consists of cleaning and priming. An optional step, phosphoric acid-etching, can be completed immediately after cleaning to provide better adhesion for the primer.

CLEANING

The surfaces of steel parts must be completely free of both corrosion and contaminants to provide good adhesion of the primer and to prevent the formation of corrosion beneath the surface finish. Sandpaper, Scotch Brite pads, wire brushes and steel wool are all acceptable tools for attacking surface rust on steel parts, but we recommend sand or bead blasting as this removes corrosion more surely than hand methods and minimizes the amount of residue remaining on the part.

To clean contaminants from rust-free steel parts, use a cleaner formulated for all metals, such as Prep-Sol, Aquaprep or Poly-Fiber Metl-Sol C-2200. Check the label on the cleaner you acquired for aluminum surfaces; it may be okay for use on steel as well. If you are not going to acid-etch your parts, wipe them dry with clean rags or towels, after cleaning and rinsing, and use a heat gun or blow drier in less accessible nooks and crannies. After the parts are dry, protect them from contaminants until they've been primed—even the body oils deposited by handling the parts with your bare hands could inhibit good adhesion of the primer. If you are going to acid-etch your parts, there is no need to dry them after cleaning as long as you proceed directly to the acid-etching step.

Phosphoric Acid-Etch (Optional)

Phosphoric acid serves the same purpose on steel parts as alodine on aluminum parts—it provides microscopic roughening of the surface to promote adhesion of the primer. (If you sandblasted your parts, acid-etching is not necessary as the sandblasting itself produces adequate surface roughness.) Dilute the phosphoric acid with equal parts water and apply to the surface with a sponge or a brush. Allow the solution to remain on the surface for 5–10 minutes and then rinse thoroughly with clean water and dry as described above.

Warning Common sense dictates that you protect yourself from exposure to phosphoric acid. At least, wear rubber gloves and a face shield.

Priming

Our recommendations for priming steel parts are the same as for aluminum parts: use either the traditional zinc chromate or, even better, a two-part epoxy primer such as Dupont DP-50. Whatever primer you choose, apply it as soon as possible after cleaning and etching, preferably within 1–2 hours.

Apply the finish paint after the primer has cured. You can use any finish paint that's compatible with your primer, but we recommend painting the parts white or another light color to make it easier to inspect for cracks. The only exception to this is the V-brace in the windshield area of the cage; this should be painted a darker color with a matte finish to minimize glare.

Hint FAA Advisory Circular 43-4A, *Corrosion Control for Aircraft*, is a good source for further information on this subject. See also the article "Rust Protection" by Tony Bingelis in the October 1995 issue of *Sport Aviation*, pp. 86-91.

AIRCRAFT FINISHING AND PAINTING

To exhaustively cover the entire subject of finishing and painting an airplane would almost double the size of the Sportsman Assembly Manual, so we'll provide only some general guidance here. For additional information, refer to the publications listed in "RECOMMENDED READING" in "SECTION I: INTRODUCTION." Probably the best sources of information for painting and finishing procedures are the paint manufacturers' own published guidelines for the use of their products.

The first issue to consider is whether you need to paint the airframe at all. Especially if you want to minimize the weight of the finished airplane, as well as the time and expense required to build it. All of the airplane's metal skins are Alclad aluminum, so they are fairly corrosion resistant without finish paint. The biggest disadvantage to leaving the aluminum skins unpainted is the occasional polishing required to keep them looking bright.

All the fiberglass parts are delivered with a white Duratec (vinyl ester resin based) primer that will need to be finish sanded and painted. Instead of painting decorative trim stripes, you can make them from self-adhesive vinyl. Sign shops exist almost everywhere that can computer-generate vinyl trim stripes, graphics and "N" numbers in virtually any size, shape and color. Or you can use ready-made vinyl stripes, which are available in a variety of widths.

Assuming that you have decided to paint your Sportsman, the next issue to consider is whether you want to paint it yourself. We recommend completing most of the surface preparation yourself and letting a professional apply the conversion coating (if used) for metal parts, the primer and the finish paint. A good professional painter has a climate-controlled work area to achieve the best finish and also has experience with different types of paint to avoid problems (such as "orange peel," "blushing," "fish eyes" or paint runs) that a novice might encounter.

Letting a professional apply the paint also saves the price of a spray gun, reduces your exposure to hazardous chemicals and eliminates the problem of dealing with overspray in your home workshop environment. If you choose this route, consult with the painter before beginning surface preparation to both clarify what is expected in terms of surface preparation and to ensure that the solvents and primer you use will be compatible with the finish paint.

As you chose the paint color for your Sportsman's fuselage, be aware that fiberglass products may be adversely affected by extreme high temperatures. While the Sportsman's fiberglass resin system has a Glass Transition Temperature of 200 degrees F., we recommend painting the fuselage white, or at least a very light color, with a minimum of dark color trim. Light colors, especially white, absorb less solar energy and keep the painted surfaces as cool as possible. A dark finish can absorb enough solar energy on a hot, sunny day to attain a surface skin temperature of almost 200° F. A white surface, on the other hand, will be at or only slightly above the ambient air temperature. One of the effects of high skin surface temperatures is a tendency for the fiberglass cloth pattern to slightly show through to the surface after a period of time.

If you choose to do the final painting yourself, we will leave it to you to learn the procedures and acquire the necessary skills on your own. The work to prepare the Sportsman for painting naturally divides into two separate topics: preparing the sheet metal parts and preparing the fiberglass parts.

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104:

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Preparing Sheet Aluminum Parts for Painting

The steps to prepare sheet aluminum parts (the wings, empennage and control surfaces) for painting are essentially the same as the steps for "CORROSION PROTECTION" discussed previously: cleaning, sanding and/or etching and priming. Cleaning involves using a suitable solvent or a detergent solution to remove oils and other contaminants from the surfaces of the parts. The parts are scuffed with a Scotchbrite pad and/or etched with some kind of conversion coating or acid etching process. Finally, a suitable primer is applied. Refer to the "INTERIOR CORROSION PROTECTION" section for a further discussion of these steps.

Before you can begin this process, however, you will have to choose the type and brand of paint you are going to apply. The most common paints for aluminum airplanes are acrylic enamels and lacquers, and polyurethane enamel. Consult with your paint professional to choose a paint system, then follow the paint manufacturer's recommendations for preparation. Remember that it is always best to stick to the same brand for primers, thinners, top coat and other chemicals. While two different manufacturers might specify the same type of thinner, for example, compatibility is not guaranteed unless you use each manufacturer's own products exclusively.

Finishing Fiberglass Parts

Duratec 1794-005

The composite fuselage panels are fabricated by first spraying Duratec primer into the mold and then applying the structural laminates on top of it. The primer and the resin are both styrene based compounds, so they bond together to become integral parts of the whole structure. The primer finish is sandable.

PREPARING FIBERGLASS PARTS FOR PAINTING

Regardless of who will be painting your fuselage, we recommend doing as much of the preparation work as possible yourself and then having a professional finish sand the primer and apply the finish paint. Consult with your paint shop in advance to choose a paint (we recommend an acrylic urethane or polyurethane top coat) and follow the manufacturer's (and the paint shop's) recommendations for preparation. The general preparation sequence is filling the seams and other surface imperfections, then sanding the entire fuselage and, finally, cleaning in preparation for the finish primer and paint. All of the fillers, cleaners, solvents and putties used in preparation must be compatible with the top coat you plan to use.

SURFACE FILLING

Because of its factory-molded fuselage panels, preparing the Sportsman fuselage for painting involves much less filling and smoothing than is typical with an aircraft fabricated from hot-wired foam cores and built-up fiberglass laminates. The only filling required on the Sportsman is in the seam areas where the fuselage panels fit together.

Use Ultralite body filler (Bondo) to fill seam areas on the fuselage and then sand smooth and flush starting with 180 grit and progressing to 320 grit sandpaper. If a depression exists in the primed fuselage panels which you want to fill, you must first roughen the primer thoroughly with sand paper to provide a good grip for the filler material. Several applications of filler, with sanding in between, may be required to achieve the desired results.

For filling irregularities of significant depth (not likely to be encountered) we recommend using a very thick Q-cell/resin mixture. This will result in the minimum extra airframe weight and will be fairly easy to sand when cured. Fill smaller imperfections with Ultralite body filler. Although the body filler is much heavier than a thick Q-cell mixture, the weight penalty is acceptable (for the small areas involved) in return for the body filler's other advantages: quick curing and easy sandability.

After initial sanding of the filled areas, go over the areas with an air nozzle. This will reveal any dust-filled cavities and pin holes. Fill these holes with Ultralite body filler or glazing putty before final sanding.

SANDING THE FUSELAGE

The factory-applied primer finish may be glossy and contain mold release waxes from being next to the mold when the fuselage panels are fabricated. Start by scrubbing the fuselage with a wax and greaswe remover such as PPG Acryli-Clean DX 330. Next, the glossy surface must be block sanded to provide a "tooth" to grip the primer and finish paint. When sanding, use a good light and view the surface from different angles to make sure that no shiny or glossy areas remain.

Achieving the best possible finish on your Sportsman fuselage requires a complete sanding with several progressively finer grades of sandpaper until a smooth, even surface condition exists. Since the entire Sportsman fuselage consists of compound curves, use a flexible sanding block for all sanding.

First, use a 220 grit dry sandpaper using 45° angle strokes to WL 100 in opposite directions to remove all glossy or shiny areas. After this initial sanding, use a finer grit (320) wet or dry sandpaper to work on small imperfections and scratches. Just before painting, lightly sand the entire fuselage with 400 grit wet or dry sandpaper. Wet sanding is preferable because it keeps dust to a minimum and the water keeps the sandpaper from loading up with primer.

FINAL SURFACE PREPARATION

After you are satisfied with the sanding phase of surface preparation, you are ready for the final finish coats of primer and paint. Use an air nozzle to blow out any dust that may have accumulated in cracks and crevices throughout the fuselage. If you don't do this now, the air from the paint spray gun will raise the dust during final paint spraying, to the detriment of the airplane's final finish. Also, thoroughly vacuum the entire fuselage and, if you are doing your own painting, use a solvent compatible with the finish to wipe down the surfaces to be painted. Besides helping to remove dust, the solvent removes fingerprint oils and other surface contaminants that might interfere with good paint adhesion. As a final step immediately before painting, use a tack cloth to remove dust from the airframe surfaces. (If you are taking the fuselage to a professional painter, the paint shop will take care of the final cleaning and tack rag steps.)

For optimal results if you are painting the fuselage yourself, seal the entire surface with one or two coats of epoxy primer per the manufacturer's specifications as a sealer. An epoxy primer provides the best adhesion and durability for urethane top coats. Again, follow the manufacturer's recommendations for preparation, mixing, application and safety.

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SECTION III: RUDDER ASSEMBLY

PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1.1	Skin, Left hand	1	301-00001-03
1.2	Skin. Right Hand	1	301-00001-04
2	Skin, forward	1	301-00002-01
3	Spar, forward	1	301-00003-01
4	Spar, aft	1	301-00004-01
5	Rib, counterweight	1	301-00005-01
6	Rib, root	1	301-00006-01
7	Rib, tip	1	301-00007-01
8	Bracket, forward spar/counterweight rib	1	301-00008-01
9	Bracket, forward spar/hinge	1	301-00009-01
10	Plate, hinge mounting	1	301-00010-01
11	Bracket, aft spar/counterweight rib	1	301-00011-01
12	Bracket, aft spar/root rib	1	301-00012-01
13	Hinge	1	301-00013-01
14	Shim, hinge	1	301-00014-01
16	Yoke weldment	1	301-01000-01
17	Sheet, lead, 12" wide	16"	750-0372-002
18	Bolt	2	AN3-10A
19	Nut	3	AN315-3R
20	Nut, nylon self-locking	3	AN364-1032A
21	Bolt	2	AN4-6A
22	Screw	2	AN507-10R16
24	Washer	3	AN960D416
25	Large washer	3	AN970-3
26	Nutplate	6	K1000-08
27	Nutplate	2	K1000-4
28	Sheet metal practice kit	1	075-00001-01

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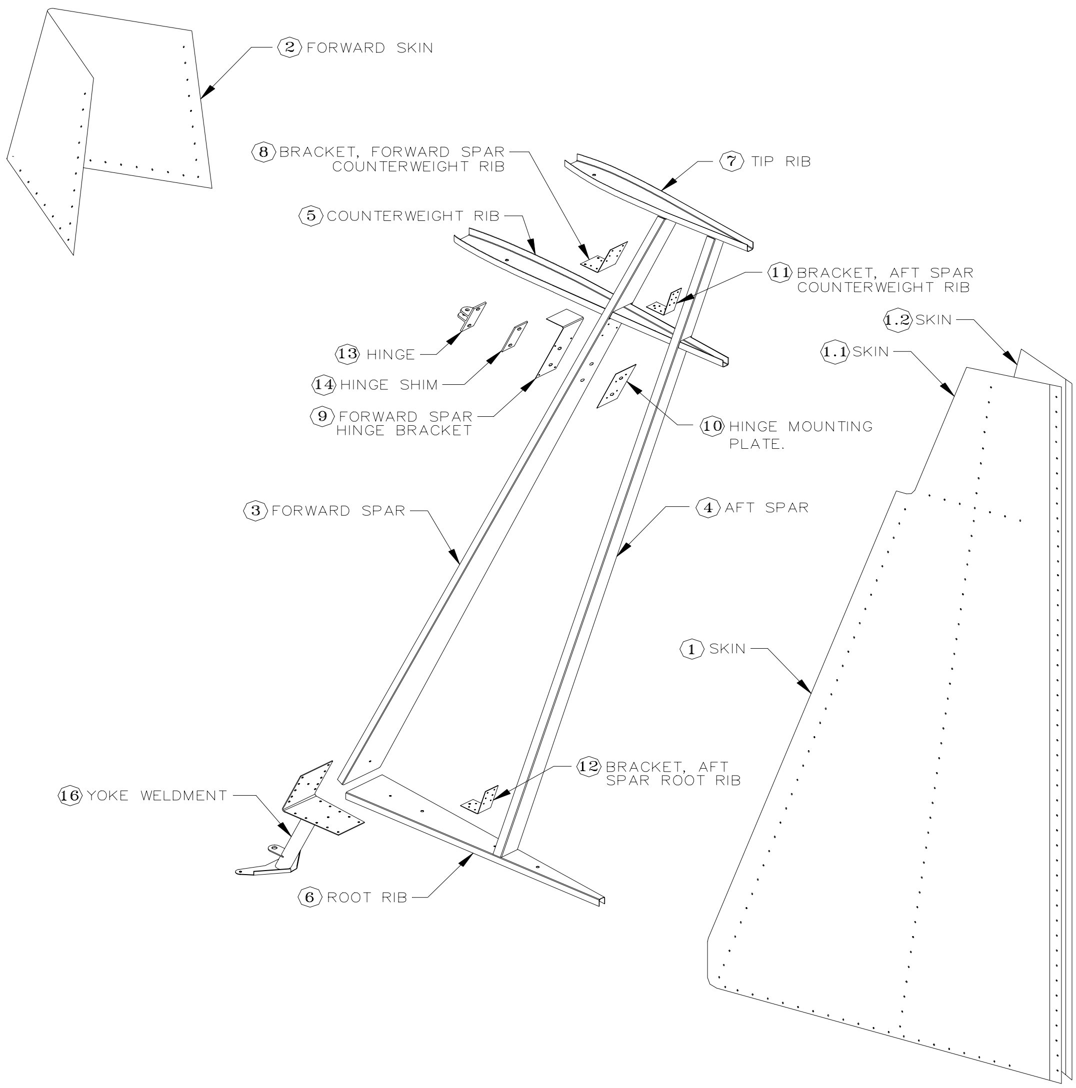

Figure 1: Rudder Assembly

Tool List

1. Flat and round files or edge deburring tool
2. Fine point marking pen, pencil
3. 6' straightedge (or chalk line)
4. Carpenter's square (framing square)
5. Clecos, 3/32" and 1/8" (approximately 80 and 25 each, respectively), with pliers
6. Cleco side-grip clamps or small C-clamps
7. Electric drill or air drill with #40, #30, #19 and #10 bits
8. Right-angle drill with #40 and #30 bits
9. Hole deburring tool
10. Dimple dies, 3/32"
11. Machine stop countersink tool with #40 and #10 piloted cutters
12. Riveting frame (optional)
13. Rivet gun, air compressor and bucking bars
14. Flush-head rivet set
15. Universal-head rivet sets, 1/8" and 3/32"
16. Rivet squeezer with 3/32" and 1/8" sets (optional)
17. Blind rivet puller

Additional Materials

1. Sheetrock screws and driver bit for drill
2. 2' X 3' piece of 1/2" plywood
3. Wood scrap blocks
4. Corrosion-proofing materials

Workspace

To assemble the rudder, you will need a six foot long (minimum) work table and adequate space to walk all around the table. The width of the table is not important, although a narrower table (three feet wide, or less) will provide easier access to both sides of the rudder when it is in the jig. The best procedure would be to build your wing jig table, as described in "Section VI: Wing Assembly," and use one end of the table to assemble the rudder. The wing jig table can also be used to build the horizontal stabilizer and the elevator.

ASSEMBLY SEQUENCE

The goal of the rudder assembly procedures is to produce a straight finished rudder without bows or twists. A simple jig will be used to help accomplish this goal, but the jig by itself will not guarantee a straight rudder; you must also think about what you're doing and check the rudder for proper alignment in the jig at every step, especially before any major drilling or riveting operation. Also, make sure that rivet lines marked on rib and spar flanges are parallel to the flange; if the rivet line on a spar is allowed to drift toward the edge of the flange, for example, the result will be a twisted rudder if the skin rivet holes are drilled through the line. Finally, follow the standard procedures for drilling lines of rivet holes and driving lines of rivets, as detailed in "SECTION II."

The general assembly sequence is as follows:
1. Inspect, deburr and straighten the parts, as necessary.
2. Fabricate the rudder jig.
3. Cleco together the internal structural framework (the spars and ribs)
4. Clamp the skins to the structural framework and drill the rivet holes to size
5. Disassemble the rudder, deburr all the rivet holes, and remove chips and shavings
6. Fabricate the counterweight
7. Corrosion-proof the parts
8. Install the counterweight
9. Rivet the assembly together

PREPARING THE PARTS

Step 1: Inspect and Deburr the Parts

Use small, fine files or an edge deburring tool to deburr the edges of the rudder spars, ribs and skins as necessary.

Completed: [ ]

Step 2: Mark the Flange Centerlines

Use a marking pen to mark centerlines on all of the spar and rib flanges. Take care, as mentioned above, to mark the lines parallel to the flanges of the parts.

Completed: [ ]

FABRICATING THE RUDDER JIG

Step 3: Mark the Rudder Trailing Edge Line

Draw a straight line on a 6' long (minimum) work table perpendicular to the end of the table, as shown in Figure 2. This line positions the rudder trailing edge when the rudder is in the jig. The trailing edge is slightly above the table during assembly.

Completed: [ ]

Step 4: Install and Mark the Spar Support Board

Use sheetrock screws (or whatever other means is handy) to fasten a 2' X 3' piece of 1/2" plywood, the "spar support", to the end of the table centered on the trailing edge line, as shown in Figure 2. Position the spar support with its long dimension oriented vertically. Draw a vertical line onto the spar support upward from and perpendicular to the rudder trailing edge line on the table. The trailing edge line on the table and the vertical line on the spar support define the center plane of the rudder panel. Draw a horizontal line on the spar support **25-1/2"** above the surface of the table. Drill two **1/4"** holes through the spar support; each hole is centered on the horizontal line **2-31/32"** from the vertical line, as shown.

Note When the rudder yoke is fastened to the spar support at the 25-1/2" dimension, the trailing edge of the skin will not contact the table. This is desirable, as it will allow you to slide the skin on and off the framework without unfastening the yoke from the support. Wooden blocks on each side will be used to center the skin over the trailing edge line. Also, the holes for fastening the rudder yoke to the spar support board are 1/4" rather than 3/16" in diameter to ensure that the yoke is free to pivot up and down when fastened to the support. (See the Note on page 9.) Finally, the spar support board can twist from side to side when viewed from above. This is not a concern; string lines and plumb bobs will be used to verify proper alignment of the structure before drilling any rivet holes.

Completed: [ ]

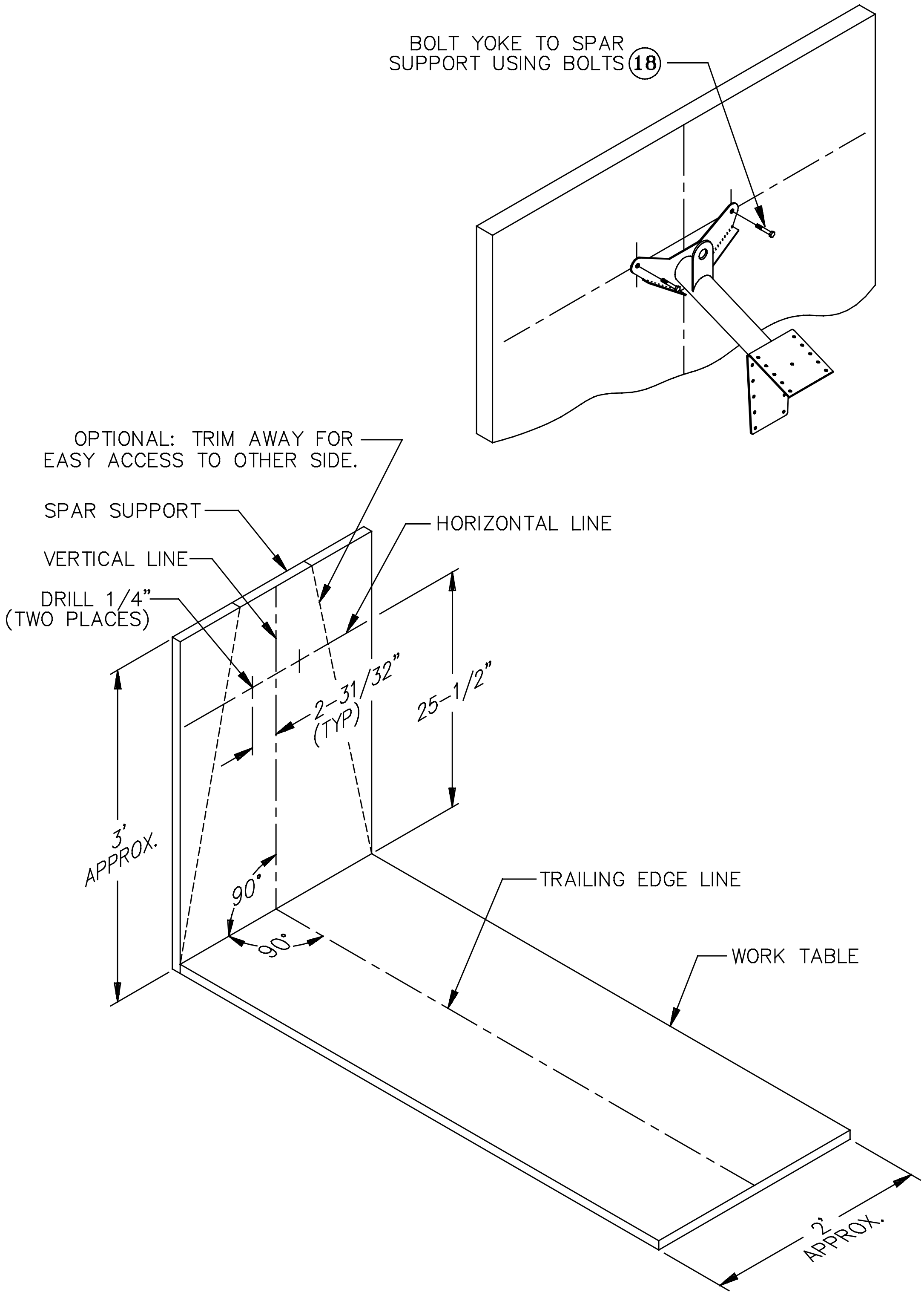

Figure 2: Rudder Jig

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Step 5: Fasten the Yoke Weldment to the Spar Support

As shown in Figure 2, use two 3/16", AN3-10A **bolts** [18] and AN315-3R **nuts** [19] to fasten the **yoke weldment** [16] to the spar support through the two holes drilled in the previous step. **Don't tighten the nuts**; the yoke weldment should be free to pivot up and down slightly to accommodate changes in the rudder assembly's position.

> **Note** This jig **is** intended to allow the yoke to pivot freely up and down. If it does not, slightly enlarge the bolt holes in the support board.

Completed: [ ]

Preliminary Assembly of the Structural Framework

In this section, the rudder's internal structure (the forward and aft spars and the root and counterweight ribs) will be assembled and mounted to the jig. In order to avoid building a twist into the rudder, it is important that all components be properly aligned with the jig during assembly, so **check the structure for straightness at every step**. The other important consideration here is to assemble the internal structure in such a way that the pre-punched rivet holes in the skin fall on the centerlines of the spar and rib flanges. Specific procedures for ensuring straightness and rivet hole alignment are incorporated in the following instructions.

Step 6: Join the Forward Spar/Hinge Bracket and the Hinge Mounting Plate to the Forward Spar

Use small C-clamps (or the equivalent) to clamp the **forward spar/hinge bracket** [9] to the forward surface and the **hinge mounting plate** [10] to the aft surface of the **forward spar** [3], aligning the three parts with 1/4", AN4-6A **bolts** [21] inserted through the pre-punched holes, as shown in Figure 3.

> **Note** Check the fit of the forward spar/hinge bracket inside the flanges of the forward spar. This bracket must **not** ride on the bend radii of the spar at any point, but rather must lie flat against the spar web. If necessary, use fine-toothed files or a belt sander on the bracket to relieve any interference. Remove as little material as possible and try to do it equally on both sides.

Use the four small holes in the forward spar/hinge bracket as guides to drill **#40** holes through the assembly from the forward side. Cleco each hole after drilling.

Also, use the pre-punched holes near the rectangular hole in the forward spar as guides to drill **#40** holes through the assembly from the aft side.

Finally, use the four small holes in the hinge mounting plate as guides to drill **#40** holes through the assembly from the aft side. These last holes are for the AN426AD3 flush-head rivets that mount the nutplates; countersink these holes on the forward side of the forward spar/hinge bracket.

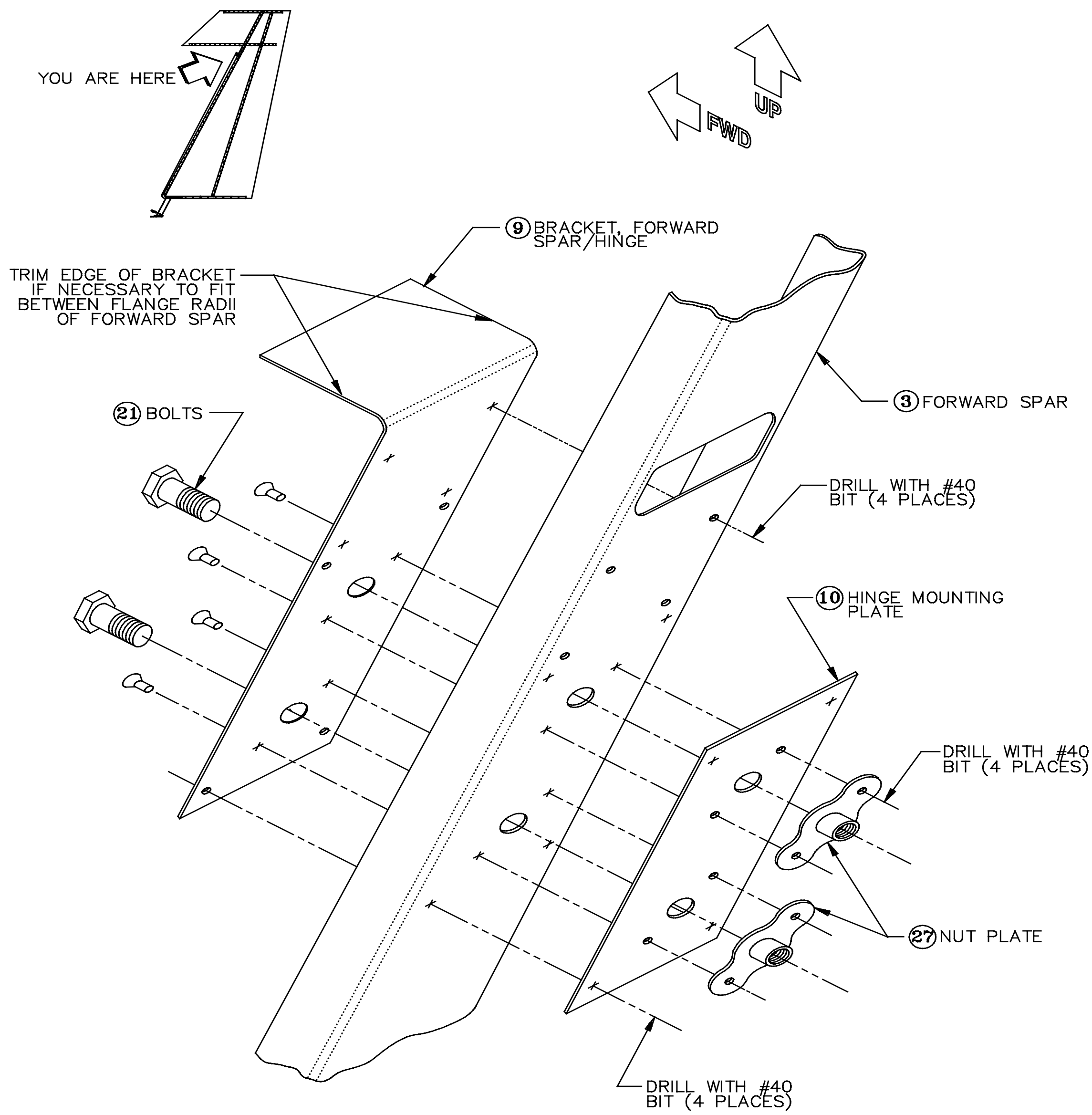

Figure 3: Hinge Mounting Plate and Forward Spar/Hinge Bracket Assembly

Separate the hinge bracket and the hinge mounting plate from the forward spar; these will be reinstalled later, in Step 10.

Completed: [ ]

Step 7: Drill and Cleco the Forward Spar to the Yoke Weldment

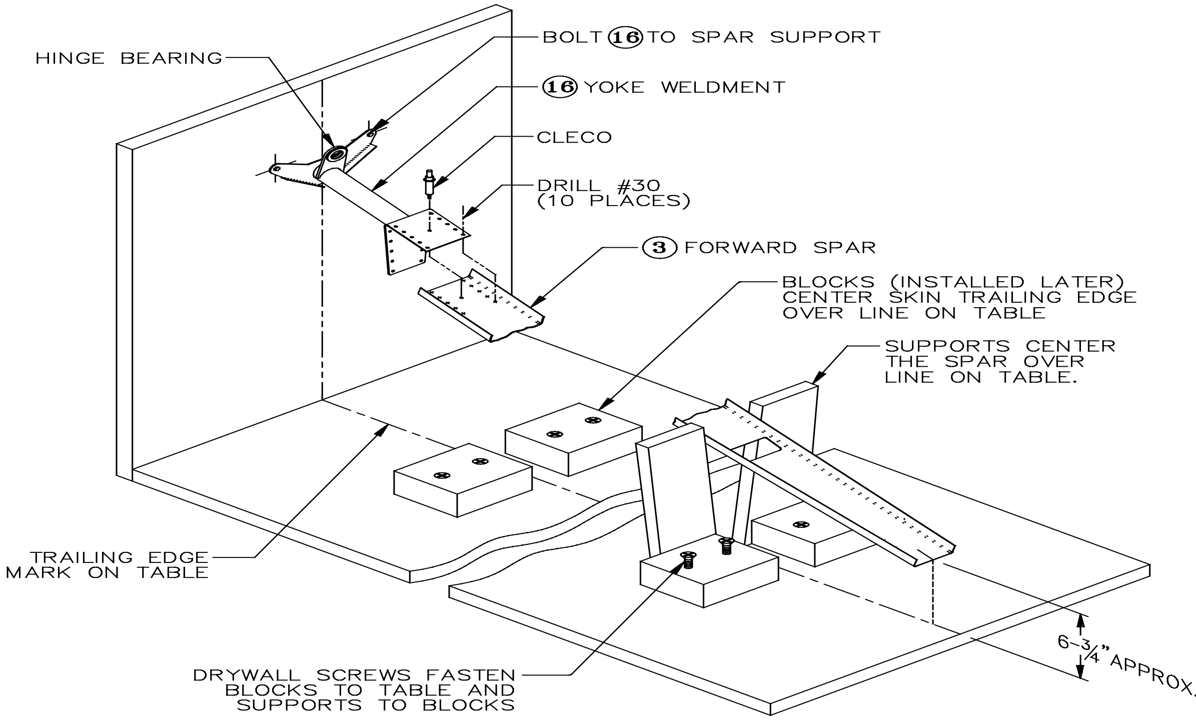

Figure 4: Forward Spar/Yoke Weldment Assembly

Cleco the forward spar to the yoke weldment, using the one pre-drilled hole in each part. (The spar fits on the **aft** side of the yoke weldment plate, as shown in Figures 1 and 4.) Fabricate supports from scrap wood, as shown in Figure 4, to center the forward spar over the trailing edge mark on the table. Position the supports an inch or so **below** the hole in the spar for the counterweight rib.

Note As with all other location and direction references used throughout the *Assembly Manual*, the words "aft" and "below" refer to a direction **as installed in the aircraft**, not relative to the jig.

Note Since the supports that center the spar over the trailing edge line are angled and the yoke is free to pivot up and down, you should be able to lift the spar/rib assembly up slightly to slide the skin into position without removing the rudder structure from the jig. Position (or bevel) the cleats that fasten the angled supports to the table to allow the skin to fit all the way down into the "vee" between the supports. Aim for a distance between the two vertical supports of each pair of about 1/4**"** at the table surface. This will guarantee that the rudder skin will be held securely between the supports without bottoming out against the table top.

Do not drill any holes through the spar, yet.

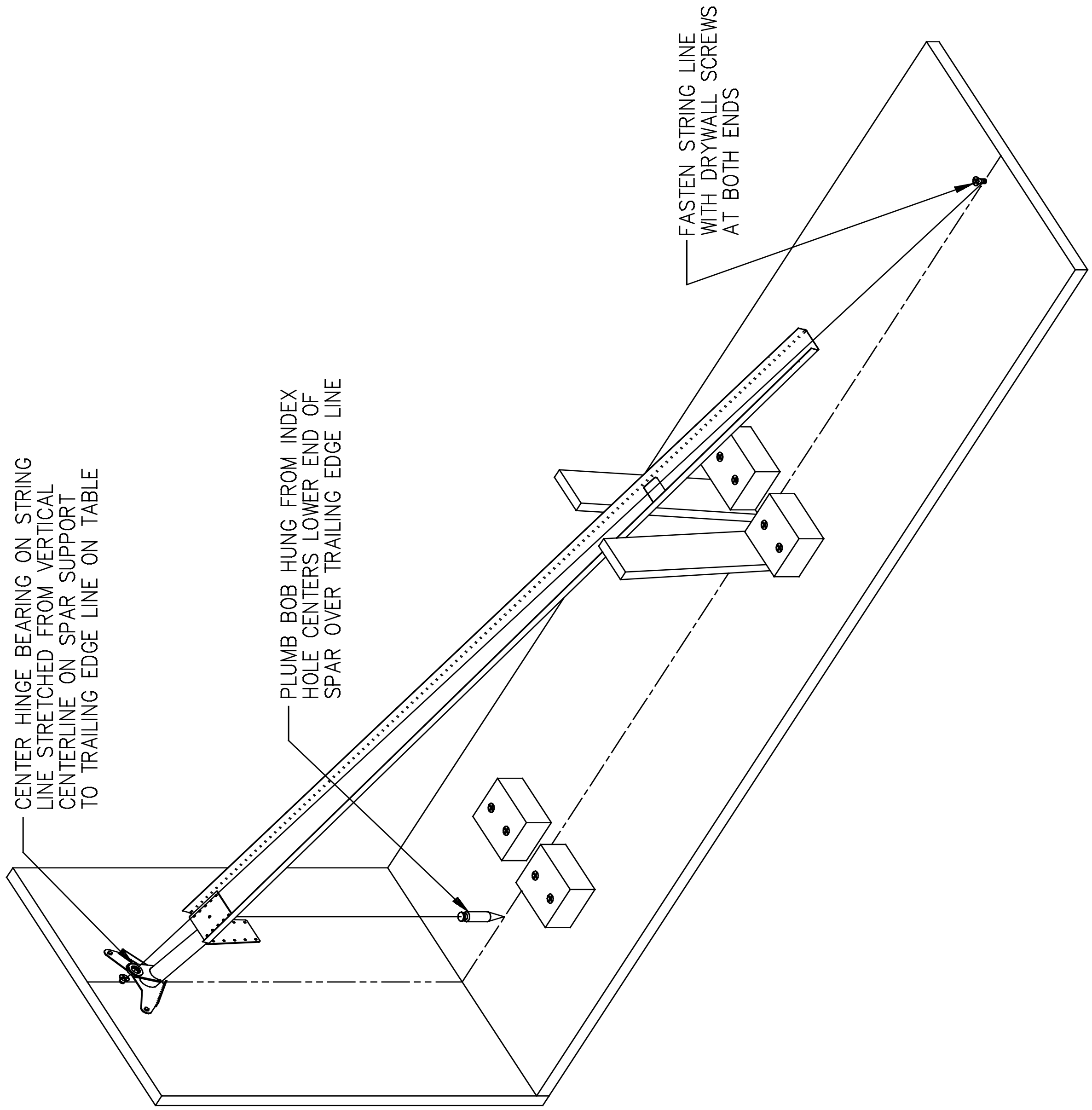

Figure 5: Centering the Forward Spar over the Trailing Edge Line

It is very important that the hinge bearing on the yoke weldment and the centerline of the forward spar both remain centered over the trailing edge line on the bench top. One way to ensure this is shown in Figure 5: run a string line from the vertical centerline on the spar support through the center of the bearing hole in the yoke weldment to the centerline at the tip of the forward spar and then to the trailing edge line on the table. In addition, hang a plumb bob from the Cleco hole that fastens the forward spar to the yoke weldment to center the lower end of the spar over the trailing edge line. Adjust the positions of the spar and the yoke until the hinge bearing is centered on the string line when the spar is centered over the trailing edge line at both ends.

Note Naturally, your table must be **level** in order for the plumb bob to be useful in centering the rudder spar over the trailing edge line.

Note Because of slight (and unimportant) manufacturing variances in the angles of the yoke arms, you may need to insert washers as shims between the yoke and the jig in order to bring the yoke and the spar into proper alignment. If this is necessary, don't worry about it; keeping the hinge bearing and the spar plumb takes precedence over keeping the yoke square against the jig.

When you're satisfied that the forward spar and the hinge bearing in the yoke are properly aligned and centered, use C-clamps to clamp the forward spar to the yoke weldment. Use the ten holes in the yoke as a guide to drill matching **#30** holes in the spar, as shown in Figure 4. Insert Clecos into several of the holes to maintain alignment.

Completed: [ ]

Step 8: Drill and Cleco the Root Rib to the Yoke Weldment

Cleco the **root rib** [6] to the yoke weldment using the one pre-drilled hole in each part, as shown in Figure 6.

> **Note** All of the ribs typically have two relatively large tooling holes (3/16" diameter or larger) that are used to reference the rib blank to the form block during manufacture. These holes will not be used for anything during assembly.

Center the aft end of the root rib over the trailing edge line on the table and clamp the rib to the yoke to maintain its position while drilling. Use the holes in the yoke as a guide to drill matching **#30** holes in the rib. Cleco several of the holes, after drilling, to maintain alignment.

> **Note** Use a right-angle drill for this procedure, or carefully remove the entire assembly from the jig, without disturbing the position of the root rib relative to the yoke weldment, to provide access for a regular drill.

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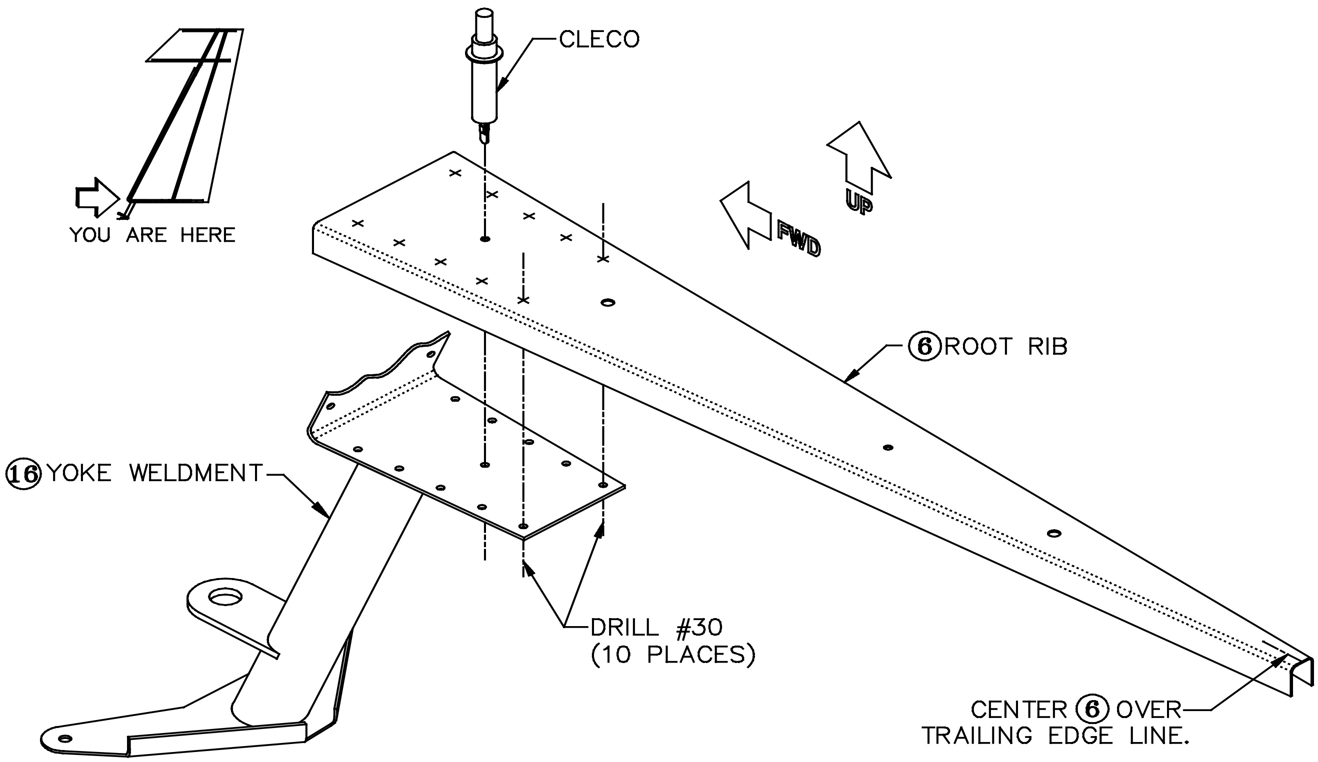

Figure 6: Root Rib/Yoke Weldment Assembly

Step 9: Join the Aft Spar to the Root Rib

As shown in Figure 7, Cleco the **aft spar/root rib bracket** [12] to the root rib [6] using the single pre-punched hole in each part. Use C-clamps to clamp the **aft spar** [4] to the aft spar/root rib bracket while centering the aft spar over the trailing edge line on the work table. Make sure the aft spar is centered laterally on the root rib. (The "vee" support described in Step 7 centers the **upper** end of the aft spar over the trailing edge line. If the root rib is centered over the trailing edge line and the aft spar is centered relative to the root rib, then the lower end of the aft spar will also be centered.)

> **Note** Position the aft spar so that there is just the very slightest gap (1/32" or less) between the lower end of the spar and the surface of the root rib (if the spar actually contacts the root rib, vibration could wear a hole in the rib).

Use the pre-punched holes in the aft spar/root rib bracket as guides to drill **#40** holes through the bracket, the root rib and the aft spar. Insert enough Clecos to maintain alignment while drilling.

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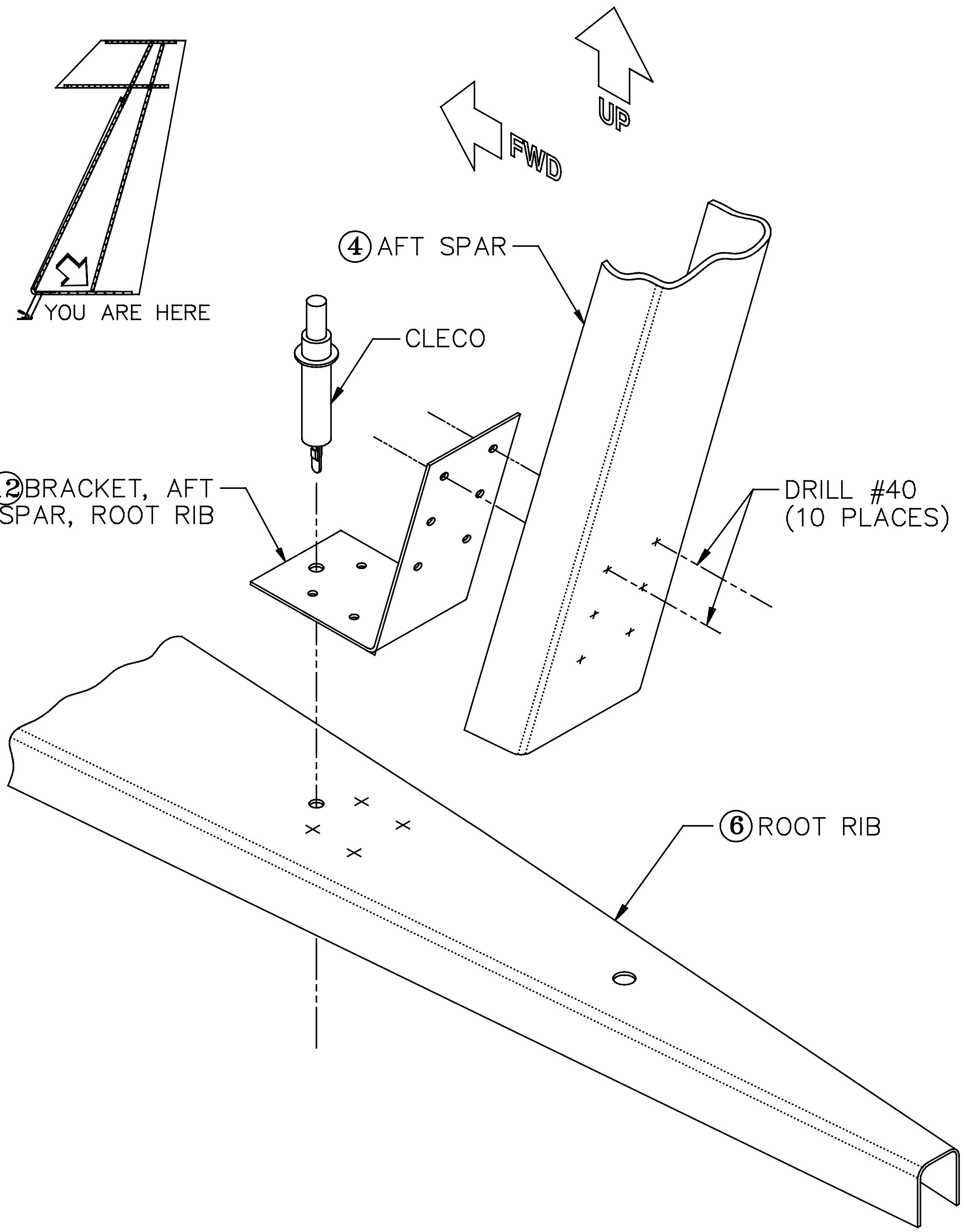

Figure 7: Aft Spar/Root Rib Assembly

Step 10: Join the Counterweight Rib to the Spars

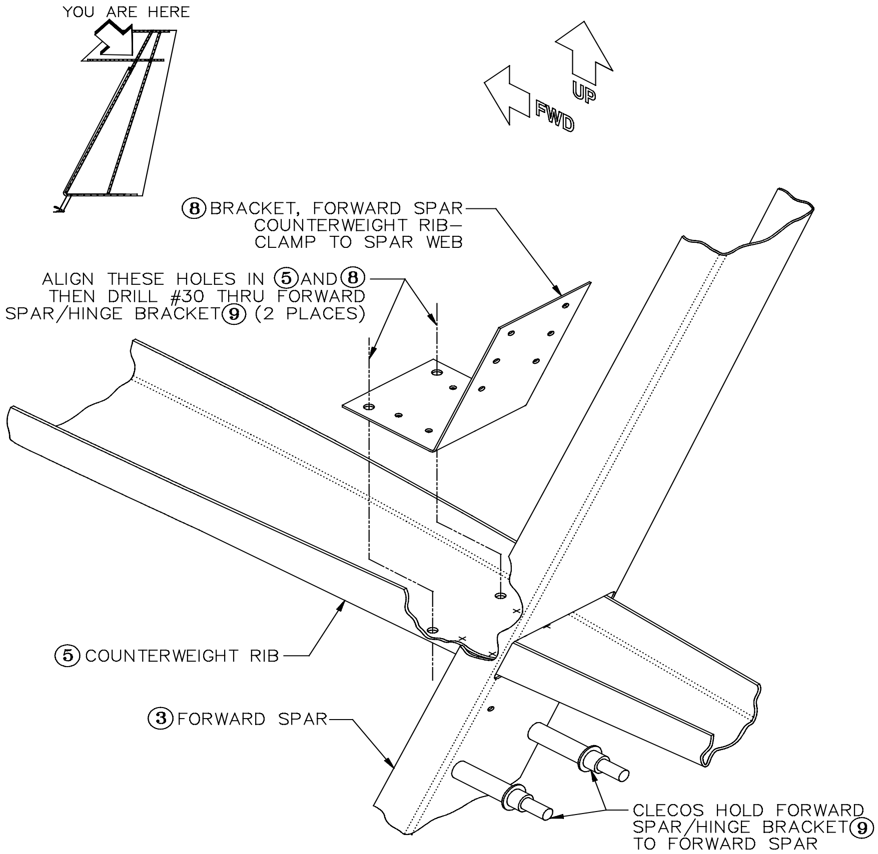

Figure 8: Counterweight Rib/Forward Spar Assembly

Using two or three Clecos, re-attach the forward spar/hinge bracket to the forward spar (see Figure 3). Slide the **counterweight rib** [5] through the holes in the forward and aft spars. (The forward spar/hinge bracket sets the vertical position of the counterweight rib relative to the forward spar.)

> **Note** Enlarge the opening in the forward spar in both the horizontal and the vertical directions, if necessary, to allow the counterweight rib to be slipped into place.

With the web of the counterweight rib resting on the top flange of the forward spar/hinge bracket, use a small C-clamp to clamp the **forward spar/counterweight rib bracket** [8] to the spar web. Position the bracket so that: (a) it is **centered** between the flanges of the spar, and (b) its lower flange effectively clamps the rib web tightly against the forward spar/hinge bracket.

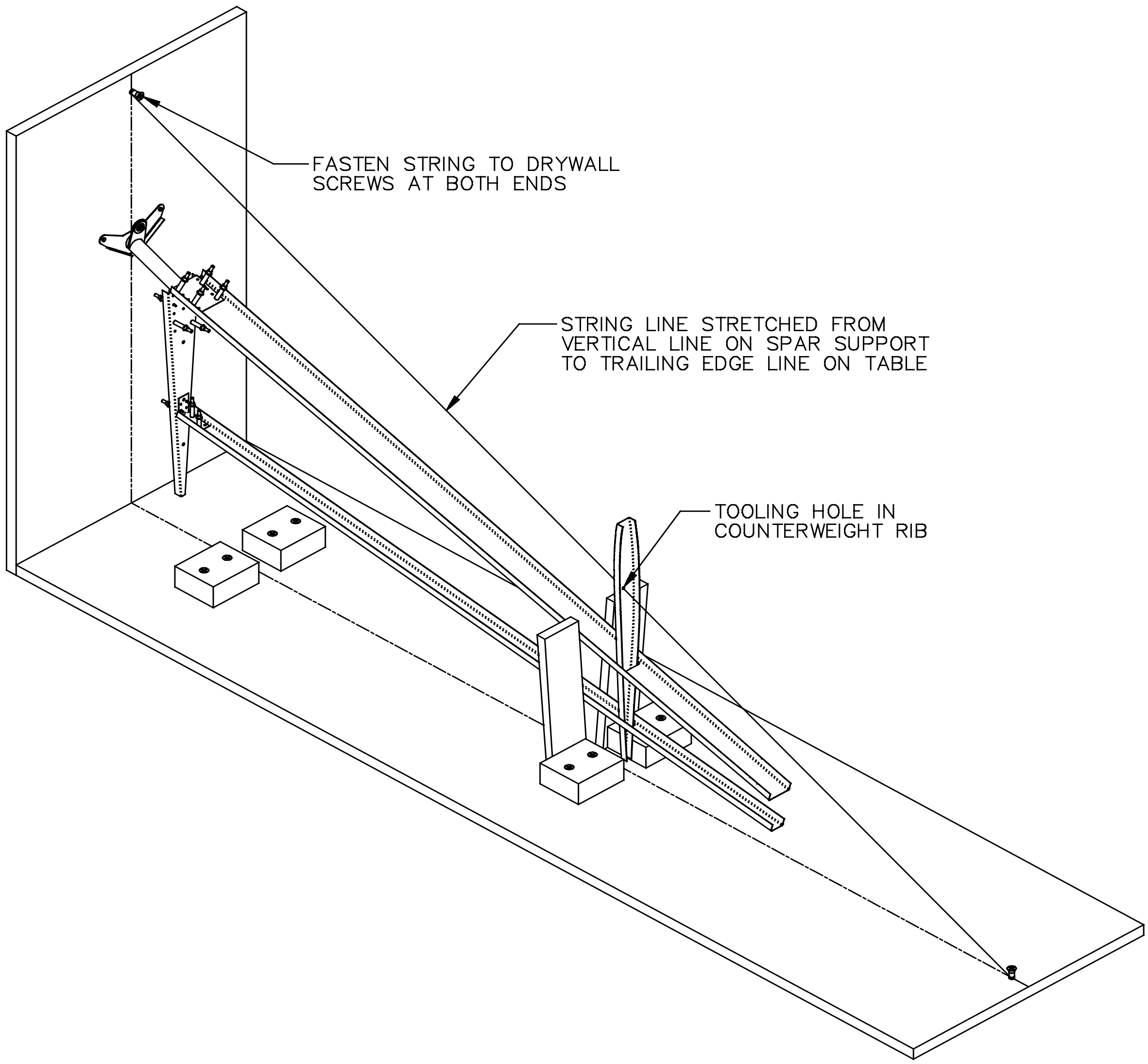

Figure 9: Centering the Counterweight Rib

Now, before drilling any holes through the bracket/spar/counterweight rib assembly, check to make sure that the counterweight rib is properly aligned with the rest of the rudder framework. You can use a plumb bob or a try square to verify that the trailing edge of the counterweight rib is centered over the trailing edge line on the table. To check alignment of the rib's forward end, stretch a string from the vertical centerline on the spar support through the forward tooling hole in the counterweight rib to the trailing edge line on the table, as shown in Figure 9.

Both the **counterweight rib** and the **forward spar/counterweight rib bracket** have two pre-punched #30 holes, which are used to align the two parts. Since the **forward spar/hinge bracket** lacks the two #30 index holes, it cannot be Clecoed to the other two parts for drilling. To transfer the locations of the two index holes to the forward spar/hinge bracket, proceed as follows: Slide the counterweight rib forward and aft as necessary to bring the two pre-punched #30 index holes in the rib web into alignment under the corresponding holes in the forward spar/counterweight rib bracket. Be careful to **keep the counterweight rib centered** relative to the jig while doing this. If necessary, adjust the side-to-side position of the bracket on the spar in order to align these two holes as precisely as possible. With the holes aligned, use a **#30** bit to drill both these holes through the underlying forward spar/hinge bracket, as shown in Figure 8. Insert a Cleco in each hole after drilling.

With Clecos holding the counterweight rib to both brackets, and after verifying that the counterweight rib is still centered relative to the jig, you can drill the six **#40** holes through the forward spar/counterweight rib bracket and the forward spar, as shown in Figure 10. Cleco a couple of these holes, and remove the C-clamp holding the forward spar/counterweight rib bracket. Finally, use the pre-punched holes in the other flange of the forward spar/counterweight rib bracket as guides to drill four #40 holes through both brackets and the rib web, as shown in Figure 10. Cleco to maintain alignment while drilling.

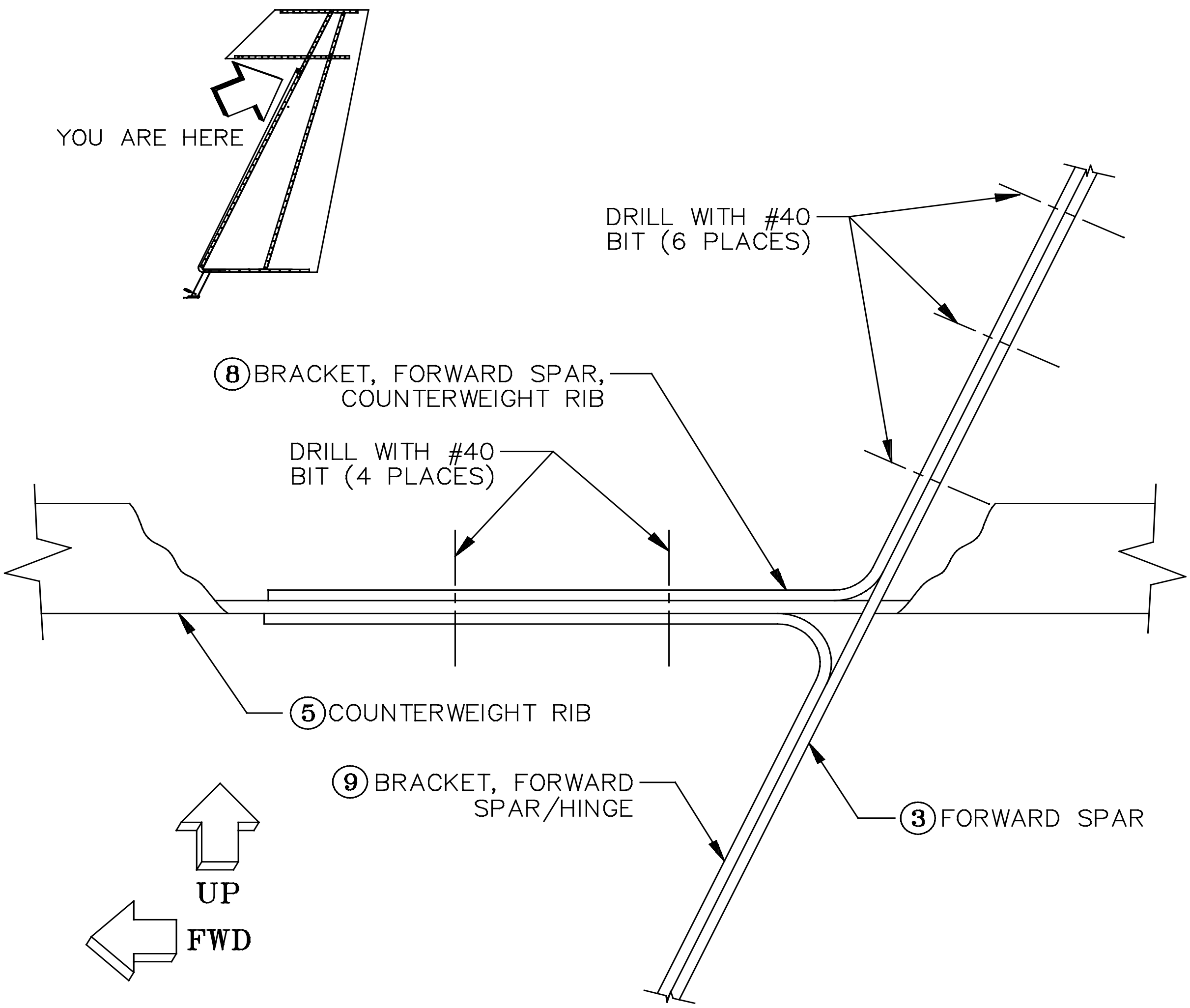

Figure 10: Forward Spar/Hinge Bracket Assembly

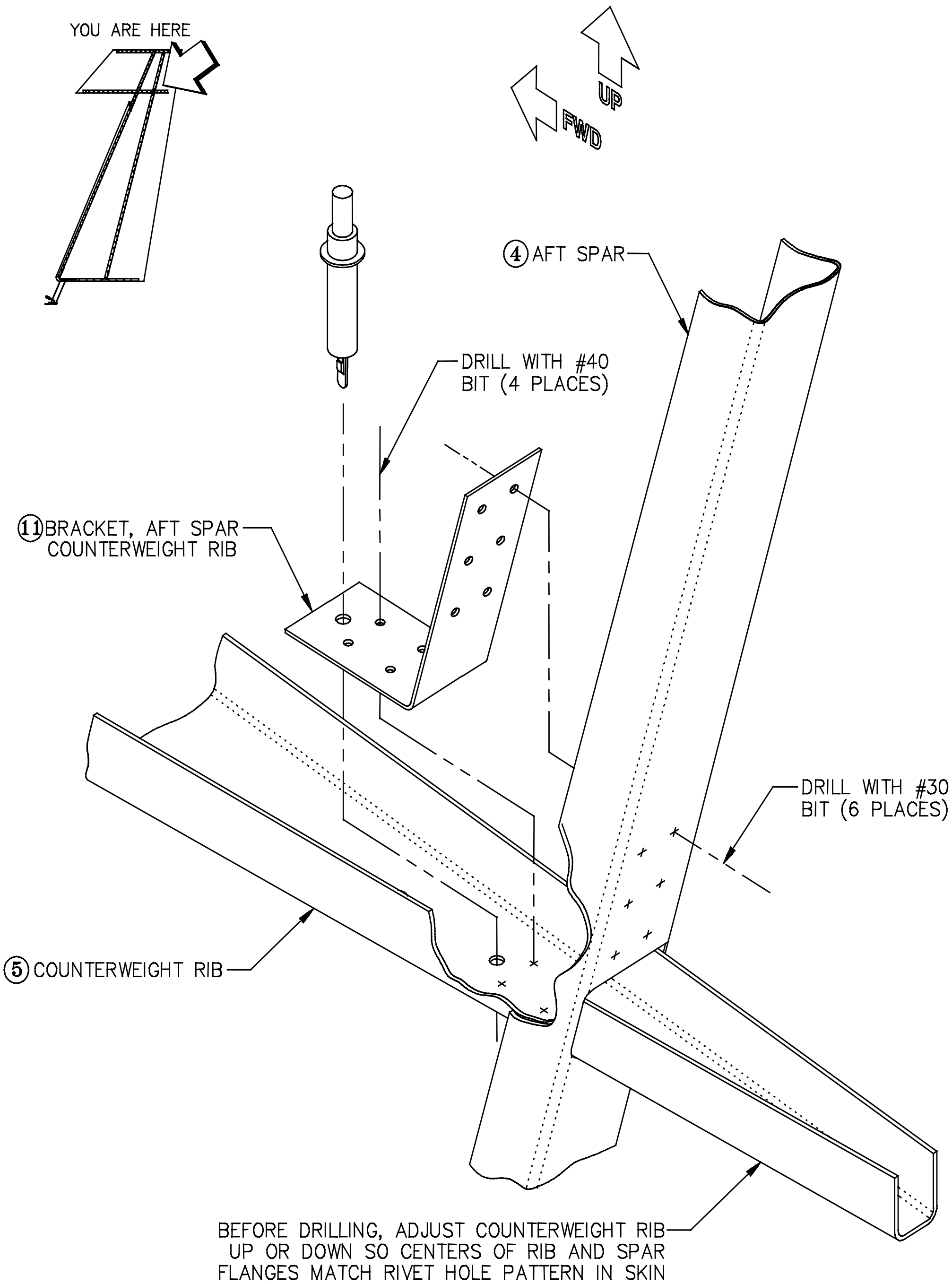

Figure 11: Aft Spar/Counterweight Rib Assembly

Cleco the **aft spar/counterweight rib bracket** [11] to the counterweight rib [5], as shown in Figure 11, using the single pre-drilled hole in each part. **Do not drill any holes yet.**

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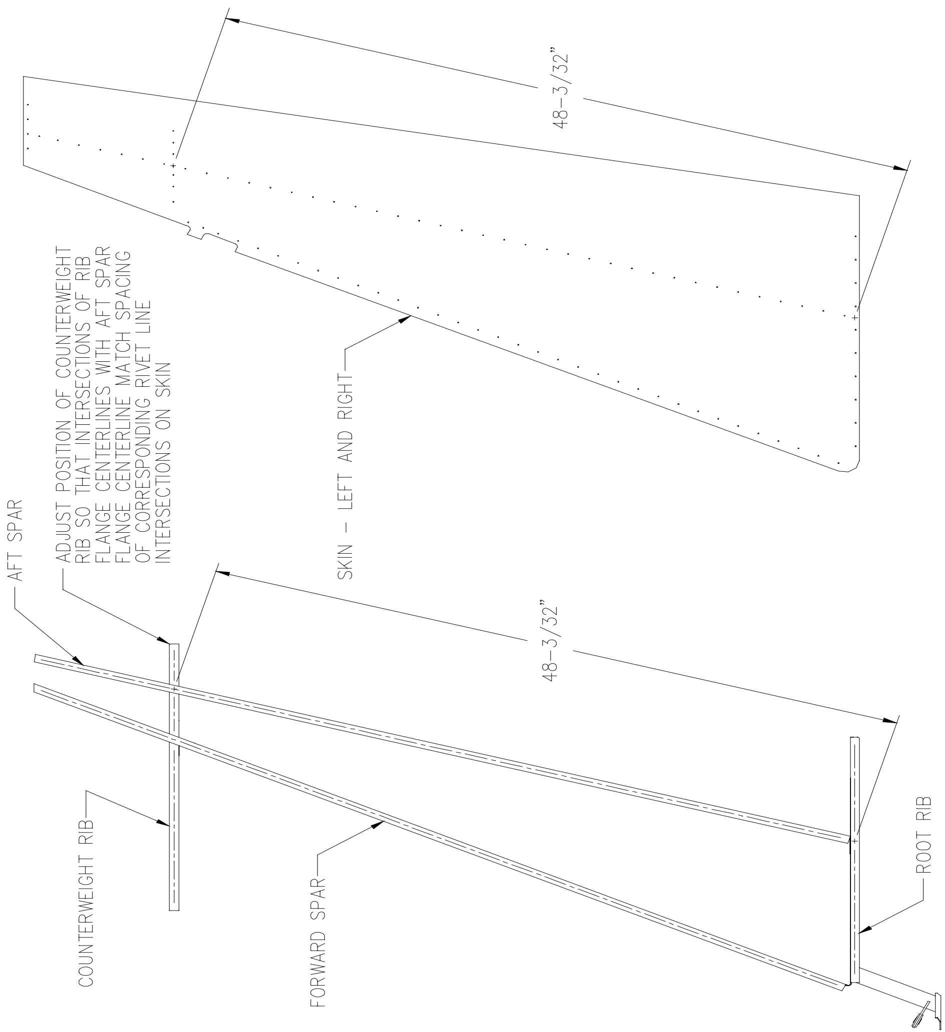

Figure 12: Setting the Vertical Position of the Counterweight Rib

> **Note** Before drilling any holes in the aft spar/counterweight rib bracket, the counterweight rib must be positioned vertically relative to the aft spar such that the pre-punched skin holes will fall on the centers of the rib and spar flanges when the skin is installed. On the **skin**, the point where the **counterweight rib** rivet line intersects the aft spar rivet line is **48-3/32"** from the point where the **root rib** rivet line intersects the aft spar rivet line, measured along the aft spar rivet line. So, as shown in Figure 12, move the counterweight rib up or down, as necessary, until the centerline of its flange is **48-3/32"** from the centerline of the root rib flange, measured along the centerline of the aft spar flange. With the counterweight rib in this position, use small C-clamps to clamp the aft spar/counterweight rib bracket to the aft spar.

Now that the counterweight rib is correctly positioned relative to the aft spar, use the four pre-punched holes in the leg of the aft spar/counterweight rib bracket that fits against the counterweight rib as guides to drill **#40** holes through the **bracket** and the **rib**, as shown in Figure 11. Use the holes in the leg of the bracket that fits against the spar as guides to drill six **#30** holes through the **bracket** and the **spar**. Cleco to maintain alignment while drilling.

> **Note** The hole that you Clecoed initially through the bracket and the rib is simply an index hole to make alignment of the bracket easier. It does not itself need to be drilled to any final size, nor does it need to be riveted later, although you may do so if you wish.

Completed: [ ]

Preliminary Assembly of the Skins to the Structural Framework

Step 11: Fit the Skins into Place

With the spar/rib assembly still in the jig, fit the rudder **skins** [1.1 and 1.2] into place over it.

Hint To keep the skin from becoming scratched, leave the protective covering on until you are ready to begin riveting.

Verify that the trailing edge of the skins are centered over the trailing edge line on the table. **Note:** Do not attempt to force the trailing edges so they are flush to each other or that the extreme aft ends match. It is more important to have the marked centerlines visible through the skin holes and the assembly free of twist. Skin mismatches can always be trimmed later. They should hang freely on the framework. Fasten scrap wood blocks to the table near the lower end of the skins, as shown in Figure 4, to keep the skins centered over the trailing edge line. If necessary, adjust the supports described in Step 7 to center the spars and the upper end of the skins trailing edge over the trailing edge line.

Adjust the position of the spar/rib framework inside the skins so that the centerlines marked on the spar and rib flanges in Step 2 show through the pre-punched pilot holes in the skins. Also, align the lower edges of the skins with the edges of the root rib flanges, and align the leading edges of the skin above the counterweight rib with the forward spar flanges. Use side grip clamps or small C-clamps to secure the skins in several places to the spar/rib framework.

Note If the aft spar is bowed slightly, you may not be able to align its marked rivet lines with the rivet holes in the skins for its entire length. Just do the best you can for now; the alignment will be adjusted before drilling.

Completed: [ ]

Step 12: Drill and Cleco the Skins

Use the pre-punched holes in the skin as guides to drill the **#40** rivet holes through the assembly. First, drill the two holes on each side where the counterweight rib rivet line intersects the forward and aft spar rivet lines. Cleco the intersection holes.

Hint You may want to drill a few holes first on both sides so the assembly can be inspected for straightness. Then as you drill more and more holes in the subsequent steps the assembly will become more stable and less prone to movement. Make sure you do not have any big gaps between the spars and the skins, which will later turn into oilcans during riveting.

Now, drill the forward spar on both sides **below the counterweight rib only**, inserting a Cleco into every third to fifth hole after drilling. Follow standard procedures for drilling a line of holes, as described in "SECTION II: TOOLS AND TECHNIQUES:" first, drill holes at the end of the line and at several places along the line; Cleco these first holes to maintain alignment, and then drill the intervening holes.

Note As always, the word "below" refers to a direction **as installed in the aircraft**, not relative to the jig.

Next, drill and Cleco the root rib and the counterweight rib. Finally, verify that the rivet lines on the aft spar flanges are properly aligned with the rivet holes in the skin, and drill and Cleco the aft spar. If the aft spar is bowed, lift the skin on one side so you can reach in to align the spar with its rivet holes; drill enough holes to hold the spar in alignment and then re-Cleco the skin on both sides and finish drilling.

> **Note** The holes for the front spar **above the counterweight rib** are not pre-drilled through the skin. Do not drill these holes at this time. The pre-drilled holes in the **forward skin** [2] will be used as guides to drill these holes in the next step. Also, **1/8"** pull rivets will secure the skin to the counterweight rib **aft of the forward spar only.** Use a **#30** bit to drill these holes.

Completed: [ ]

Step 13: Drill and Cleco the Forward Skin

Mark forward spar rivet lines **above the counterweight rib** on both sides of the rudder skin. To do this, use a straightedge to extend the existing lines of forward spar rivet holes to the top of the skin, and mark the lines with a felt pen. Make sure the rivet line corresponds with the center of the forward spar flange at the top.

> **Note** Some adjustment of the counterweight rib flange angles will be necessary before the **forward skin** [2] can be installed. The rib flanges are hydroformed at 90°, which isn't an exact match, especially near the leading edge of the forward skin. Use smooth or padded duck bill pliers to adjust the flanges.

Position the **forward skin** [2] on the rudder assembly. Align the pre-punched rivet holes along its aft edges with the rivet centerlines just marked; align the row of pre-punched holes along its lower edges as nearly as possible with the rivet lines marked on the counterweight rib flanges.

Use nylon strapping tape, some extra hands, and/or large C-clamps (padded) to secure the forward skin to the counterweight rib.

> **Note** When the pre-punched rivet holes along the lower edge of the forward skin are aligned with the rivet lines on the counterweight rib, the skin will probably hang down a bit below the bottom of the rib, but that's OK. Likewise, the top of the forward skin may not be perfectly aligned with the top of the main skin; that's OK too.

Install the **tip rib** [7] and position it with its leading edge **10-1/8"** forward of the forward spar web. (Adjust the rib flanges with duck-bill pliers to fit the contours of the forward skin.) Use side-grip clamps or small C-clamps to clamp the tip rib to both the rudder skin and the forward skin.

> **Note** If necessary, trim the upper ends of the forward and aft spars so that the tip rib can be installed with the upper edges of its flanges even with the upper edges of the skins. Trim enough to provide a small gap (approximately 1/32") between the tip rib and the ends of the spars.

Use the pre-punched holes in the forward skin as guides to drill **#40** holes through the skins, the counterweight rib and the forward spar. Insert a Cleco into every other hole after drilling.

Drill **four #40** rivet holes per side through the skins and the tip rib in the locations shown in Figure 13. Center the holes vertically on the tip rib flanges. The forward hole is centered between the first and second flutes in the rib; the second hole is centered between the second and third flutes; the third hole is **5-3/4"** from the aft end of the rib; the last hole is centered on the overlap between the two skins.

Completed: [ ]

Step 13a: Drill and Cleco the Trailing Edge

When you are satisfied the assembly is true and plumb, bring the trailing edges together over the center line on the table. Drill and cleco the trailing edge with #40 holes using the holes in the one side of the skin as the guide. You may need to have a helper give back pressure on the skins paying attention to keeping the trailing edge straight.

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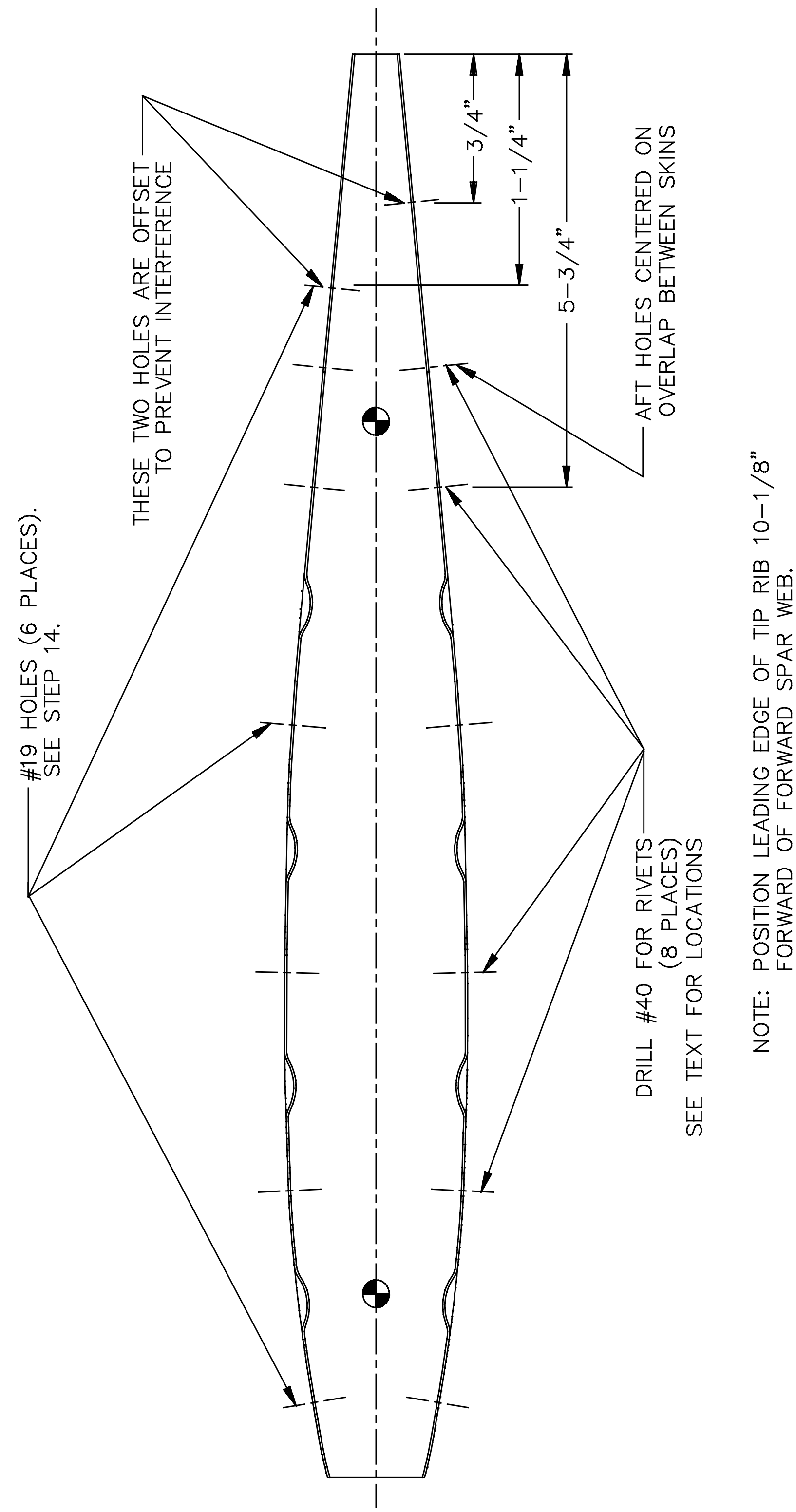
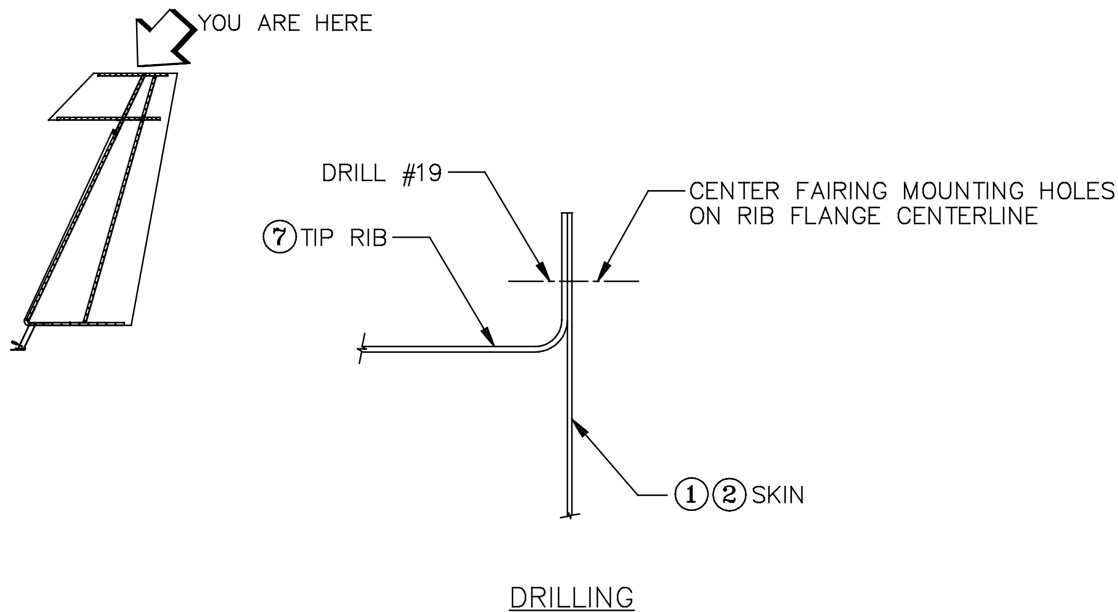


Figure 13: Tip Rib Hole Locations



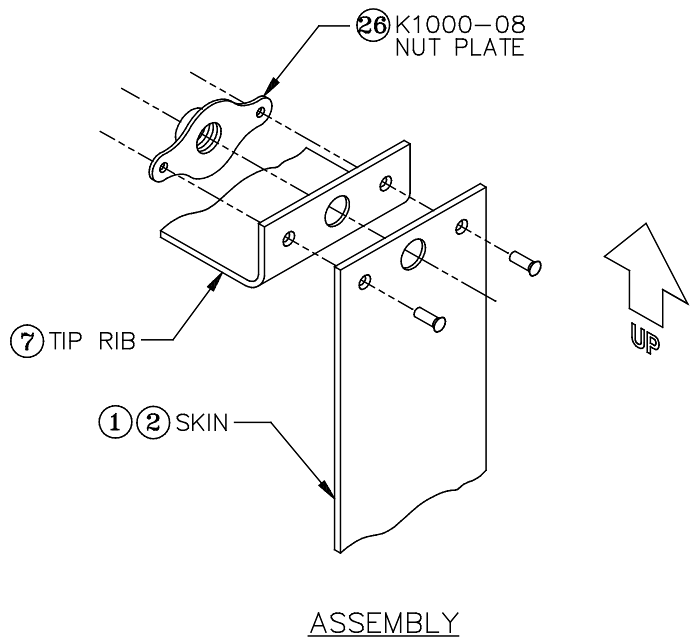


Figure 14: Tip Fairing Nutplate Installation

Step 14: Drill Holes for Mounting the Tip Fairing

> **Note** The rudder tip fairing is shipped as **left** and **right tip fairing halves** that you will seam together using fiberglass cloth and vinyl ester resin. Since the resin has a limited shelf life, however, it won't be shipped until you request it for work on the fuselage. Instructions for installing nutplates to mount the rudder tip fairing are included in this section. Instructions for seaming the fairing halves together and for final mounting are included in "SECTION X: FINAL ASSEMBLY."

Mark the locations of the tip fairing mounting holes on the outside of the rudder skins on both sides, as shown in Figure 13. The holes are centered vertically on the tip rib flanges. The forward hole is midway between the tip rib leading edge and the first flute; the second hole is midway between the third and fourth flutes; the third hole is **3/4"** from the aft end of the tip rib on one side and **1-1/4"** from the aft end of the tip rib on the other side. Drill **#19** holes through the tip rib and the main and forward skin at the six marked locations.

> **Note** The two mounting holes near the trailing edge are intentionally staggered relative to each other to facilitate installing the nutplates and to prevent interference between the two mounting screws.

Use a **#40** drill bit to drill mounting holes for K1000-08 **nutplates** [26] through the skins and the tip rib flange at every #19 hole, as shown in Figure 14. Use the nutplates themselves as guides for drilling the rivet holes.

Completed: [ ]

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FINAL RUDDER ASSEMBLY

Step 15: Disassemble, Clean and Deburr

Remove all of the Clecos to completely disassemble the rudder assembly.

Use a hole deburring tool or a drill bit to deburr the rivet holes in all of the parts. Use an air nozzle to remove all drilling chips, both from the parts and from the work table.

Completed: [ ]

Step 16: Dimple the Skin, the Forward Spar and the Tip Rib

Use 3/32" dimple dies and either a rivet squeezer or a riveting frame to dimple the rivet holes in the forward spar flanges below the counterweight rib and the corresponding holes in the skin.

> **Note** Dimple **only** the rivet holes below the counterweight rib. "Below" means closer to the bottom of the aircraft **as installed**, not as it is positioned in the jig.

Also, dimple the eight tip rib rivet holes in both the skin and the rib. Finally, dimple the rivet holes for mounting the nutplates to the skins and the tip rib. (Do not dimple the holes for the screws that will secure the tip fairing.)

Completed: [ ]

Step 17: Fabricate the Lead Counterweight

Cut **4"** long pieces of the **lead sheet** [17] shaped to fit between the flanges at the leading edge of the counterweight rib; cut enough pieces to make a **1-1/2 lb.** (680 ±20 grams) counterweight. Stack the lead pieces and clamp them in place in the counterweight rib, as shown in Figure 15. (The stack might have to angle back slightly as it goes up to clear the inside of the forward skin.) Drill two **#10** holes through the counterweight rib/counterweight assembly in the locations shown.

> **Note** Don't worry about the loss of mass due to the bolt holes; the specified 1-1/2 pounds provides adequate material to produce the proper final mass.

> **Hint** Drilling through lead can be rather difficult. The drill bit tends to pull itself into the soft material, which causes binding. Use drill wax, soap, or some other lubricant on the drill bit and work slowly, backing off frequently to clear the chips. Since the bit tends to bind, make sure the work is clamped securely to prevent damage or injury. You can also grind flats onto the cutting edges of the drill bit so that they meet the material at a steeper angle; this reduces the tendency of the bit to pull into the material.

Mark the locations of the rivet holes in the counterweight rib flanges onto the lead counterweight. Disassemble the lead counterweight from the rib and use a **#10** bit to drill a **1/2"** deep hole into the counterweight at each rivet location. (Again, don't worry about the loss of mass.) These holes provide clearance for the 1/8" blind rivets that will be used to secure the forward end of the forward skin to the counterweight rib. Use a **#30** bit to enlarge the four rivet holes at the forward end of the counterweight rib flange on each side to accommodate the 1/8" blind rivets. Also use a **#30** bit to enlarge the corresponding holes in the forward skin.

> **Hint** We made a template from thin aluminum sheet to fit between the rib flanges and then drilled the two #10 mounting holes through the template and the rib. We then used the template to cut the counterweight pieces from the lead sheet, drilling the mounting holes as we went. The counterweight was bolted into place and the rivet holes in the rib flanges used as guides to drill into the counterweight, marking the locations of the rivet holes.

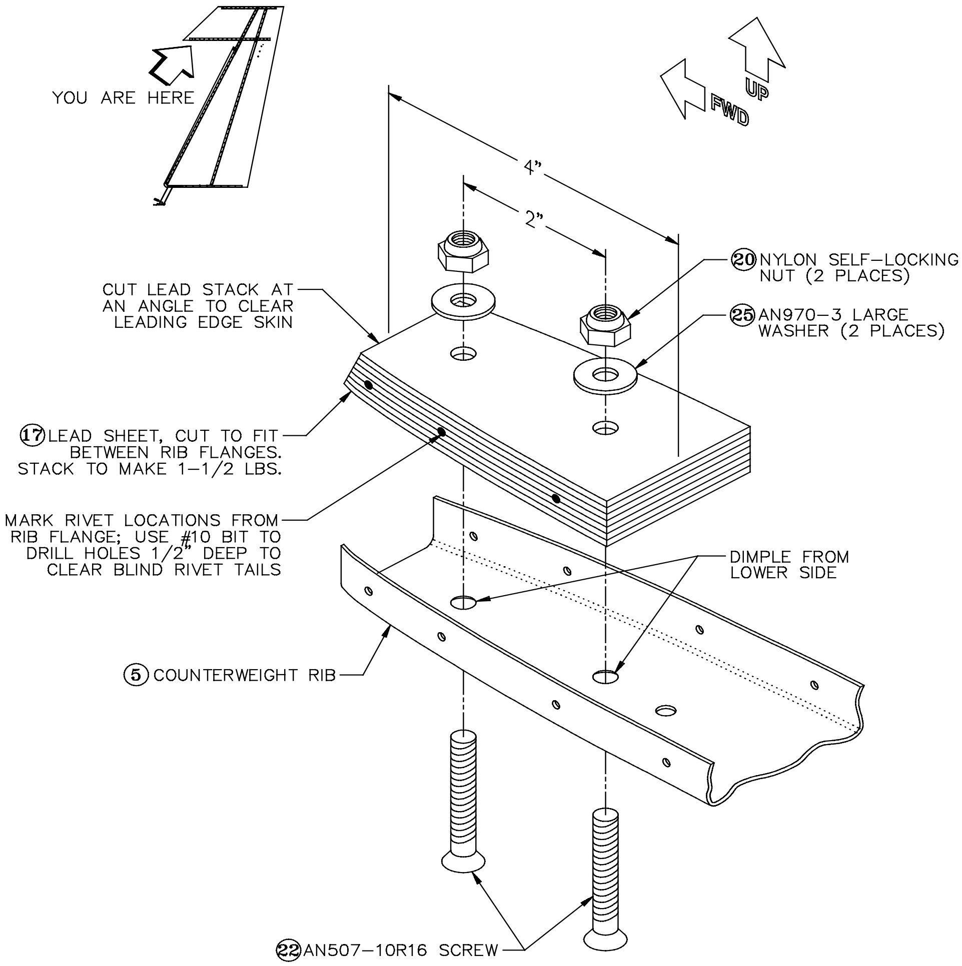


Figure 15: Lead Counterweight Assembly

Dimple the counterweight mounting holes in the counterweight rib to match the heads of the mounting screws. You can make your own female dimpling die for this application by drilling and countersinking a **3/16"** hole in a hardwood or aluminum block. Use the mounting screw itself as the male die, and drive it with a hammer or a flush rivet set to deform the rib into the female die.

Countersink the mounting holes in the lead counterweight so they fit over the dimples in the ribs. Set the counterweight aside for later installation.

Completed: [ ]

Step 18: Apply Corrosion Protection

At this time, apply the corrosion protection of your choice to the rudder components. At the very least, first apply an aluminum cleaner or an acid etch and then alodine all interior parts. Refer to "INTERIOR CORROSION PROTECTION" in "SECTION II: TOOLS AND TECHNIQUES" for a further discussion of this subject.

Completed: [ ]

> If you are choosing to flush rivet the rudder assembly, the spars and ribs must be dimpled and not counter sunk. Be careful, because dimpling the narrow flange width of the spars will sometimes cause the spar to deform considerably.

Step 19: Install the Counterweight

Fasten the lead counterweight to the counterweight rib with the AN507-10R16 **screws** [22], AN364-1032A **nuts** [20], and AN970-3 **washers** [25]. Apply packing tape between the lead counterweight and both the aluminum rib and the steel fasteners to help prevent corrosion caused by contact of the dissimilar metals (or just apply a thick coat of paint to the counterweight before installation).

Completed: [ ]

Step 20: Rivet the Rudder Assembly Together

> **Hint** Before riveting the rudder assembly, you must remove the protective plastic covering from the skins, at least along the rivet lines. An easy way to do this is to run a hot soldering iron down both sides of the rivet line to melt through the plastic. Then you can peel off the plastic between the melted lines.

Note As you're riveting the rudder assembly together, it is very important to continually check that the assembly is straight and untwisted as you proceed. Before starting, verify that the support blocks center the rudder over the trailing edge line on the table. To help make sure the rudder is straight, you can also run a string line from the vertical centerline on the spar support board, through the forward tooling holes in both the counterweight and the tip ribs, and down to the trailing edge line on the table. Follow standard procedures for installing a line of rivets: start by driving rivets at the center and each end of the line; then drive a rivet halfway between the center and the end on each side; continue in this manner, driving rivets at the centers of unriveted areas, until the line is finished. Check frequently for twist by sighting down the rudder assembly from the top. If the rudder begins to twist, apply force in the opposite direction from the twist and ream the rivet holes to bring the structure back into line.

Rivet the rudder assembly together in the sequence listed below. Place the parts in the rudder jig while riveting, and use as many Clecos as you can, to ensure that the assembly remains straight and true. The rivet type and diameter for each location is specified; choose a rivet of the proper length as described in "SECTION II: TOOLS AND TECHNIQUES".

Work in this order:

1) Rivet all the brackets, ribs and spars together:

   a) Rivet the aft spar/root rib bracket [12] to the aft spar [4] with 3/32"-diameter, AN470AD3 universal-head rivets. See Figure 7.

   b) Rivet the hinge mounting plate [10] and the forward spar/hinge bracket [9] to the forward spar [3], using 3/32" AN470AD3 universal-head rivets. Use 3/32" AN426AD3 flush-head rivets to rivet the K1000-4 **nutplates** [27] to the forward spar assembly. Refer to Figure 3.

   c) Rivet the root rib [6] and the forward spar [3] to the yoke weldment [16], using 1/8" AN470AD4 universal-head rivets. Wherever possible, install the rivets with the tails (shop heads) on the yoke side and the manufactured heads on the aluminum side. See Figures 4 and 6.

d) Insert the counterweight rib [5] through the hole in the forward spar [3]. Use 3/32" AN470AD3 universal-head rivets to rivet the forward spar/ counterweight rib bracket [8] to the counterweight rib, the forward spar/hinge bracket and the forward spar. See Figures 8 and 10.

e) Rivet the aft spar/counterweight rib bracket [11] to the **counterweight rib** [5], using 3/32" AN470AD3 universal-head rivets. Refer to Figure 11.

f) Use 1/8" AN470AD4 universal-head rivets, rivet the aft spar/counterweight rib bracket [11] to the aft spar [4]. See Figure 11.

g) Use 3/32" AN470AD3 universal-head rivets to rivet the aft spar/root rib bracket [12] to the root rib [6]. See Figure 7.

h) Verify all brackets are riveted to the spars and ribs.

2) Position and Cleco the left skin to the frame assembly.

a) Using 3/32"-diameter, AN470AD3 universal-head rivets, rivet the skin to the **aft** spar **up to a point 4 rivets below the tip rib**.

b) Rivet the skin to the counterweight rib. **Do not rivet the rivet common to the forward skin.**

3) Position and Cleco the right skin to the frame assembly.

a) Using 3/32"-diameter, AN470AD3 universal-head rivets, rivet the skin to the **aft spar** up to and including the counterweight rib.

b) While accessing from the top and front, finish riveting the skins to the aft spar working your way up. You should be able to hard rivet all of them. If not, drill up for 1/8" rivets and us AAPQ-42 as necessary.

4) Position and Cleco the forward skin to the assembly, leaving access from the front spar.

a) Rivet the forward skin to the counterweight rib. Use 1/8" AAPQ-42 Cherry Q rivets for the four rivets on each side in the area of the lead counterweight; for three of these rivets on each side, the tails fit into the #10 holes drilled in the counterweight in Step 17 (the fourth will be just aft of the counterweight).

b) Use 3/32" AN470AD3 universal-head rivets for the rest of the rivets in the counterweight rib and for the spar. Gain access for bucking from the open top of the rudder.

c) Rivet the skins to the rest of the forward spar, using 3/32" AN426AD3 flush-head rivets.

d) Rivet the skins to the root rib, using 3/32" AN470AD3 universal-head rivets. You can use a rivet squeezer here.

5) Position the tip rib into place.

a) Rivet the tip rib into place, using four flush rivets per side in the locations described in Step 13.

b) Using 3/32" AN426AD3 flush-head rivets installed through both the tip rib and the skins, rivet the K1000-08 nutplates to the insides of the tip rib flanges. Refer to Figure 14. (Mounting the fairing itself will be described in "SECTION X: FINAL ASSEMBLY.")

6) Verify the trailing edge is straight and true to plumb. If the holes are slightly misaligned, pass drill the holes in both skins while the skins are relaxed and plumb. Holes that are misaligned, will tend to cause a wavy trailing edge as the rivet distorts during riveting. An angle or some other long straight edge clamped to the trailing edge can help hold a very straight line while riveting.

7) Rivet together with AN470AD3 rivets.

Completed: [ ]

Hint Do you want a really straight trailing edge, one that will be the envy of other builders? Try applying a **very** thin layer of any epoxy adhesive, like JB Instant Weld or Sikaflex (available at most auto parts stores) to the inside of the two skins at the joggle. Then clamp two angles over the trailing edge and let that cure overnight. When you remove the angles the next day, you will have a nice straight edge that can be easily riveted resulting in a superior trailing edge.

Step 21: Install the Hinge and the Hinge Shim

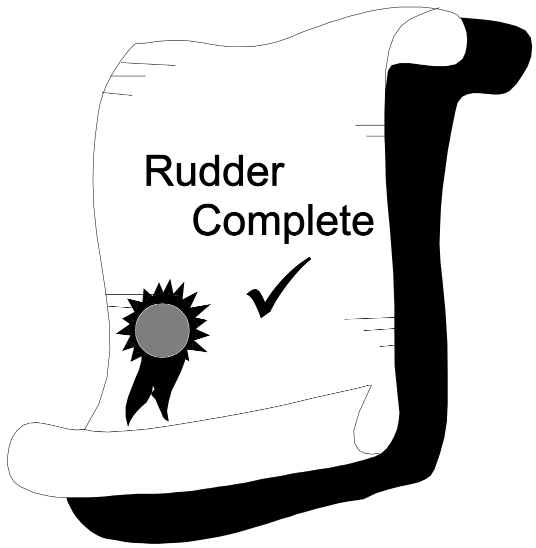
Bolt the **hinge shim** [14] and the **hinge** [13] to the forward spar using the AN4-6A bolts and AN960D416 **washers** [24].

> **Hint** After the hinge installation is complete, we recommend marking the bolt heads with a product called "Torque Seal," which is a colorful paste used as an inspection aid. Torque Seal is applied across the interface between two objects (the end of a bolt and its nut, for example, or a fitting and the bolt head that secures it) that you want to ensure are not moving relative to each other. Movement between the two objects breaks the seal, indicating the need for remedial action. Stoddard-Hamilton offers Torque Seal in a set of five different colors. Order P/N 620-0642-501.

Completed: [ ]

CONGRATULATIONS!

You've completed the rudder assembly! You're off to a good start and are ready to move on to the next major component, the horizontal stabilizer.



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SECTION IV: HORIZONTAL STABILIZER ASSEMBLY

PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Skin, left	1	302-00001-01
2	Skin, right	1	302-00002-01
3	Spar, forward	1	302-00003-01
4	Spar, aft	1	302-00004-01
5	Doubler, forward spar web, front	1	302-00005-01
6	Doubler, forward spar web, rear	1	302-00006-01
7	Bracket, aft attach	1	302-00007-01
8	Cap, forward spar	2	302-00008-01
9	Rib, nose	12	302-00009-03
10	Rib, main, left-flange	6	302-00010-01
11	Rib, main, right-flange	6	302-00010-02
12	Pin, alignment	2	302-00011-01
13	Flange, main rib	1	302-00012-01
14	Tape, aluminum, 2" width	180"	062-00001-01
15	Bracket assembly, forward attach	1	300-01000-01
16	Nut	3	AN315-6R
17	Nut, nylon self-locking	3	AN365-624A
18	Washer	3	AN960D616

Tool List

1. Screwdriver (cordless electric recommended)
2. Try square or combination square
3. Duck bill pliers (with jaws taped to protect Alclad aluminum parts)
4. Assorted flat and round files
5. Edge deburring tool (optional)
6. Rule, 12", graduated in 1/32nds of an inch
7. Fine-point marking pen
8. Clecos, 3/32" and 1/8" (approximately 150 and 100 each, respectively), with pliers
9. Cleco side-grip clamps or small C-clamps (approximately 10)
10. Digital level, accurate to 1/2° (recommended) or carpenter's level (acceptable)
11. Electric or pneumatic drill motor with #40, #30 and 1/16" bits
12. Rib alignment probe, or scriber or awl
13. Straightedge, 72" or longer
14. Hole deburring tool
15. Tape measure
16. Adjustable wrench or 9/16" open-end wrench
17. Aviation snips, straight and offset
18. Belt sander, bench-mounted (optional)
19. Bandsaw or scroll saw (optional)
20. Center punch
21. 90° drill motor or adapter, with bits
22. Universal-head rivet sets, 3/32" and 1/8"
23. Rivet gun, air compressor and bucking bars
24. Socket wrench with 9/16" socket
25. Blind rivet puller
26. Rivet squeezer with 3/32" and 1/8" universal-head sets (optional)
27. Curved-tooth body file (“panzer file”)

ADDITIONAL MATERIALS

1. Scrap wood blocks
2. Anti-corrosion primer
3. Four small sand or shot bags

WORKSPACE

The horizontal stabilizer is built in one assembly. It has a total span of 119" and a chord of about 17-1/2". The main workspace requirement is thus a **flat** table of sufficient area. Keep in mind, however, that in the next section ("SECTION V: ELEVATOR ASSEMBLY"), the elevator will be mounted to the horizontal stabilizer, resulting in an overall assembly that is 129" X 35". Plan your workspace accordingly. As with the rudder assembly, it may be best to build the stabilizer on one end of the wing jig table described in "SECTION VI: WING ASSEMBLY."

Other than the flat table mentioned above, no jig is required to build either the stabilizer or the elevator. To help avoid the introduction of twist into the stabilizer, clamps and/or sand or shot bags will be used to hold the stabilizer flat to the table while drilling and riveting.

Caution Be very careful and take your time when removing the protective covering from aluminum sheets. If you pull too hard in the wrong direction, you could permanently crease or kink the sheet. To remove the covering, start from one end and then hold that end down while pulling the covering low and parallel to the surface. Do not pull the covering up perpendicular to the surface. Additionally, take care when picking up large pieces of sheet metal (like the stabilizer skins, for example) that have a joggle or a bend in one edge. If you allow the sheet to flex perpendicular to the bent edge, you will crease it, and such creases are difficult or impossible to remove.

ASSEMBLY SEQUENCE

The configuration of the horizontal stabilizer is shown in Figure 2. The basic assembly sequence consists of a positioning and drilling phase and a riveting phase. In the former, the ribs and spar web doublers are first drilled and Clecoed to the spars. Next, the skins are positioned on the spar/rib assembly, and the pre-punched skin holes are used to guide the drilling of rivet holes in the underlying structure. Then the skins are removed and additional components—spar caps and the aft attach bracket—are positioned and drilled. Finally, the assembly is riveted together.

The primary goal of the horizontal stabilizer assembly procedures is essentially the same as for the rudder assembly—to produce a straight part without bends, bows or twists. It is especially important to maintain a straight trailing edge on the upper surface of the stabilizer, as this is where the elevator hinge fastens; the elevator hinge line must be straight to allow free movement of the elevator. To accomplish these goals, it is very important to pay careful attention to the proper alignment of all the parts as assembly proceeds. In particular, make sure that the spars are held straight from end-to-end when the skins are positioned and drilled; since the stabilizer skin is supplied in two pieces, it's possible to end up with a "kink" in the stabilizer at the skin junction if you're not careful. Also, as in all other sheet metal work, it's important to satisfy the minimum edge distance requirements for rivet holes, as described in "SECTION II: TOOLS AND TECHNIQUES." Besides weakening the assembly, inadequate edge margins can also affect the straightness of a part—if a row of rivet holes on a spar is allowed to drift too close to the edge for part of its length, for example, the result will almost certainly be a twisted stabilizer after riveting. So, check the stabilizer for straightness and freedom from twist at every step and be sure that it is held straight for all drilling and riveting. Follow standard procedures for drilling lines of rivet holes and for driving lines of rivets, as described in SECTION II.

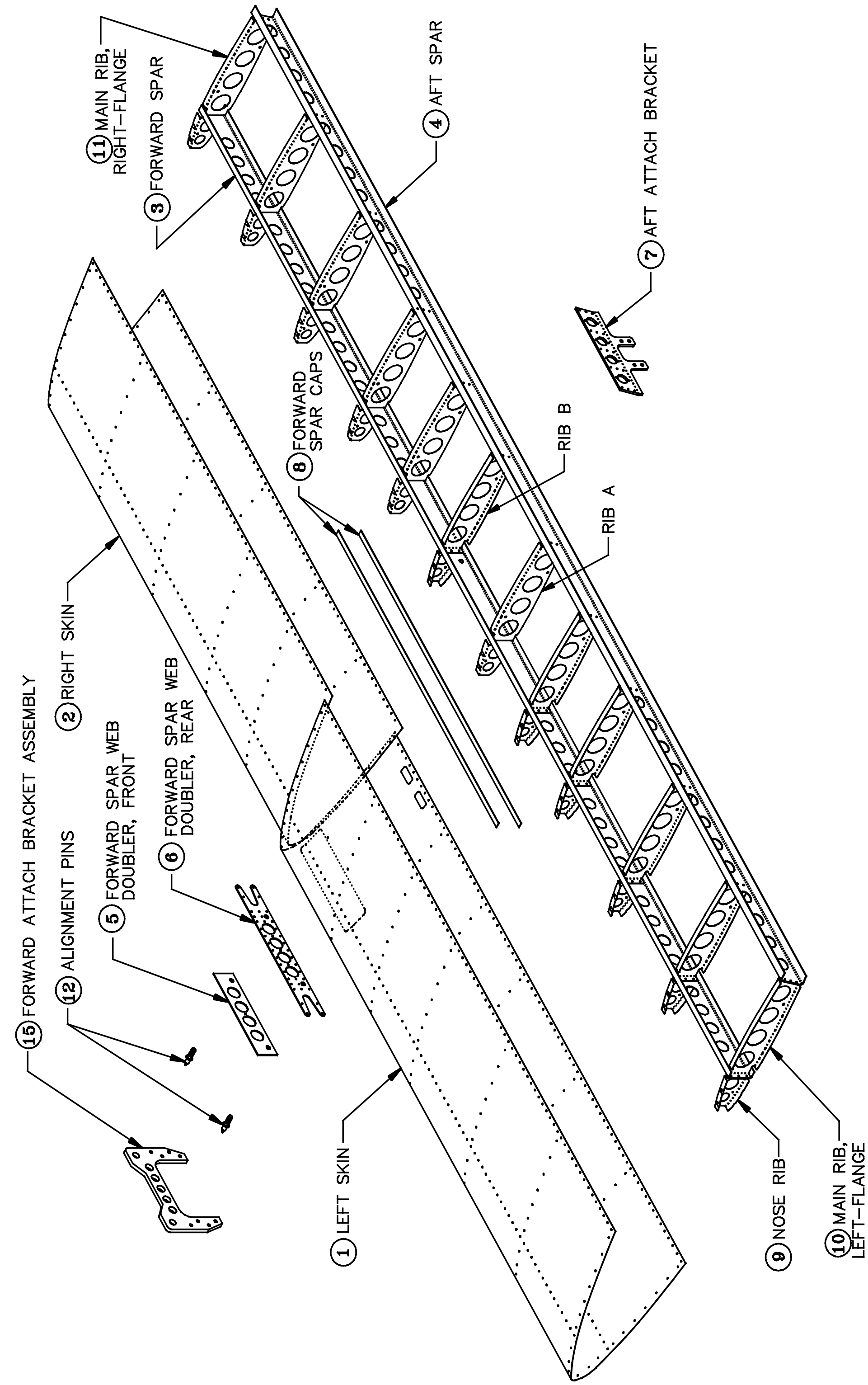

Figure 1: Horizontal Stabilizer Assembly

Positioning and Drilling

Step 1: Straighten and Deburr the Parts

Using a square, check the flanges on all the **nose ribs** [9] and **left-flange** [10] and **right-flange main ribs** [11] for squareness, straightening as necessary with a pair of duck bill pliers.

> **Note** **Left-flange** ribs are those ribs with flanges that project to the **left** relative to the aircraft when properly positioned in the assembly; **right-flange** ribs have flanges that project to the **right**. This nomenclature (which is also used in the wing, aileron and flap assemblies) is necessary because ribs of **both** flange orientations are used on **both** the left and the right sides of the assembly.

> **Note** Be sure to pad the jaws of your pliers to avoid scratching the Alclad aluminum. Simply wrapping the jaws in masking tape is sufficient.

Deburr the edges and lightening holes of all parts as necessary.

Completed: [ ]

Step 2: Mark Rivet Lines on the Flanges of the Nose Ribs and Spars

Using a **very fine** marking pen, mark centerlines on the upper and lower flanges of all the nose ribs. Rivet lines must also be marked on both the upper and lower flanges of both the **forward spar** [3] and the **aft spar** [4], but these are not strictly centerlines: as shown in Figure 3, mark these rivet lines parallel to and **3/8"** forward of the trailing edges of the spar flanges.

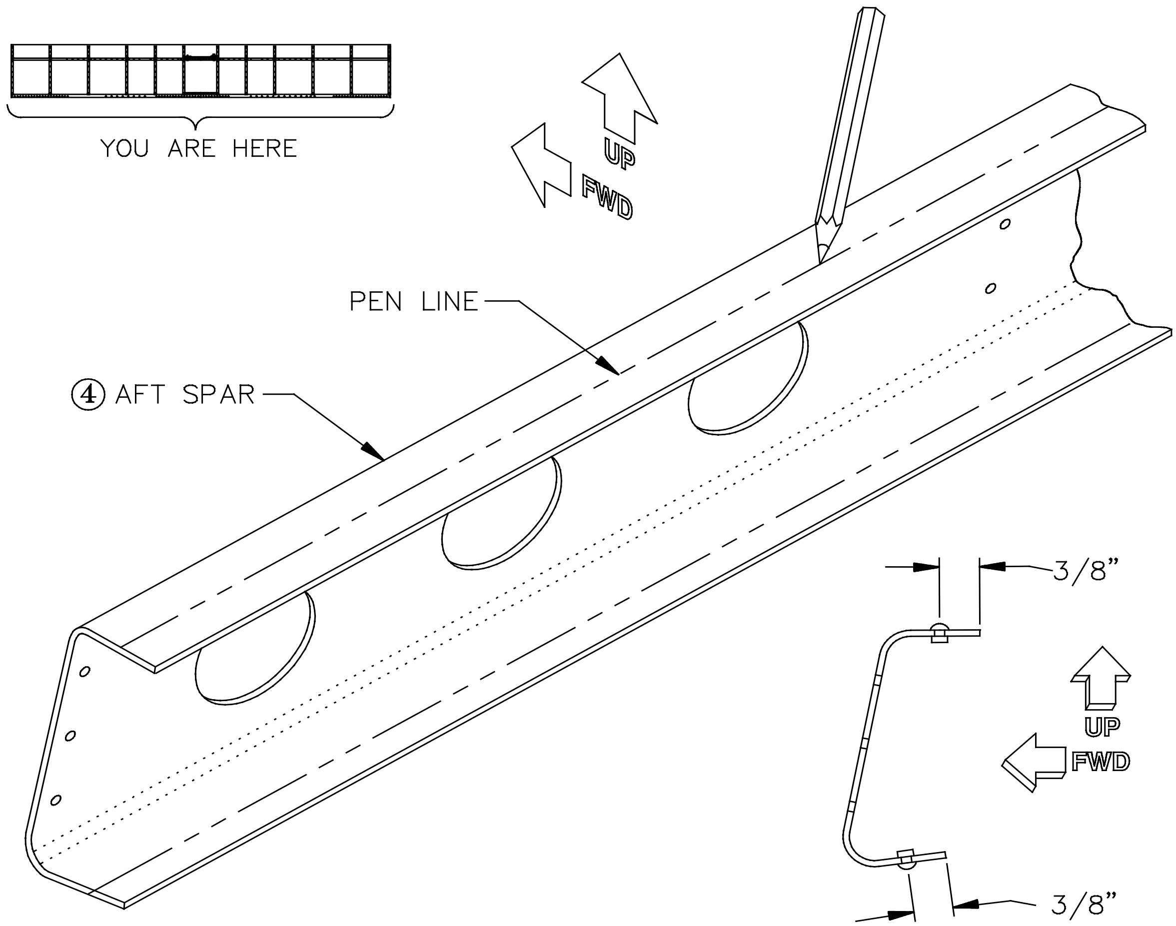

Figure 2: Aft Spar Rivet Lines

> **Note** As a result of the bending process, the spar is likely to have a slight bow in it when viewed from above. You will remove this bow in the process of aligning the skins over the spar, but in order for this to be successful, the rivet line you mark must remain **parallel** to the spar flange trailing edge. Do **not** mark a **straight** line if the spar is bowed.

Completed: [ ]

Step 3: Cleco the Main and Nose Ribs to the Forward Spar and Drill the Rivet Holes to Final Size

As shown in Figure 3, use two Clecos per rib through the pre-punched holes to clamp the main and nose ribs to the **forward spar** [3]. Each pair of Clecos holds both the main and nose rib at each position. Note that the forward end of the main ribs is the end with the flange perpendicular to the chord line. Also note that the forward spar **is not** perfectly symmetrical top and bottom; to orient it properly, make sure the two 3/8" holes near the center of the spar are **below the longitudinal centerline** of the spar. Finally, it is vital that the rib and spar flanges be oriented properly, as shown in Figure 1; the flanges of both spars should point **aft**, and all main and nose ribs should point **outboard**, **except** for Ribs A and B and their corresponding nose ribs, which should point **inboard**.

After all the ribs are Clecoed in place and you have confirmed that the flanges are properly oriented, mark each rib, specifying its location on the spar. Use any numbering or lettering system that makes sense to you; the important thing is simply that you be able to return each rib to its original position on the spar after repeated disassembly and reassembly.

Finally, juggling the Clecos as necessary, drill through the flanges of each main and nose rib and the corresponding spar web holes with a **#40** bit. Leave two Clecos holding each pair of ribs to the spar when finished.

Completed: [ ]

Step 4: Cleco the Aft Spar to the Main Ribs and Drill the Rivet Holes to Final Size

Again using two Clecos per rib through the pre-punched holes, clamp the aft spar to the ribs. Note that the aft spar also has a definite top and bottom. When properly mounted on the main ribs, the spar flanges should smoothly continue the curvature of the main ribs' upper and lower flanges (see Figure 3). If the spar flanges head off in different directions from the rib flanges, you have mounted the spar upside down!

With the spar Clecoed in place, re-drill through the spar and aft rib flange at each of the three holes at each rib location with a **#30** bit. Juggle the Clecos from hole to hole so that two Clecos are always holding each rib in place.

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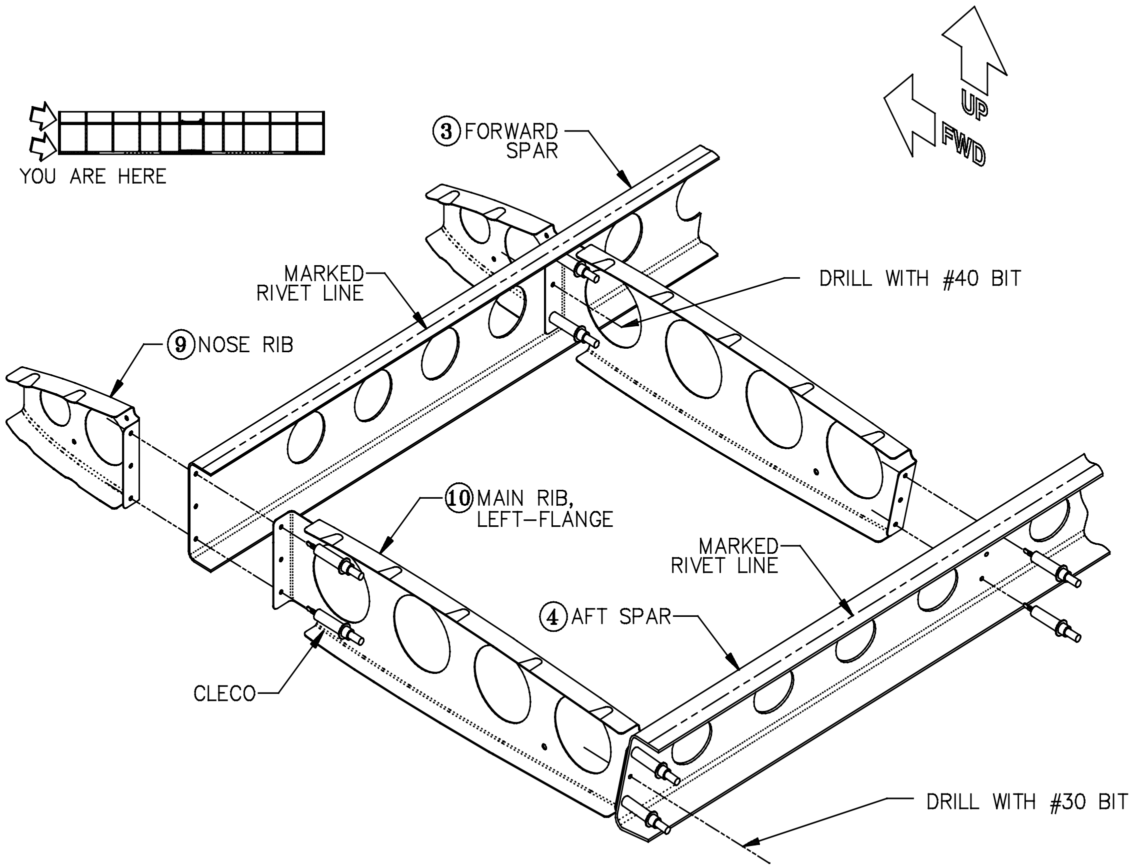

Figure 3: Clecoing the Spar/Rib Assembly

Step 5: Position and Drill the Forward Spar Web Doublers

Remove at least Ribs A and B and their associated nose ribs from the spar/rib framework, although you may find it easier to complete this step if you disassemble the forward spar completely from the spar/rib framework. Temporarily mount the **front** [5] and **rear** [6] **forward spar web doublers** on the forward spar using the **alignment pins** [12], AN315-6R **jam nuts** [16] and AN960D616 **aluminum washers**, as shown in Figure 5. The pins should be inserted from the forward side of the spar, with the pointed ends forward. Tighten the nuts firmly with an adjustable wrench or a 9/16" open-end wrench on the flats on the forward end of each pin.

> **Warning** The plain nuts are used in this step only. They allow the use of the alignment pins in positioning the spar doublers, but are easily removable. Self-locking nuts will be used later for the actual installation of the pins.

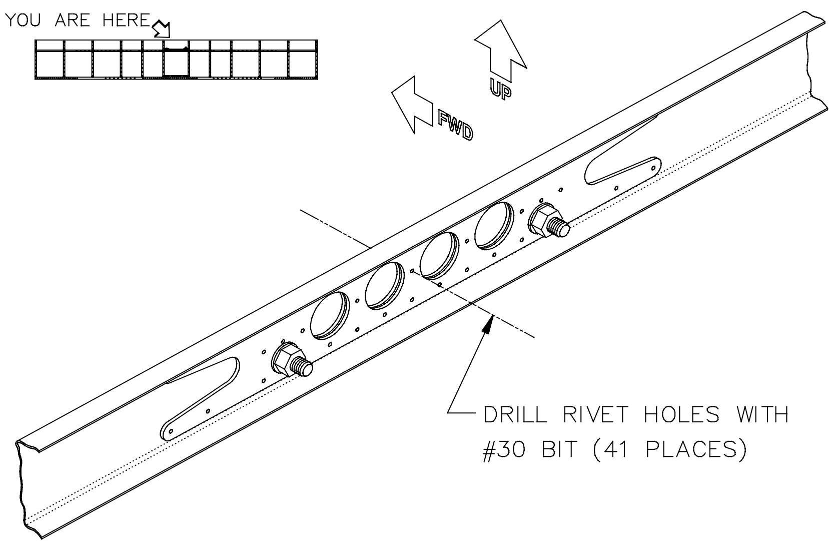

Figure 4: Drilling the Forward Spar Doublers

When both doublers are firmly pinned in place, use the pre-punched pilot holes in the rear doubler to drill through the spar and both doublers with a **#30** bit, as shown in Figure 4.

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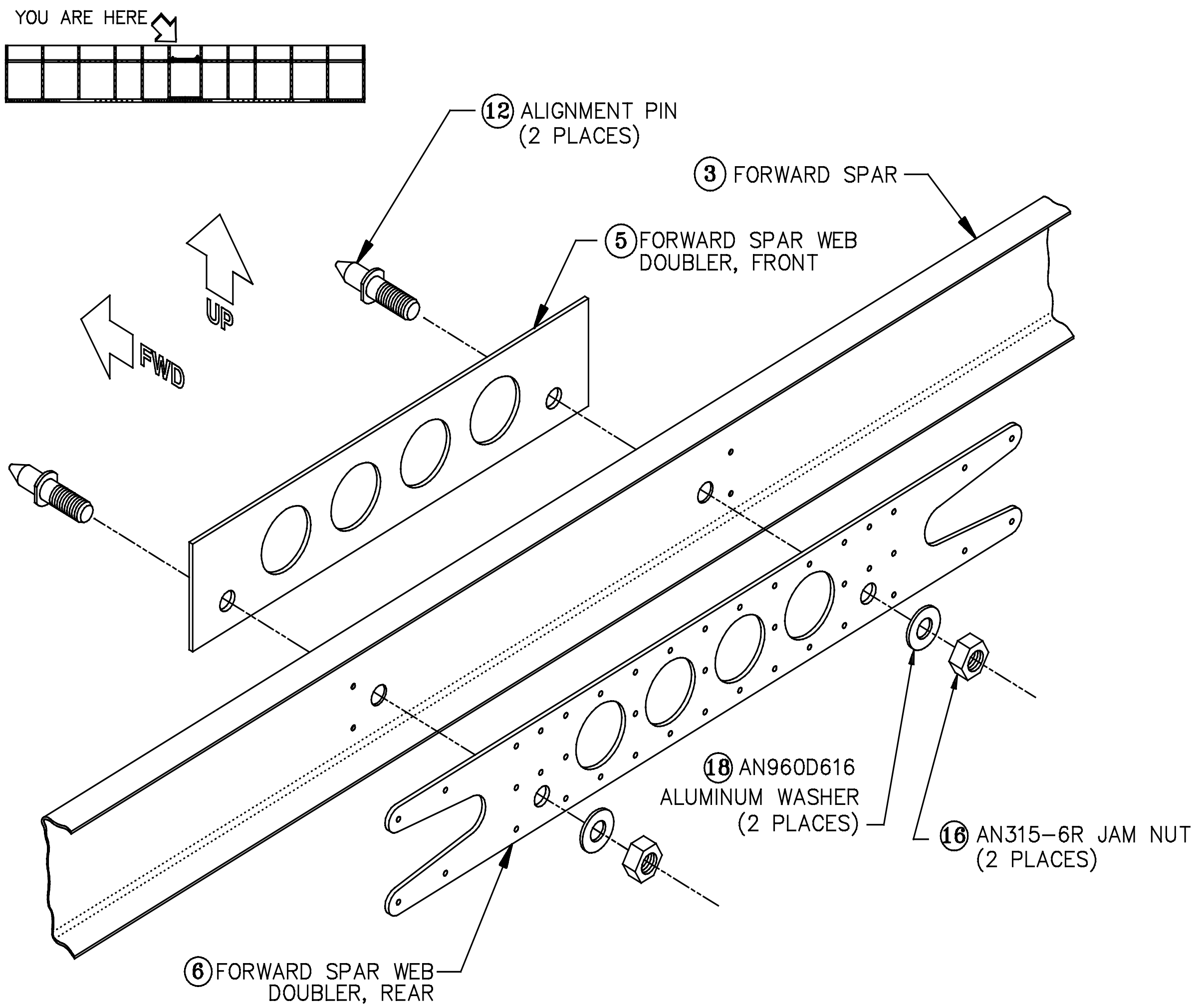

Figure 5: Forward Spar Web Doublers

Step 6: Modify the Center Main Ribs

Because the rear doubler on the forward spar extends in a spanwise direction beyond the points at which Ribs A and B attach to the spar, these two ribs must be shortened. This will be accomplished by cutting off the original forward flanges and riveting new flanges in place.

A) Remove the Original Flanges

Using a pair of aviation snips, cut the forward flanges off both center ribs right at the beginning of the bend radius, as shown in Figure 6a. Use a fine-toothed file to smooth the cut edges and round the corners.

Hint If you have one, a belt sander also works well for smoothing snipped edges and for rounding corners of sheet aluminum.

B) Cut the Replacement Flanges

Your Sportsman kit contains a piece of bent aluminum angle stock (called **main rib flange** [13] in the parts list) from which you must cut the two replacement flanges needed. The length of each new flange should be approximately the same as the height of the original flange—about **2-1/4"**—but this dimension is not critical.

Hint Use one of the flanges you just cut off as a length guide for cutting the new ones.

Use snips or a fine-toothed saw to make the cuts. Afterwards, smooth the cut edges and round the corners.

C) Drill Rivet Holes in the Rib Tabs

As shown in Figure 6c, mark a line parallel to and **1/4"** aft of the forward edge (i.e., the edge you cut) on the web of each center rib. On this line, mark and lightly center punch four rivet hole locations. The outermost holes should be a minimum of **1/4"** from the top and bottom edges of the tab, and the remaining

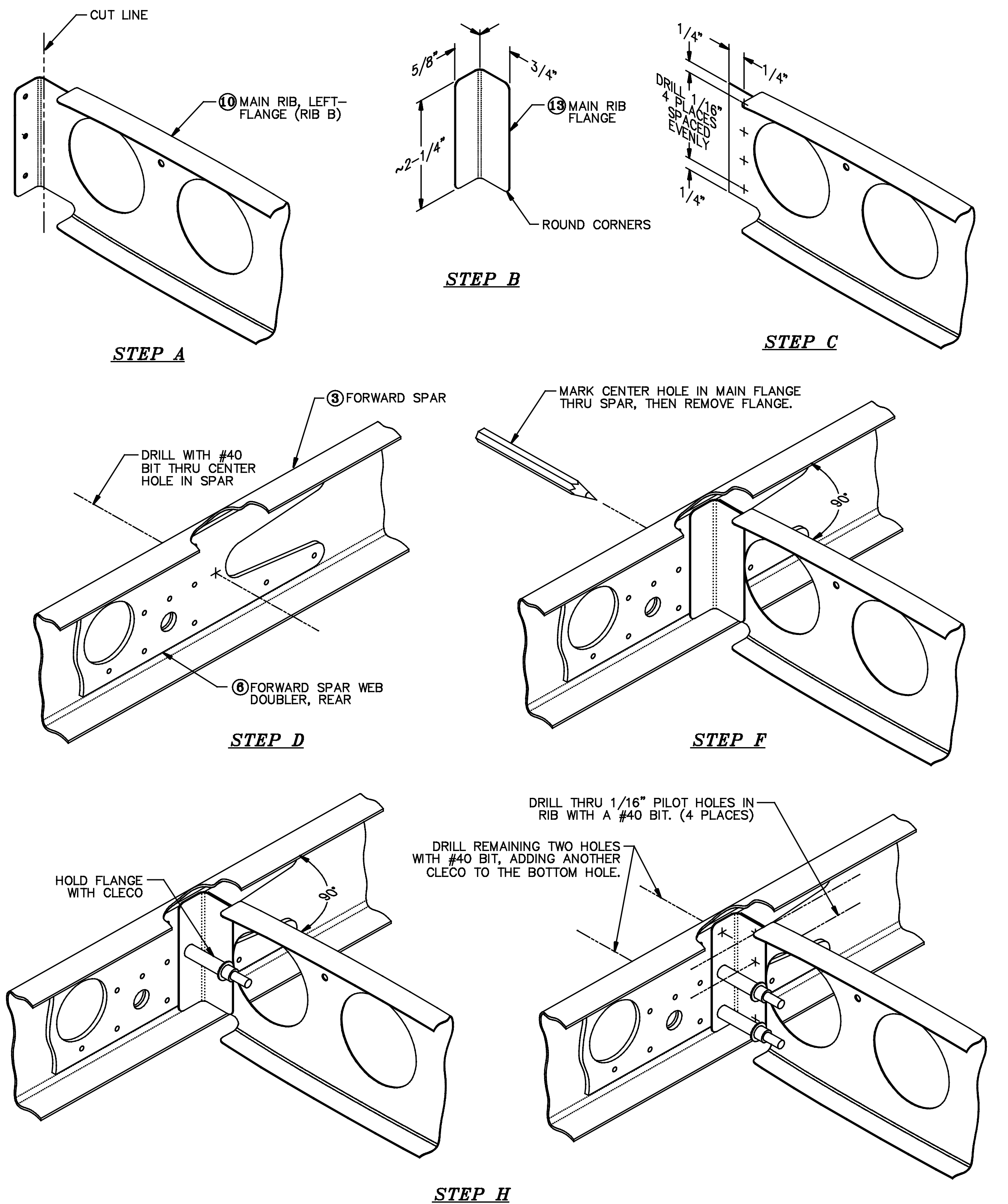

Figure 6: Center Main Rib Modification

two holes should be spaced equidistantly between the outer pair. These dimensions are not critical.

Drill all four holes with a **1/16"** bit.

D) Drill the Center Rivet Hole Through the Spar Web and the Rear Doubler

> **Note** The front and rear spar web doublers should still be pinned to the forward spar at this point; if you took them apart, pin them back together now.

The three holes for riveting the forward end of each center rib to the spar/doubler assembly have been pre-punched in the spar, but not in the doubler. At this time, drill with a **#40** bit **only the middle** one of these three holes on each side, as shown in Figure 6d. A Cleco through this hole will hold the flanges in place while the remaining holes are drilled.

E) Reassemble the Spar/Main Rib Assembly

If you disassembled the spar/rib framework to mount the forward spar web doublers, use two Clecos per rib end to refasten the main ribs between the forward and aft spars. Cleco Ribs A and B to the aft spar.

F) Mark Center Rivet Hole Locations on the Replacement Flanges

Position the replacement flange with the wider flange against the web of the rib and the narrower flange tight against the rear doubler, as shown in Figure 6f. The vertical alignment of the replacement flange is not critical; simply center it on the rib tab from which you cut the original flange. With the replacement flange held in approximate position against the rib web, mark any interference between the flange and the flared edge of the rib lightening hole. Relieve this interference by cutting away a crescent-shaped piece of the flange. Remove as little material as possible, but make sure that the flange completely clears the bend radius of the flare. Use a fine-toothed file or coarse sandpaper to smooth the cut edge of the flange.

Reposition the replacement flange, and use a square to check that the rib is perpendicular to the forward spar. While holding the replacement flange in position, use a marking pen through the hole you drilled in the spar web and doubler to mark the location of the center rivet hole on the forward face of the replacement flange.

It would also be a good idea at this time to mark the replacement flanges to distinguish the left from the right.

G) DRILL THE CENTER RIVET HOLES IN THE REPLACEMENT FLANGES

Center punch lightly on the mark you made in the last step and drill with a **#40** bit.

H) CLECO THE FLANGES IN PLACE AND DRILL THE REMAINING RIB/ FLANGE RIVET HOLES

From the aft side of the spar, insert a Cleco in the center hole of the replacement flange, as shown in Figure 6h. From the forward side of the spar, drill the remaining two holes through the spar web, doubler and flange with a **#40** bit. After the first of these holes has been drilled, add a second Cleco before drilling the final hole.

Next, from the outboard side of the center rib, drill through the four 1/16" holes in the rib web with a **#40** bit. You will probably need a 90° drill to get inside the cove of the spar to drill these holes. Take care to keep the holes as perpendicular to the rib web as possible. Also, you will need to juggle the Clecos holding the flange to the spar to keep them out of the way of the bit.

After all the holes have been drilled, disassemble, clean and deburr all the parts, including the forward spar doublers.

Completed: [ ]

Step 7: Position the Right Skin

In this step, the right stabilizer skin will be positioned over the spar/rib framework in preparation for drilling rivet holes for securing the skin to the framework. The important result of the step is to position the skin so that the spar line rivet holes in the skin are roughly centered over the flanges of both spars. By "roughly centered" we mean positioned so that the spars can be drilled without violating the minimum edge margin requirement of two rivet diameters between the **centers** of the holes and either the trailing edges or the bend radii of the spars. **It is also vital in this step that the spars be kept straight** and that the skin be pulled down tightly over the spar/rib assembly everywhere. Use a string line on the aft spar and/or clamp the aft spar to a long, metal-angle straightedge to maintain spar straightness.

Caution Maintaining spar straightness in the fore-and-aft direction is of paramount importance because this affects the straightness of the elevator hinge. If you're not careful, you can end up with a bowed stabilizer, even while maintaining proper rivet hole edge margins. Remove any bow in a spar by clamping the tips of the spar and pulling on the center; then hold the spar straight while fitting the skins.

The marked rivet lines on the spar flanges are intended only to provide a method of gauging where the pre-punched holes are falling on the spar flanges. For a variety of reasons—different clamping procedures, slight variations in manufacturing tolerances, slightly bent ribs, etc.—it's quite possible that none of the rows of pre-punched holes will be centered **precisely** on their respective rivet lines. Simply use the lines as guides to try to reduce such mismatches as much as possible. Again, the most important requirements are simply to keep the spar straight and avoid violating the minimum edge distance requirement.

Note Figure 7 has been deleted

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The **right skin** [2] is the one without the rectangular cutouts; it is also shorter than the **left skin** [1]. Although the stabilizer airfoil is symmetrical, the skins **do** have a definite top and bottom. The surfaces can be distinguished by measuring from each trailing edge to the first row of pre-punched rivet holes; on the upper surface, this distance is less than 1/2", while on the lower it is more than 1/2".

Lay the spar/rib assembly right-side up on the bench and slip the skin over the assembly. Align the skin left-and-right by placing the outboard edge of the skin flush with the outboard ends of the spars. Align the skin fore-and-aft by centering the upper-flange rivet line of the aft spar under the pre-punched holes in the trailing edge of the upper surface of the skin. When the skin is aligned left-and-right and fore-and-aft, clamp it in place using four or five Cleco side-grip clamps or rubber-padded spring clamps along the upper flange of the aft spar, as shown in Figure 8.

Note When the upper surface of the skin is properly positioned, the trailing edge will hang over the trailing edge of the upper aft spar flange by about 1/16". **Do not** attempt to make the skin and spar flange trailing edges flush with one another.

Note The spars may have slight bows in them. Devise some means to hold the aft spar straight when clamping the skin to it, and make sure that you keep the spar rivet line roughly centered under the skin holes **along the entire length** of the skin. If the aft spar is kept straight, the forward spar will also be straight.

Turn the assembly over and repeat the alignment process on the lower surface, again centering the aft spar rivet line under the pre-punched skin holes. Place some 2 X 4s or sand bags under the assembly so that the clamps along the upper spar flange clear the bench top. Clamp the skin into position along the lower spar flange as you did on the upper flange. Try to get all four spar rivet lines aligned with the rivet hole rows in the skin. If perfect alignment isn't possible, the next best situation is to have the upper skin rivet holes slightly **aft** of the spar rivet lines and the lower rivet holes slightly **forward** of the spar rivet lines.

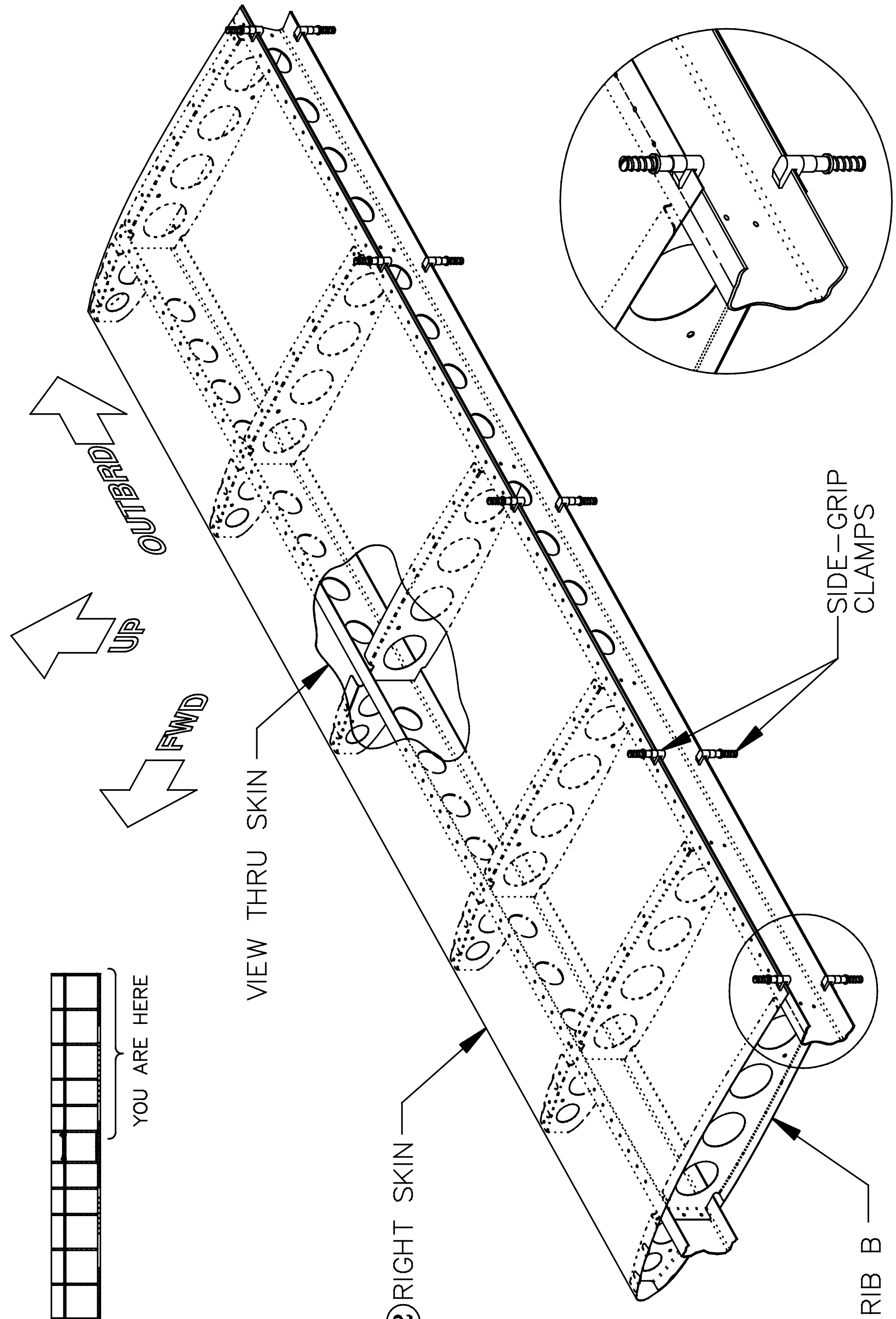

Figure 8: Positioning the Right Skin

When the lower trailing edge of the skin has been securely clamped to the aft spar, turn the whole assembly over again. Before proceeding to the next step, you need to double check to make sure that the skin is positioned squarely; otherwise, a twist will be introduced into the assembly. Figure 9 shows how this can be checked accurately. Temporarily affix a couple of small wooden blocks to the underside of a digital level (recommended) or carpenter's level (acceptable) so that the level can be set chordwise on the curved surface of the stabilizer. Place the level near the outboard end of the skin with one of the blocks on the forward spar rivet line. Use scrap shims or sand bags to adjust the assembly until the level reads level. Then move the level to the inboard end of the skin, taking care to put the same block again on the forward spar rivet line. If the level again reads level, then you have a twist-free stabilizer half; if not, shim the inboard end until it comes into level.

Note This procedure does not depend on the stabilizer **as a whole** being level relative to any given reference line; rather, it reveals whether the two ends are level relative to each other without any twist, and this is what's important.

Hint You may find the leveling process easier if you make a pair of supports for either end of the assembly. Take a 2' length of scrap 2 X 8 and trace the outline of the nose and main rib on it. Stack this piece with another one of equal size and cut out the stabilizer cross-section in both pieces. (Cut a bit outside the traced outline to accommodate the skins and spars.) Slide one of these sleeves over each end of the stabilizer assembly, and shim as necessary to bring the assembly into level. Note that the chord line of the stabilizer need not be precisely centered on the supports; they just provide a convenient shimming surface.

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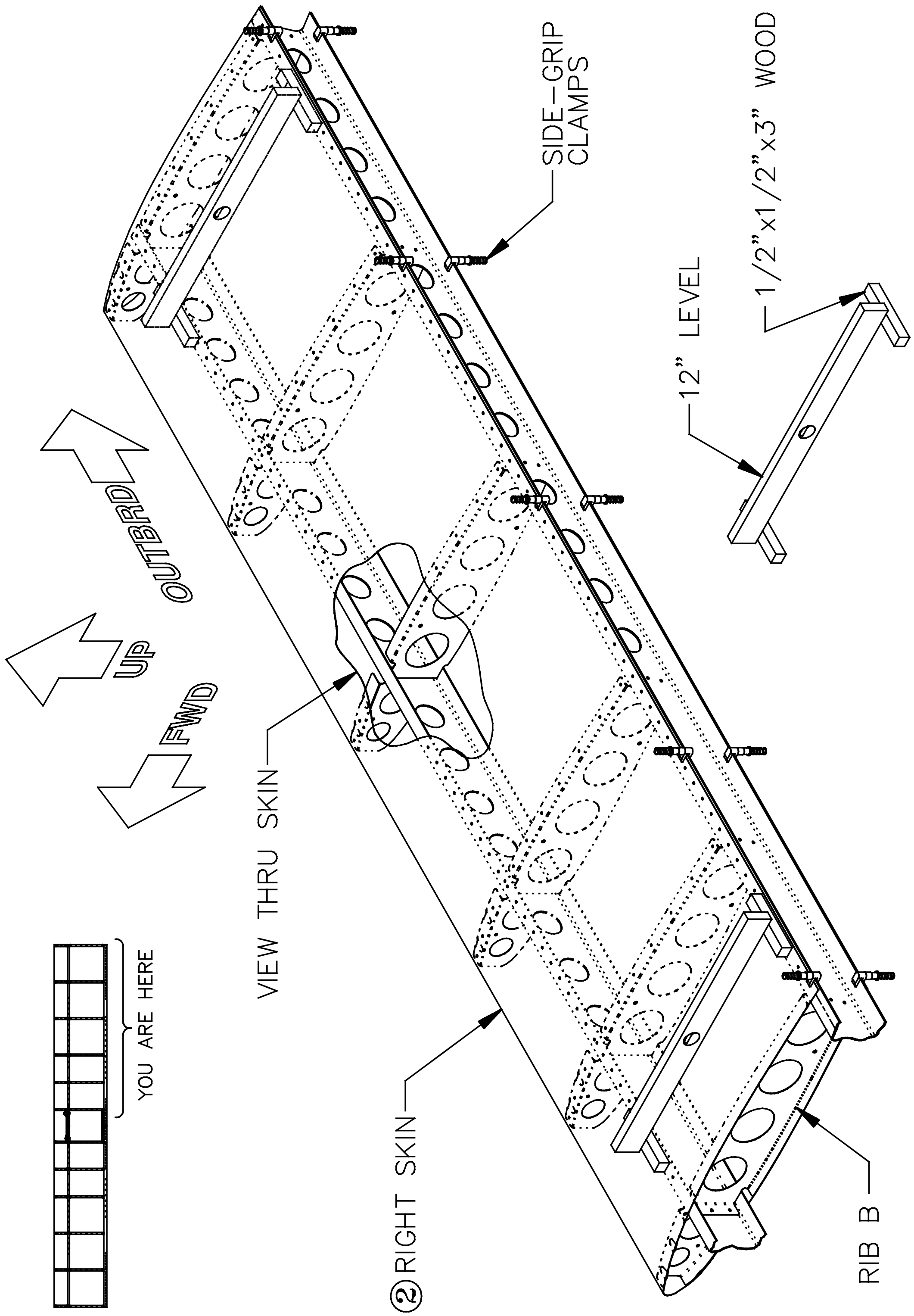

Figure 9: Stabilizer Alignment Procedure

Step 8: Drill the Upper Surface Main Rib and Forward Spar Rivet Holes

Note In this and subsequent steps pay particular attention to the drill sizes specified for the rivet holes. Most of the holes are drilled with a #40 bit, but those along the lower flange of the aft spar are drilled with a #30 bit. There is no penalty for drilling an undersize hole, as these can always be enlarged, but drilling an oversize hole will force you to use a larger rivet than necessary.

After verifying that the spars are straight in the fore-and-aft direction, use the pre-punched pilot holes as guides to drill through the skins, main ribs and forward spar with a **#40** bit. Begin at the inboard end of the spar and drill outboard once at every rib location, Clecoing these holes as you go. Then drill the remaining forward spar holes, putting a Cleco in every third or fourth hole. Repeat this process on the main ribs, drilling and Clecoing in a fore-to-aft direction along each rib.

Note Some of the forward spar rivet holes lie almost directly over the web of a main rib, making it very difficult to properly buck a hard rivet in these holes. Check your spar holes as you drill; if they appear to be too close to the underlying rib web to enable bucking—say, within 1/8"—drill them up to **#30** size for later installation of blind rivets. Use a drill stop set at **3/16"** when drilling these holes to avoid the possibility of damaging the underlying rib web.

Note Don't drill any holes along the centermost rib (Rib B in Figure 10); these will be drilled after the left skin is lapped over the right. Also, don't drill the nose rib holes; these will be done in a subsequent step.

Completed: [ ]

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Step 9: Drill the Upper Surface Aft Spar Rivet Holes

After completing all the main rib and forward spar drilling, double check to make sure that the aft spar rivet lines remain centered under the trailing edge skin holes top and bottom. If necessary, loosen the clamps holding the trailing edges in place and persuade the spar back into alignment.

When you're satisfied, drill along the aft spar once at each rib location with a **#40** bit. Again, Cleco as you go. **Do not** drill the remaining aft spar holes at this time; they will be drilled when the elevator hinge is mounted in the next section.

When the drilling is complete, remove the side-grips or C-clamps along the aft spar upper flange.

Completed: [ ]

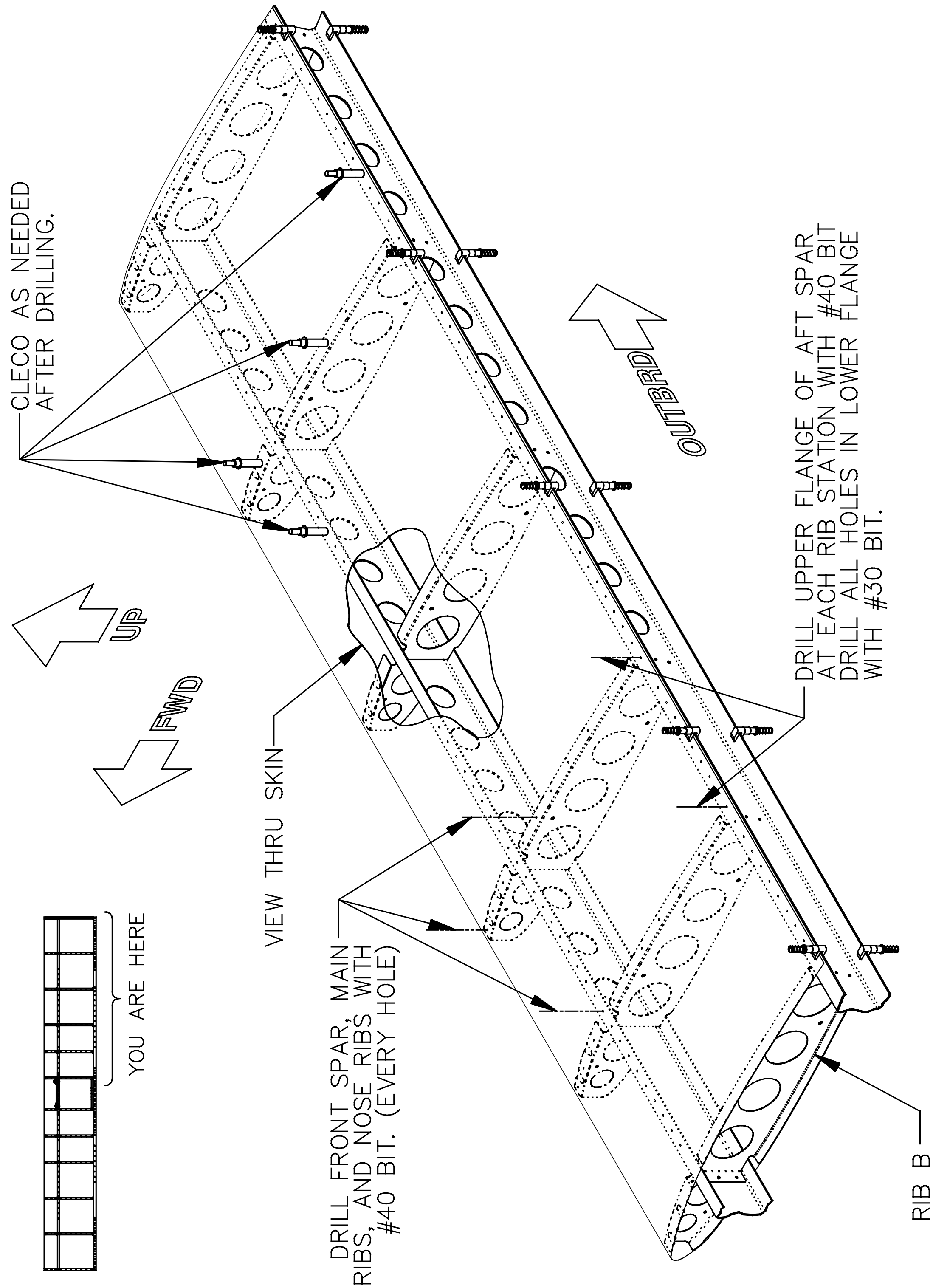

Figure 10: Drilling the Right Skin

Step 10: Realign and Drill the Lower Surface of the Right Skin

Turn the assembly over and repeat the leveling procedure to check that everything is still aligned. If necessary, adjust the remaining side-grips or C-clamps along the lower flange of the aft spar to bring the assembly back to true.

Then drill the spars and main ribs with a **#40** bit using the same procedures and sequences outlined above, with the following exceptions:

> **Note** Drill **all** the holes along the **lower flange** of the aft spar—not just once at each rib station—and use a **#30** rather than a #40 bit.

Completed: [ ]

Step 11: Align and Drill the Right-Side Nose Ribs

With the right-hand skin drilled and Clecoed firmly in place, it's necessary to ensure that the nose ribs are square with respect to the forward spar. Check this by looking for the rivet line you marked on each rib; it should be visible through the pre-punched rivet holes in the leading edge of the skin. If the line is not centered under the holes, shift the rib left or right as necessary using the rib alignment probe described in "ALUMINUM SHEET METAL WORK, *Clamping Parts Together*" in "SECTION II: TOOLS AND TECHNIQUES." The probe is simply a 4- to 5-foot length of 1/4" aluminum tubing with a small hook bent in one end, which can be inserted into the structure through the rib lightening holes to push or pull a rib into alignment. If the misalignment is slight, you can probably also correct it simply by inserting a scriber or an awl through one of the rivet holes and prying the rib slightly in the necessary direction.

When the nose ribs are all square, drill through each of the pre-punched skin holes with a **#40** bit. Begin at the spar and work forward on both the upper and lower surfaces.

Note **Do not** drill any holes in the **outermost** nose rib at this time; these will be drilled in "SECTION X: FINAL ASSEMBLY" when the tip fairings are installed.

Completed: [ ]

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28:

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Step 12: Position the Left Skin

The left skin is handled virtually the same way as the right. Distinguishing the upper and lower surfaces of the left skin is easier, however—the bottom is the side with the large, rectangular cutout in it.

Note The goals to be achieved in this step are identical to those described in Step 7 for the right skin. Review Step 7 for a detailed discussion of the goals.

Slide the skin over the spar/rib assembly with the rectangular hole inboard, as shown in Figure 11. Again, align the upper surface of the skin left-and-right on the outboard ends of the spars and fore-and-aft on the aft spar rivet line. Pull the skin aft into its final position, aligning the lower surface trailing edge holes on the aft spar rivet line as before, and clamp into place.

Caution The left skin **overlaps** the right skin at the centermost right-side rib (Rib B in Figure 11). **Do not** attempt to align the left skin in a flush butt joint with the right.

Again, use the leveling procedure shown in Figure 9 to check for twist in the left half of the stabilizer. In addition, before any left-side holes are drilled, it's important to check that the stabilizer **as a whole** is flat and that the leading and trailing edges are perfectly straight across both the left and right halves. Any bow in the spars will be reflected in crooked leading and/or trailing edges and will make it more difficult to achieve a straight elevator hinge line; this must be corrected now, because if you finish drilling the left side of the assembly without doing so, you'll be carving the problem in stone. Check for straightness with a long straightedge or a string line and adjust the assembly as necessary.

Note Because the left skin wraps around the right, there will be a **slight** mismatch (on the order of 1/32") where the trailing edges of the two skins meet top and bottom. Try to roughly split this difference between the upper and lower surfaces.

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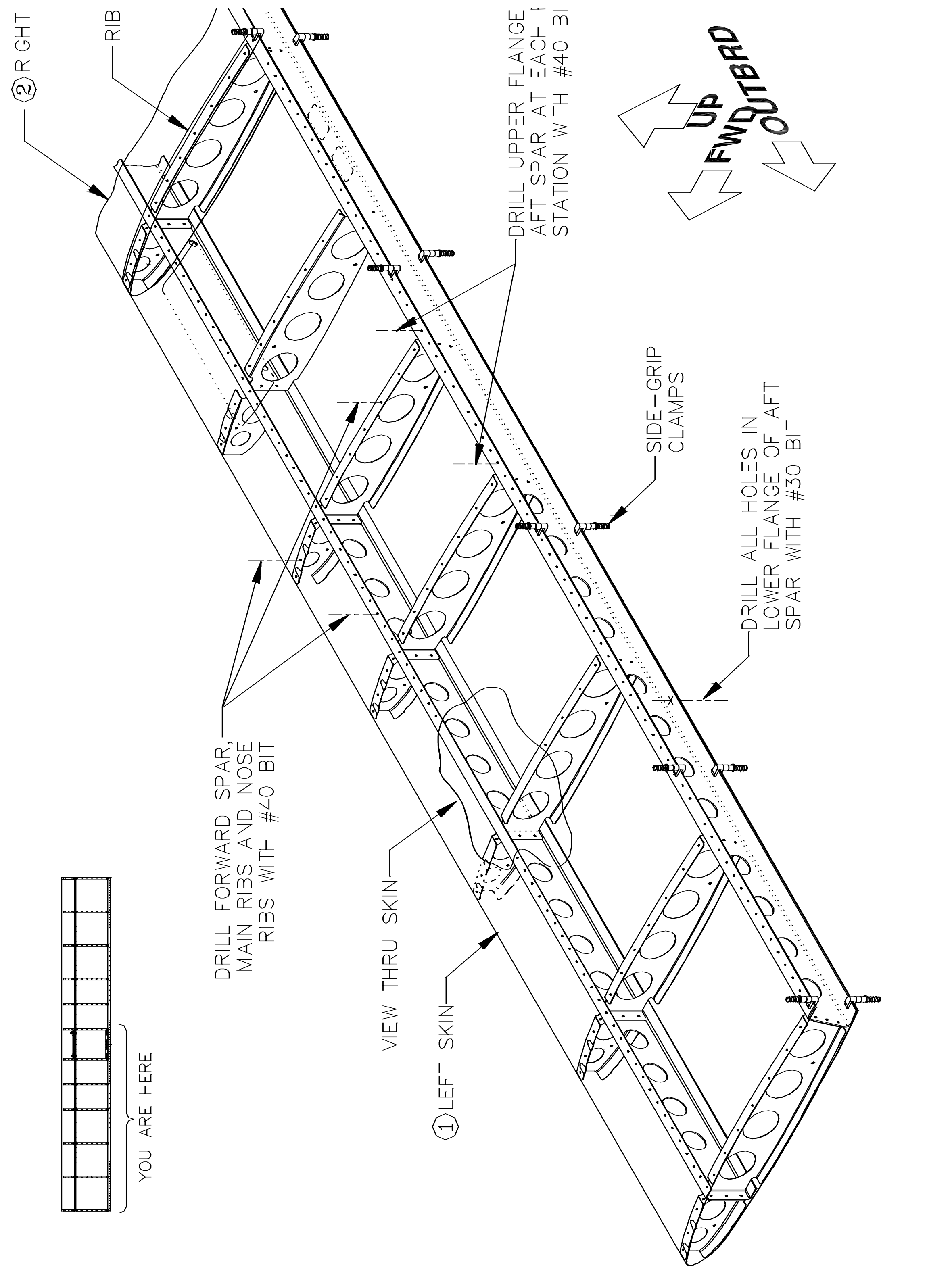

Figure 11: Positioning and Drilling the Left Skin

Step 13: Drill the Rib and Spar Rivet Holes

> **Note** Some of the forward spar rivet holes lie almost directly over the web of a main rib, making it very difficult to properly buck a hard rivet in these holes. Check your spar holes as you drill; if they appear to be too close to the underlying rib web to enable bucking-say, within 1/8" – drill them up to #30 size for later installation of blind rivets. Use a drill stop set at 3/16" when drilling these holes to avoid the possibility of damaging the underlying rib web.

Drill and Cleco the left-side rib and spar holes with a #40 bit as you did on the right side, with the following exception: don't drill the holes along Ribs A and B (or their corresponding spar holes) until last. Before drilling these last holes, check the aft spar one last time for straightness. On the upper flanges of the saft spar, remember to drill only one hole at each rib location; the remainder will be drilled when the elevator is installed.

> **Note** At the overlap between the left and right skins, you will be drilling through the right skin as well as the rib flanges. As on the right side, do not drill any holes in the nose ribs at this time.

Completed: [ ]

Step 14: Align and Drill the left-Side Nose Ribs

Repeat the nose-rib alignment and drilling procedures (#40 bit) described above. Again, **do not** drill any holes in the outermost nose rib at this time.

Completed: [ ]

Step 15: Disassemble the spar/Rib Assembly and Deburr the Parts

Un-Cleco the skins from the spar/rib assembly and the ribs from the spars. Deburr all the holes. Be sure also to brush off any shavings that might be clinging to the p-arts away from the holes. Set the skins and ribs aside.

Completed: [ ]

Step 16: Chamfer an Edge of the Forward Spar Caps

Figure 12 illustrates the position of the two spar caps [8] in side the upper and lower flanges of the forward spar. In order for the caps to nestle snugly inside the flanges of the spar, it's necessary to slightly chamfer the edges of the caps that will be against the bend radius between the spar flange and web.

To do this, simply clamp each spar cap along the edge of your bench and file the corner off one edge; any edge will do. Use long, spanwise strokes and try to leave a smooth, rounded finish. Check the cap periodically inside the spar to make sure you remove just enough material for the cap to lie flat.

Completed: [ ]

Step 17: Position the Forward Spar Caps and Drill the Rivet Holes

Note Shift each cap left or fight as necessary until the ends fall between holes with a minimum edge margin of two rivet diameters. Alternatively, shorten the cap as required to fit between rivets.

On the inside of the upper flange, measure 42" inboard from either end of the spar, as shown I figure 12, and make a mark. Position of the spar inside the flange even with this mark and as far forward (towards the bend radius of the spar flange) as possible and clamp the cap in place with Cleco side-grip clamps.

Once the cap is positioned and clamped, use the rivet holes in the spar flange as guides and drill through the spar cap with a #40 bit. Since the holes in the spar flange were already drilled to final size when the skins were drilled, be extra careful to center the drill bit in the existing hole and to keep the drill perpendicular to the surface in order to avoid enlarging the spar flange holes.

It is vitally important that the spar caps be help tightly against the spar flanges while being drilled. Fir this reason, you should begin drilling at one end and proceed a hole at a time toward the other end, clecoing every hole as you go, rather that drilling and clecoing at a few locations and then drilling the intervening holes as we have usually suggested. As you drill, be particularly attentive to make sure that no aluminum chips get caught between the cap and the flange. For the most certain results, you might want to place side-grips or C-clamps on either side of the each hole before drilling.

When the upper spar cap has been drilled, remove it from the spar and mark it as the upper cap.

Repeat the process on the lower spar cap, which is installed inside the lower flange of the forward spar. After both caps have been drilled, thoroughly clean and deburr them and the forward spar.

Note It's important to keep the spar straight while drilling the caps. A good way to ensure this is to clamp the spar to the edge of your bench with rubber padded spring clamps while fitting the caps.

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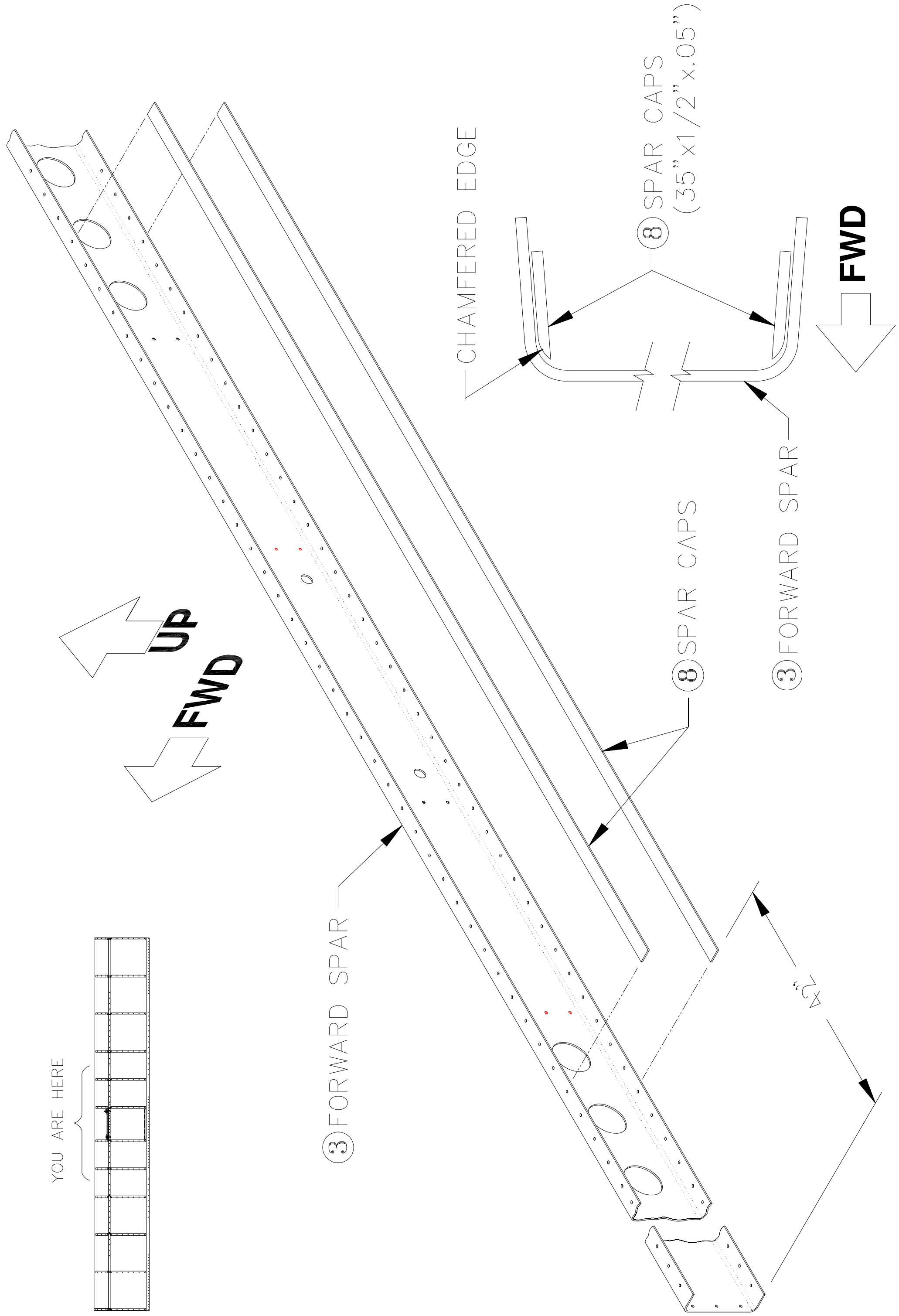

Figure 12: Forward Spar Caps

Step 18: Position and Drill the Aft Attach Bracket

Position the **aft attach bracket** [7] against the forward face of the aft spar web midway between the ends of the spar, as shown in Figure 13; clamp it in place with a pair of Clecos through the pre-punched holes in the spar web and in the middle hole in each row of three at the outermost edges of the bracket.

> **Note** When the bracket is properly **oriented, the two tongues of the bracket that project below the spar are angled** aft (see Figure 13).

When the bracket is clamped in position, use its pre-punched pilot holes to drill through the bracket and the spar with a **#30** bit. Insert a couple of larger Clecos into two of the newly drilled holes, remove the original pair of Clecos, and drill those two holes up to #30 size.

When the drilling is complete, disassemble, clean and deburr all parts.

Completed: [ ]

Step 19: Corrosion-Proof the Stabilizer Interior

Corrosion-proof all interior parts as you deem necessary (see "Interior Corrosion Protection" in "Section II: Tools and Techniques"). Minimally, we recommend first applying an aluminum cleaner and then alodizing all interior parts.

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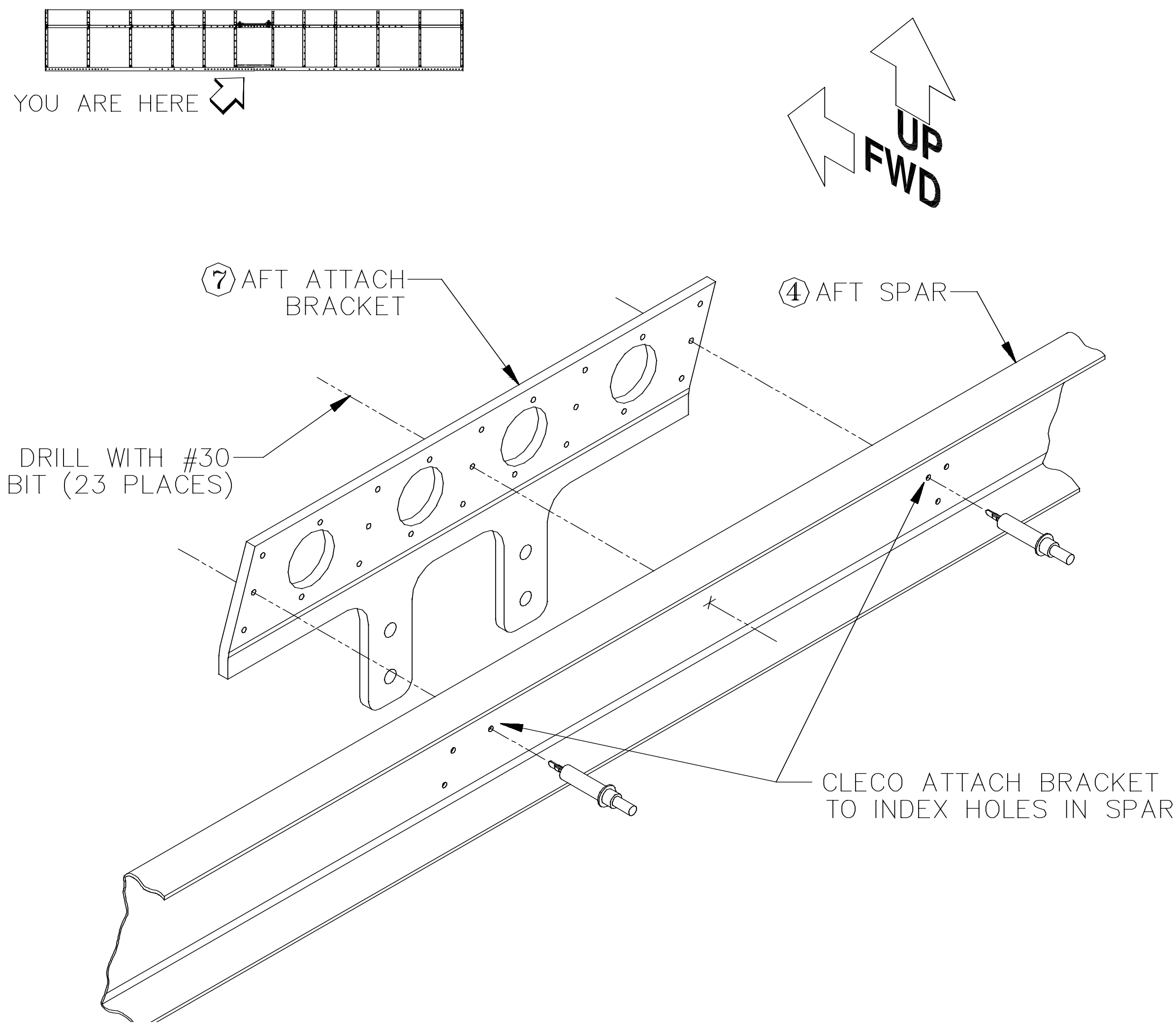

Figure 13: Aft Attach Bracket

RIVETING

Step 20: Rivet the Attach Bracket to the Aft Spar

Using 1/8" AN470AD4 universal head rivets of appropriate length, rivet the attach bracket to the aft spar. The manufactured heads should be on spar side, as shown in Figure 14. As before, be sure the two tongues of the bracket that project below the spar are **angled aft**.

Completed: [ ]

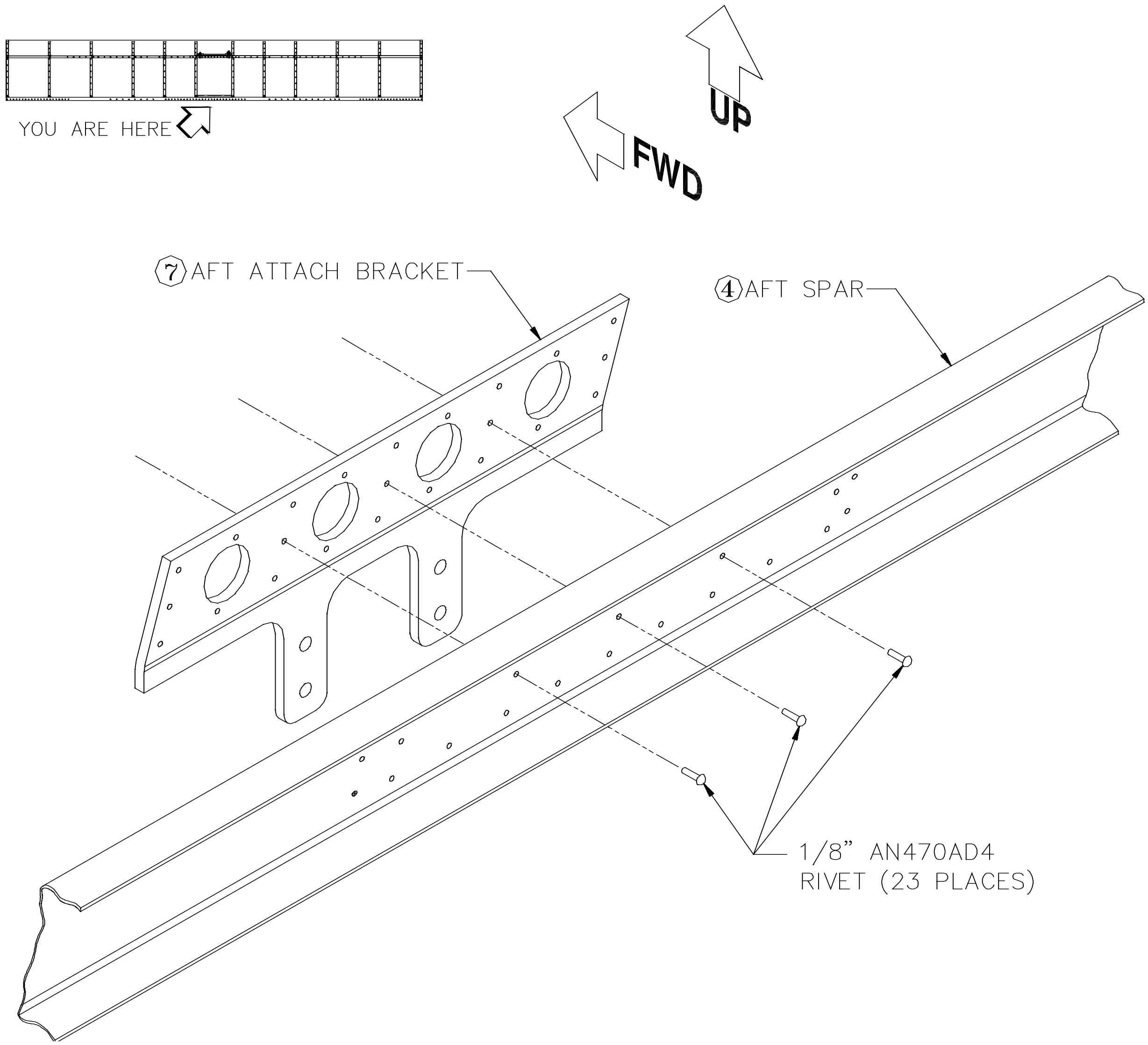

Figure 14: Riveting the Aft Attach bracket

Step 21: Install the Alignment Pins

Insert the alignment pins through both doublers and the spar web, wit the pointed ends forward, as shown in Figure 15. Secure with AN960D616 aluminum washers and AN365-624A **nylon self-locking nuts** [17].

Check the positioning of the alignment pins by sliding them into the corresponding holes in the **forward attach bracket assembly** [15]. The pins should slide in easily and precisely. When you are satisfied with the positioning of the pins, hold them with a wrench on the flats and tighten the nuts with a socket wrench.

Note Tighten the nuts firmly; once the stabilizer skins are riveted in place, there is no access to these nuts.

Completed: [ ]

Step 22: Rivet the Spar Web Doublers to the Forward Spar

With the alignment pins secured in place, use 1/8" AN470AD4 universal-head rivets to rivet both doublers to the forward spar. The rivet heads should be on the **forward** side of the spar/doubler assembly, as shown in Figure 15.

Note Be aware that the thickness of the stack-up you are riveting changes depending on whether you are riveting doubler and spar or doubler, spar and doubler. This situation will recur frequently throughout the riveting process; always alter your choice of rivet length accordingly.

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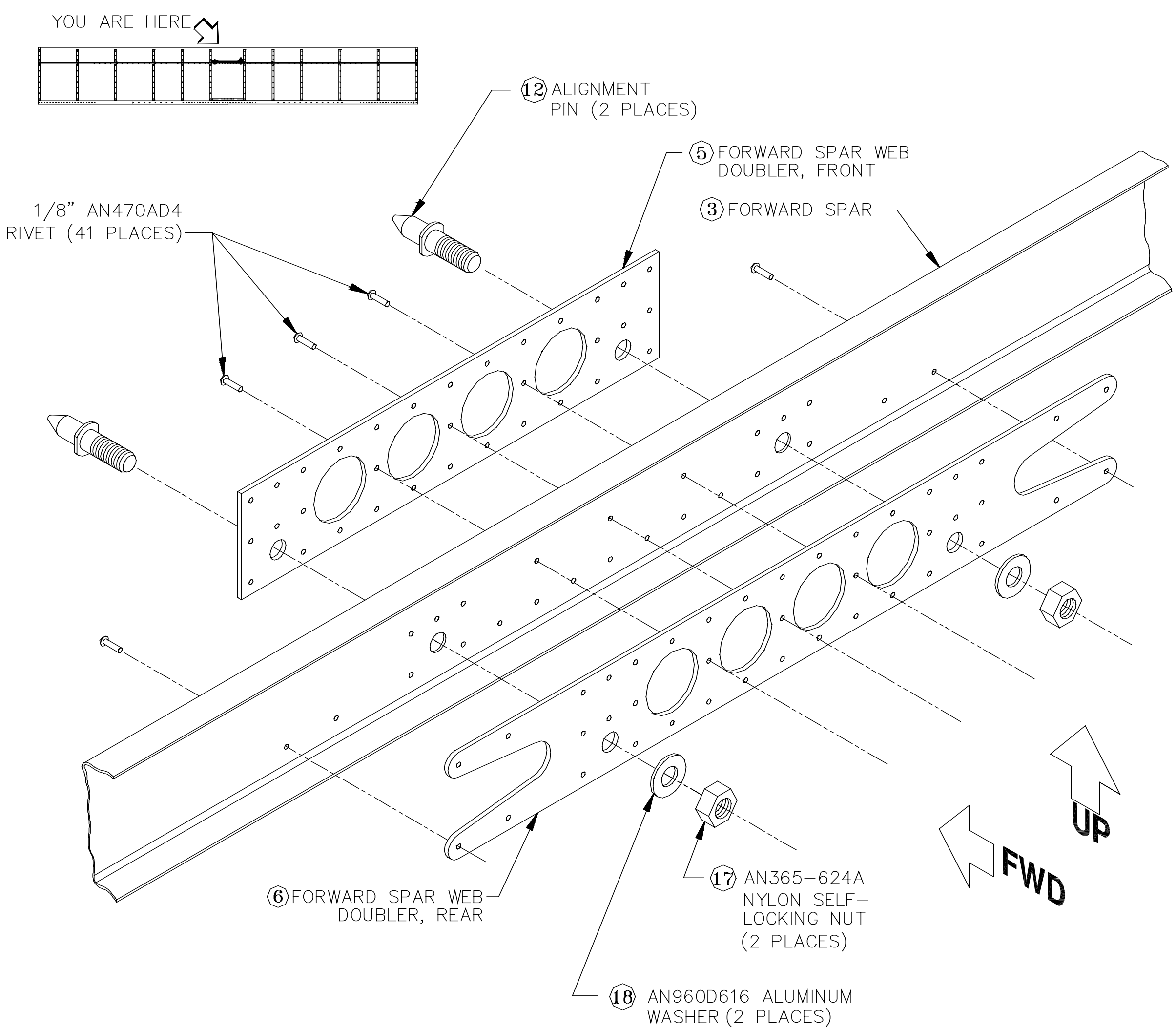

Figure 15: Riveting the Forward Spar Web Doublers

Step 23: Rivet the Replacement Flanges to Ribs A and B

Using 3/32" AN470AD3 universal-head rivets, rivet the replacement flanges to Ribs A and B. Be certain you match up each rib with the proper flange. The manufactured heads can be on either the rib or the flange-whichever is easiest for you.

Completed: [ ]

Step 24: Rivet the Ribs to the Forward Spar

Using 3/32" AN470AD3 universal-head rivets, rivet the nose and main ribs to the forward spar. Again, pay attention to the orientation of the rib flanges, as shown in Figure 2, and keep the ribs in the order they were in when you drilled them. The rivet heads can be either on the forward or aft side of the spar, but you will probably find it easier to place the bucking bar on the forward side, as shown in Figure 16.

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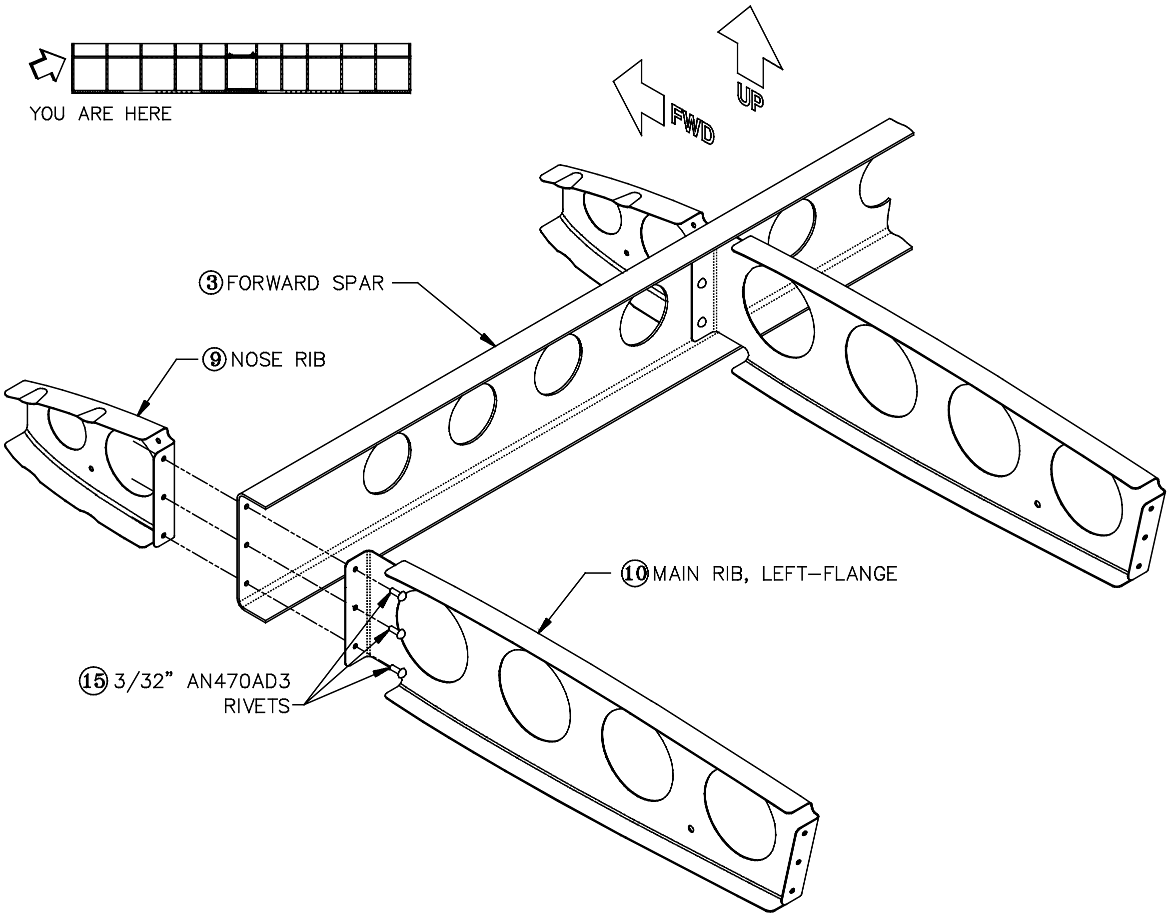

Figure 16: Riveting the Ribs to the Forward Spar

Step 25: Check the Forward and Aft Attach Brackets for Clearance with the Skin Cutouts

Cleco the aft spar to the main ribs. Cleco the right skin in place on the spar/rib assembly. Then, sliding the cutouts in the left skin over the two protruding tongues of the aft attach bracket, position the left skin over the right skin and the spar/rib assembly. Clamp the left skin in place with a few Clecos.

First check the clearance of the aft cutouts in the left skin around the tongues of the aft attach bracket. The cutouts should fit closely around the tongues, but should **not** quite touch. Check especially to make sure that no corner of the tongues binds in one of the corner radii of the cutouts. Mark any interference on the skin.

Next, slide the forward attach bracket assembly through the large forward skin cutout and over the alignment pins. Holding the bracket tightly against the forward spar doubler, check for interference with both the left and the right skin. Again, the cutout in the left skin and the edge of the right skin should fit closely with but not touch the bracket. Mark any interference.

Remove all the Clecos. If there was no interference, move on to the next step; if there was interference on either skin, use the marks on the skin as a guide and file or snip the skin as necessary until a clean, interference-free fit is achieved. Smooth and deburr all cut edges. It's especially important that the cutouts have smooth, clean radii rather than 90° corners.

> **Note** Structurally, the forward attach bracket assembly is actually part of the fuselage; it is never permanently attached to the horizontal stabilizer structure. At this point, it will not be needed again until the fuselage is assembled. You might put it aside with the remaining fuselage parts at this time.

Completed: [ ]

Step 26: Rivet the Lower Surface of the Right Skin to the Spar/Rib Assembly

> **Note** When riveting the skins to the forward spar, as described in this and the next three steps, use **AAPQ-42 blind rivets** in the holes that were drilled up to #30 diameter because they were too close to the webs of the main ribs.

Slide the lower forward spar cap into position inside the lower spar flange and Cleco the right skin to the forward spar and cap at each end and a few points in the middle. Using 3/32" AN470AD3 universal-head rivets, rivet the skin to the spar/cap/main rib structure. As described in "SECTION II: TOOLS AND TECHNIQUES" under "ALUMINUM SHEET METAL WORK, *Installing a Line of Rivets,*" begin by installing a rivet in one corner of the area defined by the spar/rib framework; then install a rivet in the opposite corner; then somewhere in the middle. Establish a pattern in which you are always riveting approximately in the middle of the remaining unriveted area.

> **Note Do not** rivet the **centermost** row of holes along Rib B, as these are shared with the overlapping left skin.

Completed: [ ]

Step 27: Rivet the Upper Surface of the Right Skin to the Spar/Rib Assembly

Repeat the process you used to rivet the lower skin surface and lower forward spar cap to the spar/rib assembly: Cleco the upper surface of the skin and the upper cap to the forward spar; Cleco the skin to the main ribs; and finally, rivet the skin to the spar/rib framework in the standard sequence—first the corners of the area, then the middle, and finish by riveting in the approximate middle of the remaining unriveted area. This will require reaching inside from the trailing edge and maneuvering the bucking bars in fairly tight quarters, but it can be done! Once again, avoid riveting the centermost row of holes (Rib B) where the skins will overlap.

Completed: [ ]

Step 28: Rivet the Right Skin to the Nose Ribs

Using 3/32" AAP-32 blind rivets, rivet the right skin to all the right-side nose ribs, beginning at the spar and working forward, top and bottom.

Completed: [ ]

Step 29: Rivet the Left Skin to the Spar/Rib Assembly

Duplicating the procedures above and in a similar order, position and rivet the left skin to the spar/rib assembly. As in Steps 26 and 27, follow the standard sequence for riveting an area: install rivets in the corners of the area first, then the middle, and finish by always riveting in the approximate middle of the remaining unriveted area.

Note Now is the time to finally rivet the row of holes through the overlapped skins along Rib B. Use 3/32" AN470AD3 universal-head rivets.

Completed: [ ]

Step 30: Rivet the Aft Spar to the Main Ribs

Verify your stabilizer attach pins are in place and secured. Bring the aft spar up close to the trailing edge of the stabilizer assembly and, taking care not to crimp the trailing edges of the skins, slip the spar between the skins until it is tight against the aft flanges of the main ribs. Cleco it in place at several locations.

Use 1/8" AAPQ-42 blind rivets to rivet the spar to the main ribs, as shown in Figure 17, except for the two outboard ribs which are accessible for riveting with 1/8" AN470AD4 universal-head rivets.

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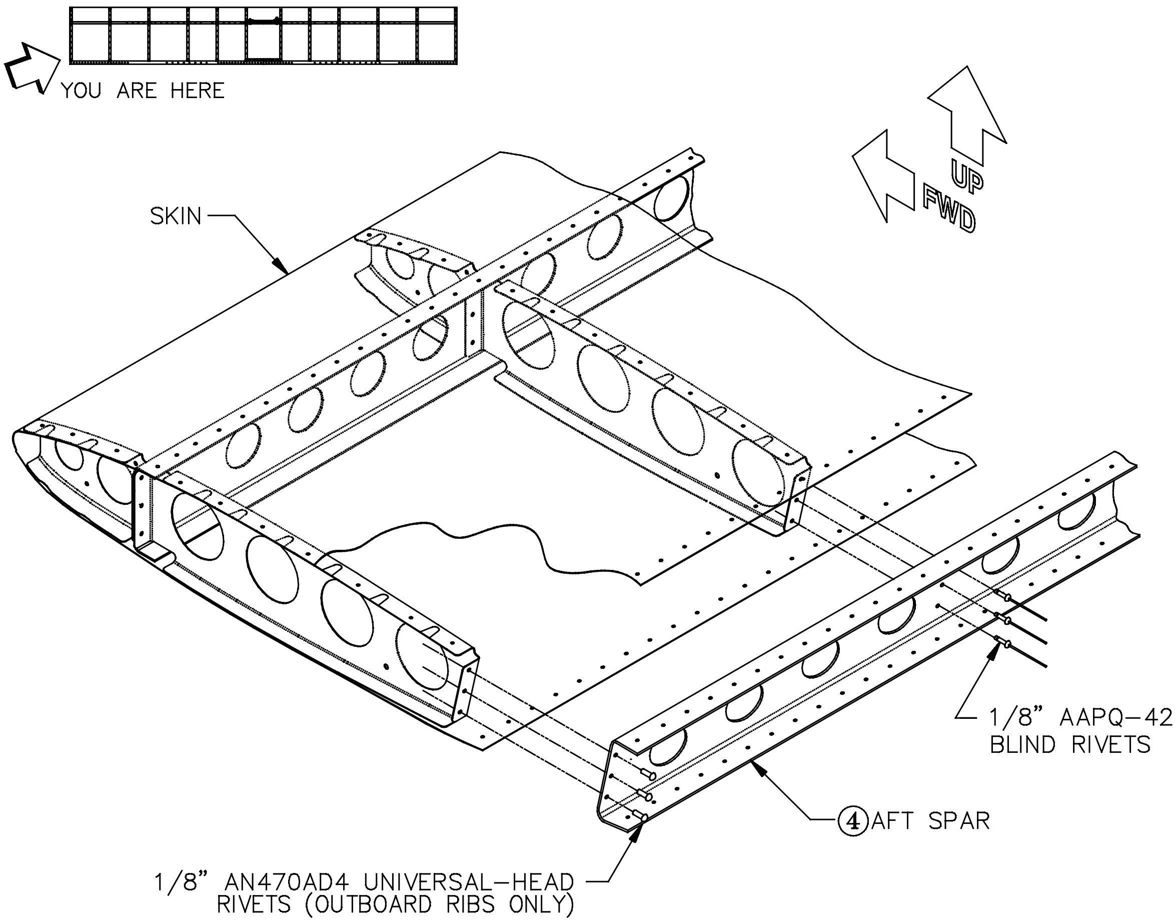


Figure 17: Riveting the Aft Spar to the Ribs

Step 31: Rivet the Lower Skin Trailing Edge to the Aft Spar

Use 1/8" AN470AD4 universal-head rivets to rivet the lower trailing edge of the left and right skins to the lower flange of the aft spar, again observing proper sequencing. If you have access to a rivet squeezer, this is an ideal place to use it.

> **Note** The trailing edge of the upper skin surface should remain unriveted to the upper flange of the aft spar for the time being. This will be remedied in "SECTION V: ELEVATOR ASSEMBLY" when you mount the elevator hinges.

Completed: [ ]

Step 32: Tape the Lightening Holes in the Outermost Ribs and the Aft Spar

Apply strips of **2"-wide aluminum tape** [14] to the webs of the outermost main ribs and the aft spar to seal the lightening holes.

Completed: [ ]

Step 33: Trim the Trailing Edges of the Upper Skins

You will notice that the upper surface of each skin extends aft beyond the trailing edge of the upper flange of the aft spar. You may also notice—unless you did an unusually painstaking job!—that when you sight down the trailing edge of the skins, they waver or bow slightly. Both the overhang and the waviness (that all but the very best stabilizers are likely to have) will make it more difficult to position the elevator hinge properly in the next section. Therefore, at this time you should shave the skin trailing edges so that they are straight and flush with the spar flange trailing edge.

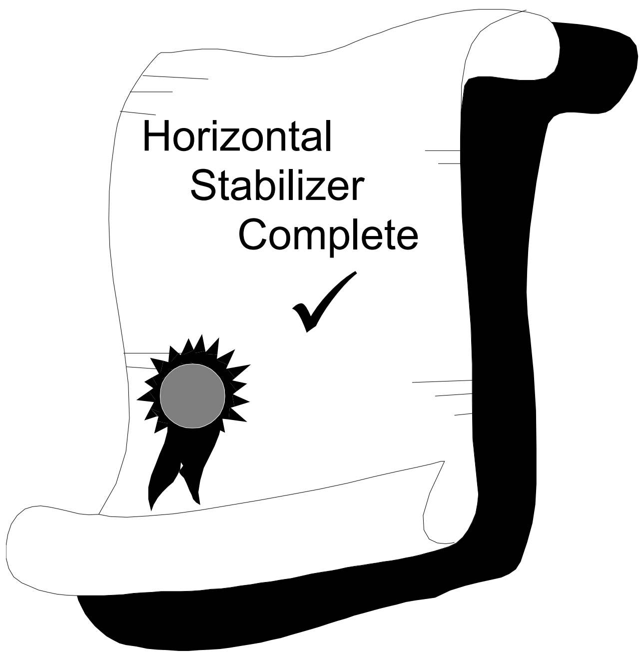
Use offset aviation snips to trim off the bulk of the overhanging skin, leaving about **1/32"** aft of the spar flange trailing edge. Remove this remaining material with a curved-tooth body file. Use long, smooth strokes to file the skins flush with the spar flange. When this has been achieved, sight along the trailing edge to check for any bow or waviness in the spar flange itself. If necessary, it's acceptable to file slightly into the spar flange itself to remove such curves and produce a clean, straight trailing edge. However, you should **not** remove more than about **1/32"** from any part of the spar flange.

When you're satisfied with the straightness of the trailing edge, use a fine-toothed file or an edge deburring tool to remove any burrs or file marks. Also, if you applied anti-corrosion primer to the spar, use a small brush to touch up the trailing edge wherever you might have filed into the primer.

Completed: [ ]

Congratulations!

You've completed the horizontal stabilizer assembly! Next up—the elevator assembly, where you will not only assemble the elevator and trim tab but also mount them on the horizontal stabilizer. Onward and aft!



SECTION V: ELEVATOR ASSEMBLY

PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Skin, upper left	1	303-00001-03
2	Skin, upper right	1	303-00002-03
3	Skin, lower left	1	303-00003-01
4	Skin, lower right	1	303-00004-01
5	Spar, forward	1	303-00005-01
6	Spar, aft partial	1	303-00006-01
7	Doubler, forward spar/hinge, center	1	303-00007-01
8	Doubler, forward spar/hinge, outboard	2	303-00007-03
9	Rib, inboard	4	303-00008-01
10	Rib, outboard	8	303-00009-01
11	Rib, tip	2	303-00010-01
12	Horn, control	2	303-00011-01
13	Angle, control horn attach	2	303-00012-01
14	Stiffener, rib/control horn	1	303-00013-01
15	(Part omitted)		
16	Flange Doubler, Counterweight Rib	2	303-00022-01
17	Angle, trim cable bracket	1	303-00020-01
18	Sheet, trim cable bracket	1	303-00021-01
19	Skin, upper, trim tab	1	303-01011-01
20	Part Deleted		
21	Aluminum tee, .050" X 1-1/4" X 1-1/2"	3.6"	100-0640-007
22	Rib, trim tab	6	303-01004-01
23	Arm, trim tab counterweight	1	303-01005-03
24	Tape, aluminum, 2" width [from Sec. IV]	265"	062-00001-01
25	Extruded hinge with pin	72"	MS20001P4
26	Rolled hinge with pin	44"	MS20257P2
27	Skin, lower, trim tab	1	303-01012-01

TOOL LIST

1. Try square
2. Duck bill pliers (with jaws taped to protect Alclad aluminum parts)
3. Assorted flat and round files
4. Edge deburring tool (optional)
5. Tape measure
6. Fine-point marking pen
7. Assorted Cleco side-grip clamps (with pliers) and small C-clamps, approximately 15 each
8. Electric or pneumatic drill motor, with #40, #30, #19, #10, 1/16" and 1/4" bits
9. Center punch
10. Clecos, 3/32" and 1/8" (approximately 150 each), with pliers
11. Protractor
12. Aviation snips, straight and offset
13. Rule, 12", graduated in 1/32nds of an inch
14. Hole deburring tool
15. Bench grinder (optional)
16. Extension bit, 12" length, #40 (recommended)
17. Blair hole cutter or Unibit, 9/16" (recommended)
18. Large spring clamps with padded jaws (recommended) or large C-clamps (acceptable)
19. Straightedge, 6'
20. Framing square
21. Scriber or awl
22. Locking C-clamp, 3" jaw (Vise-Grip-type)
23. Phillips screwdriver
24. Small hammer or mallet
25. Dimple dies, 3/32", and rivet squeezer (recommended) or riveting frame (acceptable)
26. Rivet gun, air compressor and bucking bars
27. Universal head rivet sets, 3/32" and 1/8"
28. Flush head rivet set
29. Offset universal head rivet set, 3/32"
30. Blind rivet puller

31. Two adjustable wrenches and/or 3/16" wrenches
32. Hand seamer (optional)
33. Heavy-duty wire cutter
34. Bench vise
35. Chip chaser
36. Countersink bits, for #8 and #10 screws
37. Fluting pliers (optional)

ADDITIONAL MATERIALS

1. Four sandbags or scrap lengths (approximately 12-14" long) of 2 X 4
2. One 1/4" dowel or 1/4" bolt, any length
3. Corrosion protection materials
4. One 2 X 4, approximately 48" long
5. One 3/16" hex-head bolt and nut (hardware-store quality)
6. Two 2 X 6s, approximately 24" long
7. Scraps of wood or metal, 3/16" thick (optional)
8. Wide masking tape or duct tape

WORKSPACE

As with the horizontal stabilizer, the elevator is built in one assembly without complicated jigging. The elevator, with its tip ribs, is slightly larger than the horizontal stabilizer: 129" X 30" . In the final stages of this section when the elevator is mounted on the horizontal stabilizer, the size of the entire assembly will be approximately 129" X 35". For assembly steps in which aluminum skins are lying flat on the bench, it's a good idea to pad your bench surface with cardboard to avoid unnecessary scratching of the finish. Also, you might consider leaving the plastic protective film on the outside of the skin through the positioning and drilling stages; remove it for hole deburring and riveting.

Assembly Sequence

Having already completed the rudder and the horizontal stabilizer, you'd be right to guess that the primary objective of the elevator assembly procedures is to produce a straight, untwisted finished elevator. By now you will also have experienced some of the difficulties in achieving this goal and devised some strategies for overcoming the difficulties. As with the other tail feathers, it is important to monitor the proper alignment of all parts at every step of the assembly, to maintain the proper edge margins for rivet holes in all parts and to follow proper sequences for drilling lines of rivet holes and driving lines of rivets. It is particularly important to make sure the elevator spar is held straight for all drilling and riveting operations.

The assembly of the elevator and trim tab is broken down into ten major operations:

1) **Preliminary Assembly**: fabricating, positioning and drilling components such as the spar/hinge doublers, the rib/control horn stiffeners, the control horn assemblies and the trim cable bracket assembly.
2) **Main Structure**: positioning and drilling the spar/rib assembly and the elevator skins.
3) **Main Structure Riveting**: final assembly of all the elevator components.
4) **Trim Tab**: positioning and drilling the trim tab ribs and skins.
5) **Trim Tab Riveting**: final assembly of the trim tab.
6) **Elevator Hinges**: positioning and drilling the elevator hinges.
7) **Trim Tab Hinges**: positioning and drilling the trim tab hinges.
8) **Hinge Riveting**: final mounting of the elevator and trim tab hinges.
9) **Final Assembly**: mounting the trim tab and the elevator on the stabilizer.

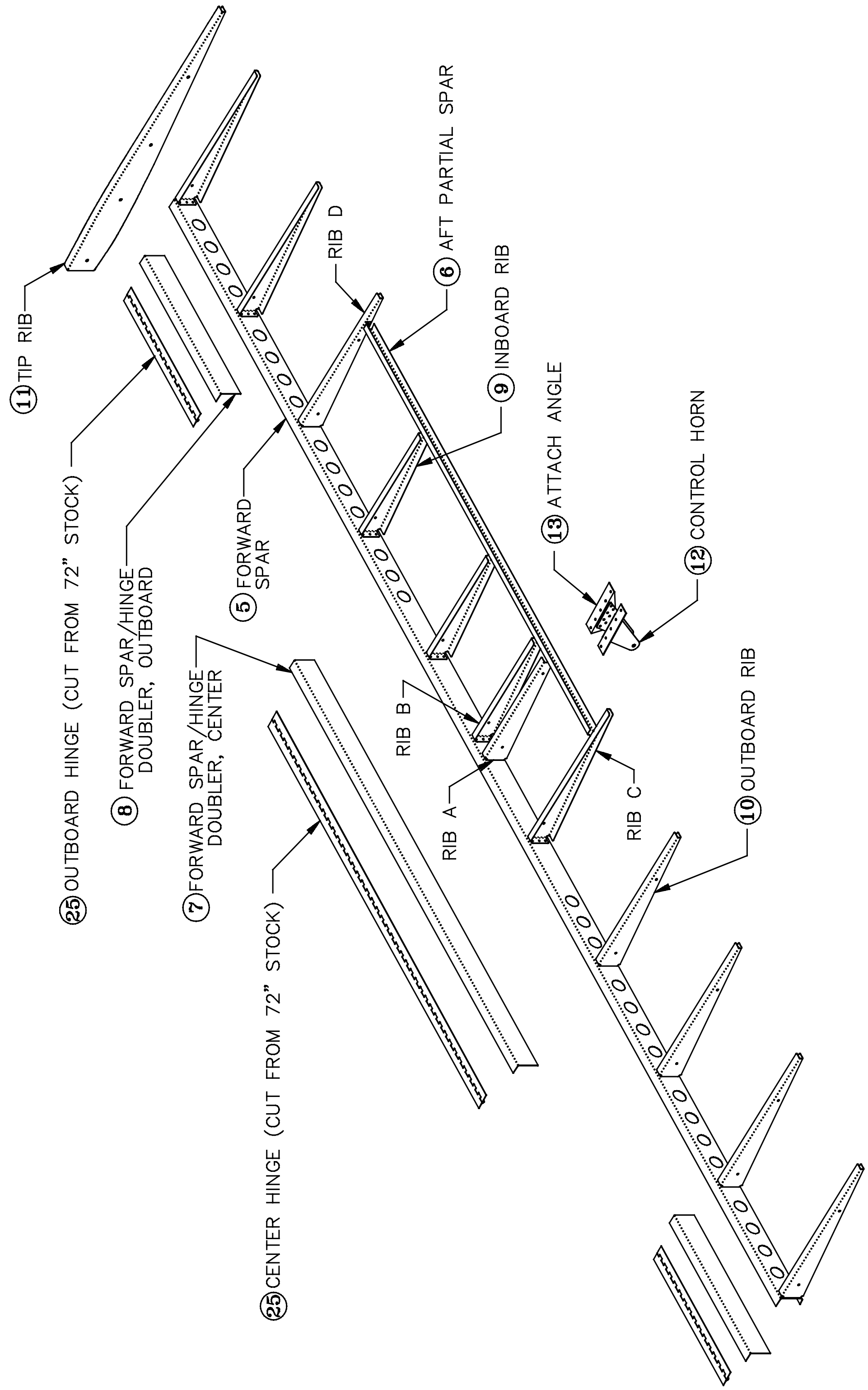


Figure 1: Elevator Assembly

PRELIMINARY ASSEMBLY

Step 1: Straighten and Deburr the Parts

Using a square, check the flanges on all the **inboard** [9], **outboard** [10] and **tip** [11] **ribs** for squareness, straightening as necessary with a pair of duck bill pliers. Also, especially for the tip ribs, use a straightedge placed against the rib web parallel to the length of the rib to check for bows. If necessary, use fluting pliers to straighten the ribs by adjusting the existing flutes in the rib flanges. Work gently, a little bit at a time, moving from flute to flute in the rib and checking the straightness frequently. It's better to make several light passes around the rib with the fluting pliers than to try to accomplish too much all at once.

> **Note** The **inboard** ribs are the short ribs that terminate in the **aft partial spar** [6]. The **outboard** ribs are the long ones outboard of the aft partial spar. See Figure 1.

Completed: [ ]

Step 2: Mark Hole Positions on the Forward Spar/Hinge Doublers

As shown in Figure 2, the **forward spar/hinge doublers** (**center** [7] and **outboard** [8]) are riveted inside the **upper** flange of the **forward spar** [5]. In this step, you will drill the sets of three holes at each rib station and use these to help mark the locations of the additional rivets that will fasten the doublers to the spar web.

> **Note** The **upper** flange of the forward spar is the **longer** one, as shown in Figure 14.

Use side-grips as shown in the figure to clamp the doublers in place. Align the outboard doublers on the outboard ends of the spar; center the center doubler with each end **36-15/16"** from the spar end. See Figure 3. When the doublers are clamped, drill through each set of three pilot holes in the spar web with a **#40** bit.

Next, remove the doublers and mark and lightly center punch locations for the remaining rivets according to the dimensions shown in Figure 2. Mark the locations on the **forward** side of the doubler web.

> **Note** Make the two outboard doublers mirror images of each other to clear the lightening holes in the spar.

Completed: [ ]

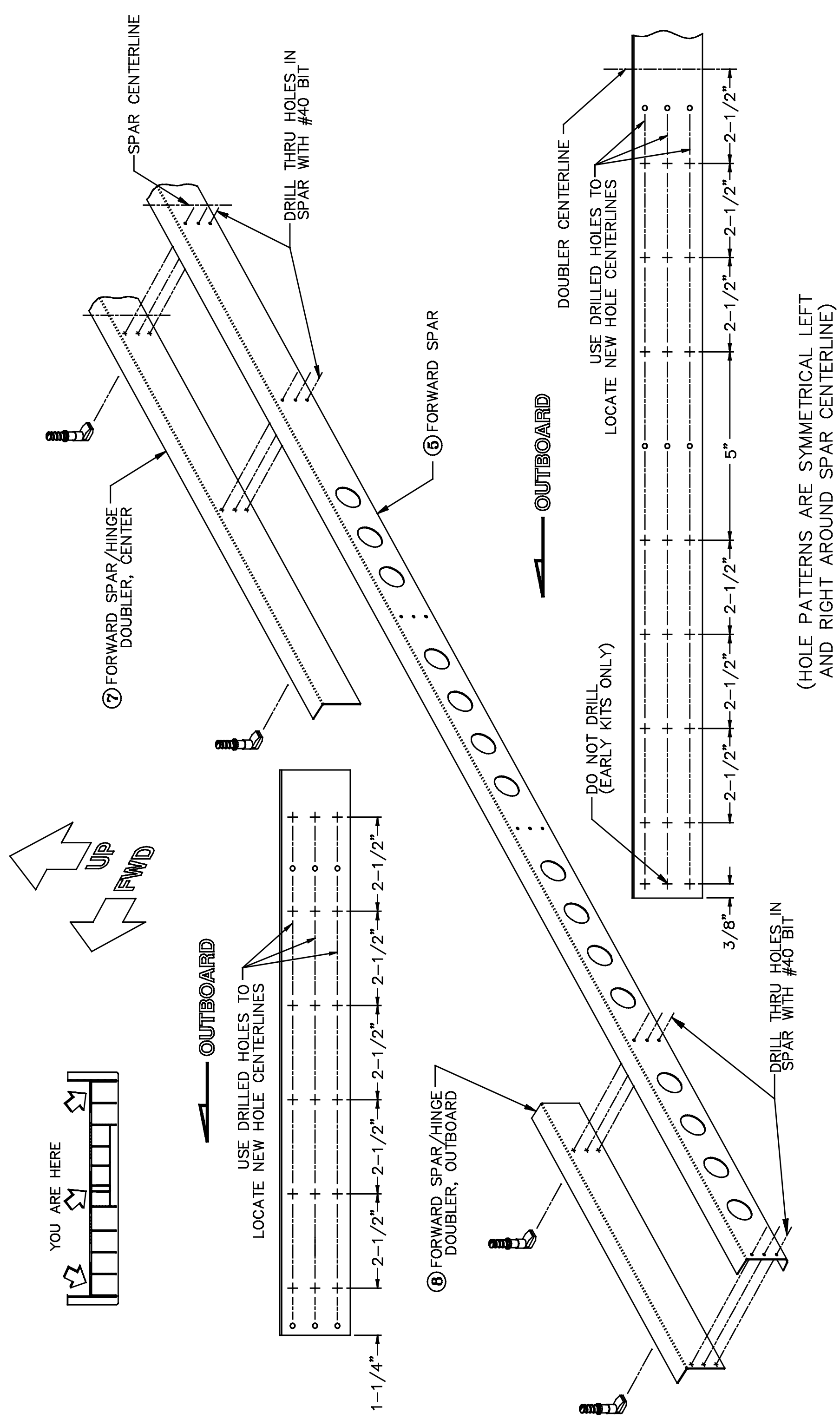


Figure 2: Forward Spar/Hinge Doubler Hole Locations

Step 3: Position and Drill the Doublers

When you have marked and center punched all three doublers, re-position them on the forward spar and clamp them in place with several Clecos through the holes at the rib stations, as shown in Figure 3.

Double check that you have marked the left and right doublers properly by making sure that the marked rivet holes clear the lightening holes on the respective spar ends.

With the doublers clamped in place, drill through the doubler and the spar web at each marked hole location with a **#40** bit, Clecoing as you go.

Completed: [ ]

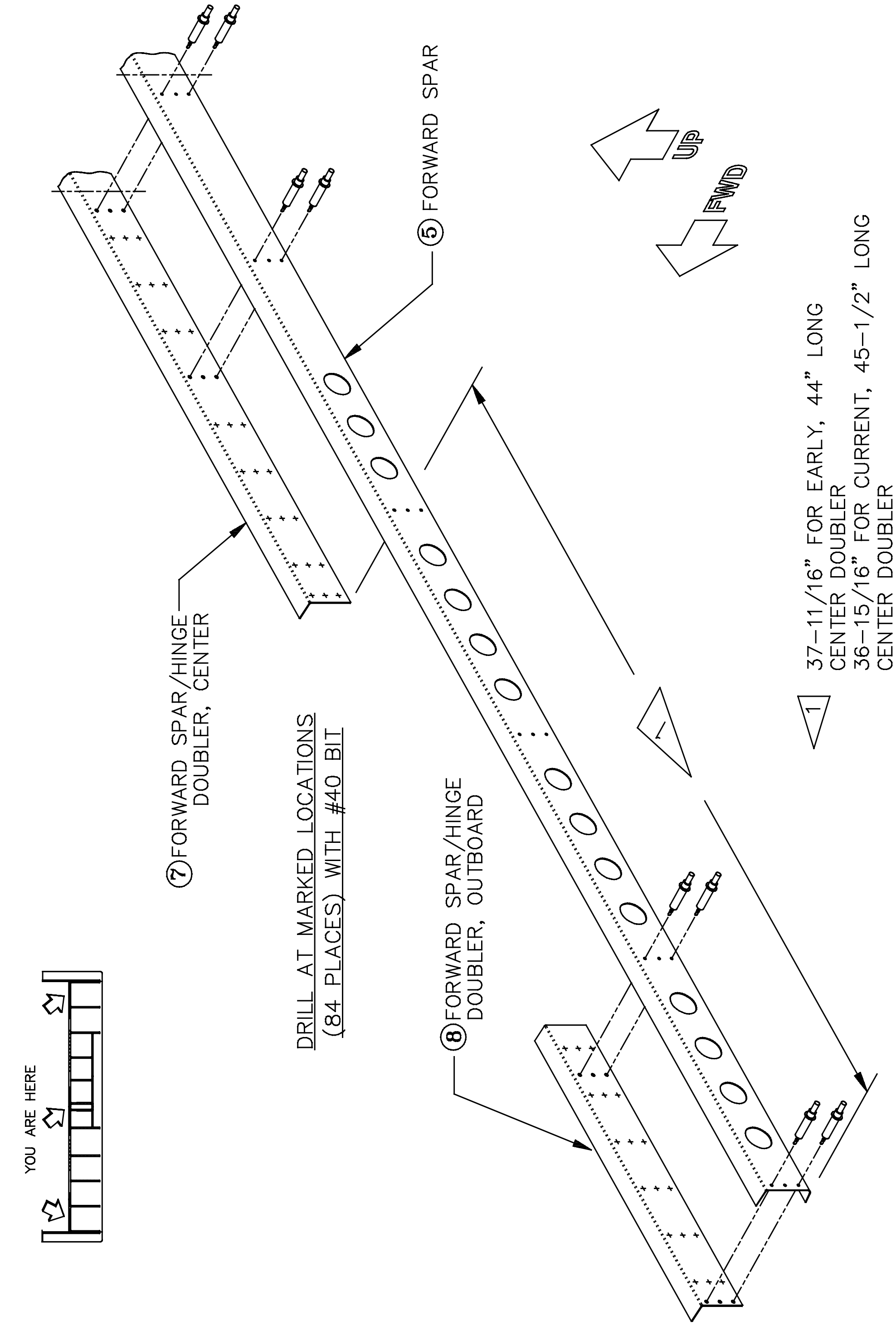


Figure 3: Positioning and Drilling the Spar/Hinge Doublers

Electric Trim Option (P/N 921-01000-01) The following step and many subsequent steps are not necessary if you are installing the Sportsman electric trim option but are required for the manual trim system. The electric trim system is designed so that it **can** be retrofitted to your Sportsman even if you complete and fly it with the mechanical system first. The converse is **not** true, however: if you build your Sportsman solely for the electric trim option now, you will be unable to revert to manual trim at a later date without fundamentally rebuilding your elevator. For this reason, we recommend completing all the required steps for the mechanical system unless you are **certain** that you will be installing the electric trim option.

There are three main advantages to the electric trim system.

- First, it makes removal of the horizontal stabilizer for trailering or storage much easier. Simply unplug an electrical connector and you're done. With the manual trim, by contrast, you have to unbolt the trim tab pushrod from the control horn and snake the trim cable through the interior of the elevator.
- Second, because the electric trim system can be controlled with a hat switch on the control grip rather than with a manual wheel, it offers less distraction to the pilot during maneuvering.
- Third, the electric trim system is easier to install, requiring less construction time.

Contact Glasair Aviation, LLC's Options Sales Desk for current pricing information.

If you are **certain** that you'll be installing electric trim, **skip to Step 5**.

Step 4: Cut an Angle Template *(Manual Trim Only)*

At several points in the subsequent steps, you will need to lay out a 105° angle on various parts, and this is most easily accomplished if you make a simple angle template, as illustrated in Figure 4.

Completed: [ ]

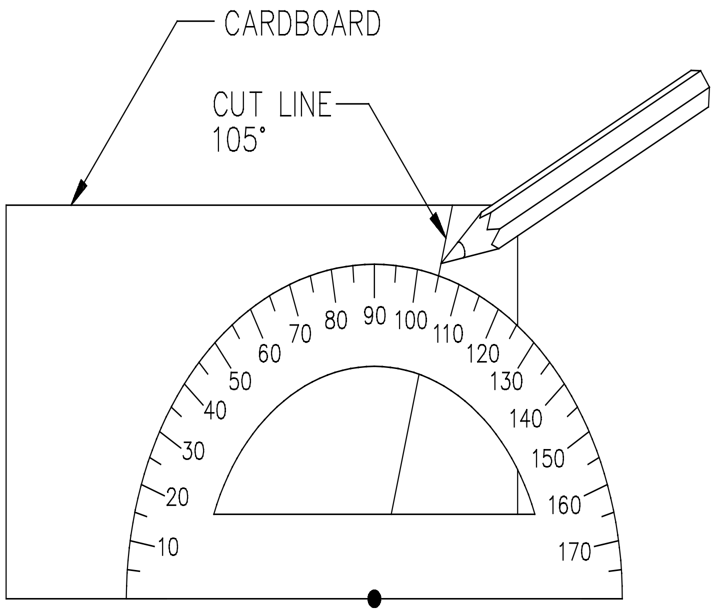


Figure 4: Cutting an Angle Template

Step 5: Cut the Rib/Control Horn Stiffeners

The **rib/control horn stiffeners** [14] strengthen the points where the control horns are fastened to the elevator. They must be cut from the angle stock provided to fit inside the flanges Ribs A and B (see Figure 1). Use a pair of aviation snips to cut out each stiffener according to the dimensions shown in Figure 5.

Note The ribs are symmetrical top-and-bottom, but the stiffeners **are not**. Before you cut, make sure that the stiffeners will nest inside the **lower** flange of each rib while the rib flanges are oriented **inboard**. Refer to Figure 5.

Completed: [ ]

Step 6: Mark Hole Locations on the Stiffeners *(Manual Trim Only)*

Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions***. Return to **Step 10** of this *Assembly Manual* when the specified option steps have been completed.

☞

Figure 5 shows the pattern of the rivets used to fasten the stiffeners to the ribs. Mark and lightly center-punch these hole locations on the **inside** face of each stiffener. The precise placement of the holes is not critical, but maintain minimum distances of 1/4" from the centers of all holes to the edges of the stiffeners and 3/8" between the centers of all holes.

Completed: [ ]

Step 7: Lay Out the Trim Cable Bracket Reference Lines *(Manual Trim Only)*

As shown in Figure 5, mark a reference line on the **inside** face of each stiffener. Use your cardboard angle template to lay out lines 105° off the flange line, intersecting the flange **6-3/16"** from the aft end of the stiffener.

Completed: [ ]

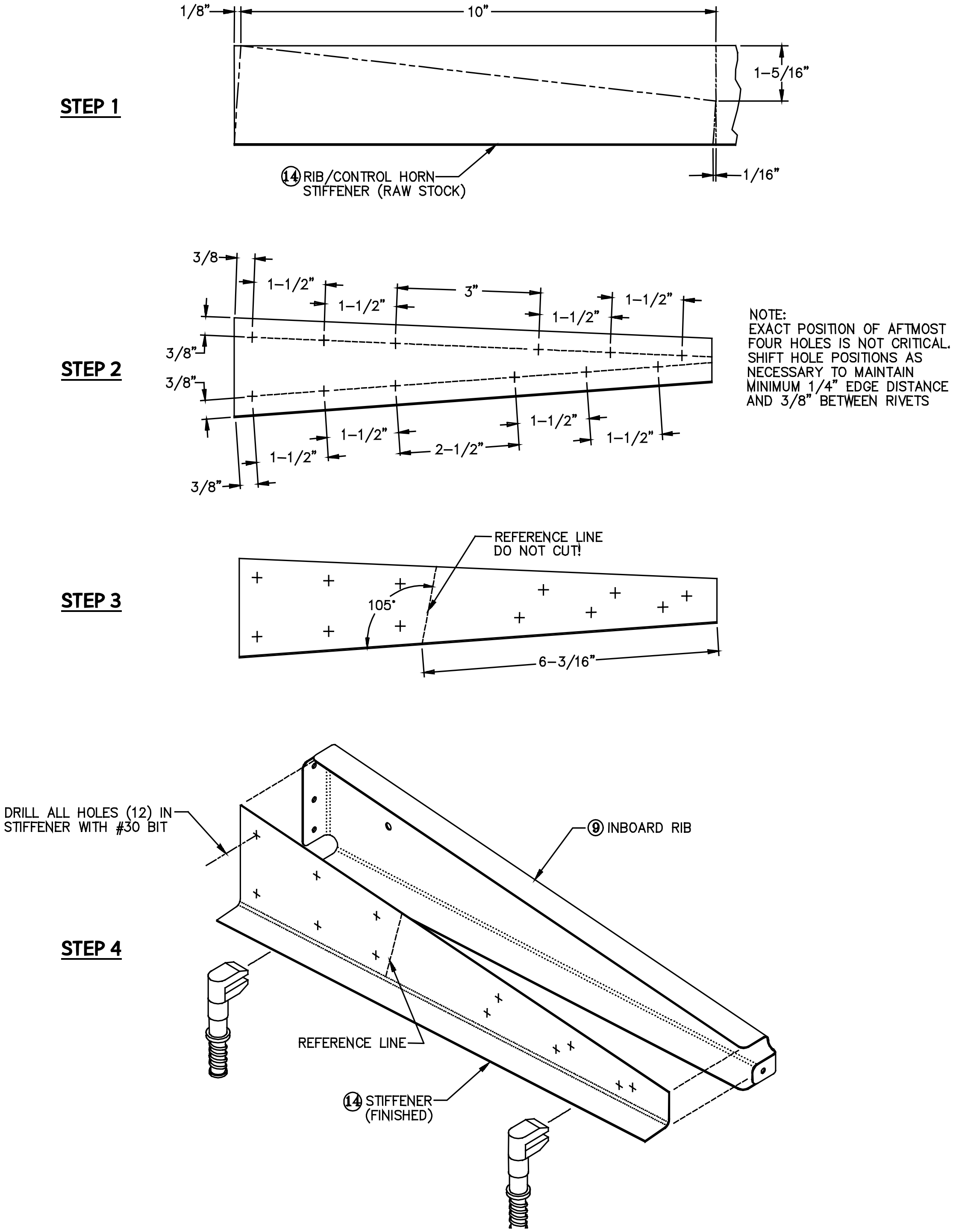


Figure 5: Cutting and Drilling the Rib/Control Horn Stiffeners

Step 8: Mark the Trim Cable Bracket Hole Locations on Ribs A and B (Manual Trim Only)

Before positioning the stiffeners inside Ribs A and B and drilling the holes you marked on them, you need to mark some hole locations on the ribs as well. These holes will be used to rivet the trim cable bracket to the ribs.

As shown in Figure 6, these holes are marked on the outboard side of the rib webs. Use your cardboard angle template to lay out the two reference lines, and then mark and lightly center punch the four hole locations according to the dimensions shown.

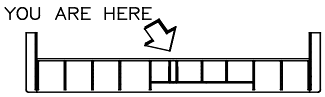
Completed: [ ]

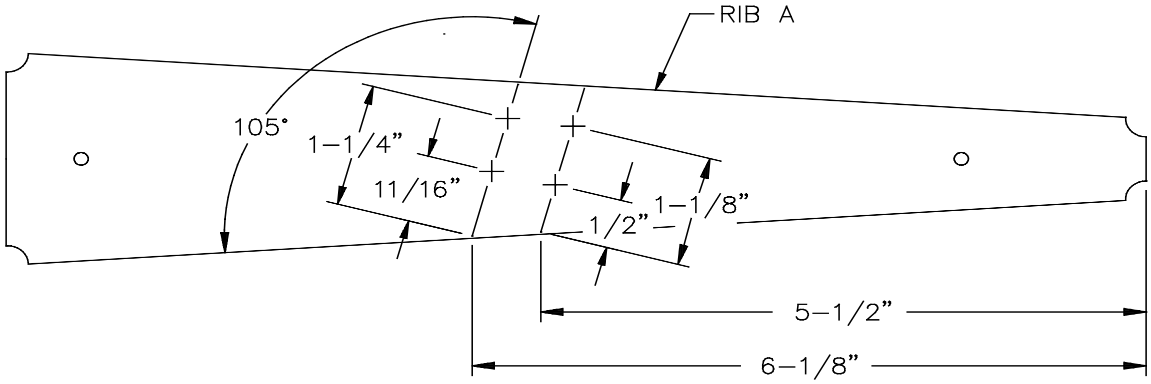
Step 9: Position and Drill the Stiffeners (Manual Trim Only)

Position the stiffeners inside their respective ribs. They should nest snugly inside the lower flange of each rib, as shown in Figure 5. Align them fore-and aft on the ends of the lower flange of the rib and clamp them in place with Cleco side-grips or C-clamps along the flange

With the stiffeners clamped in place, drill through each stiffener and rib web at each of the twelve marked locations with a **#30** bit. When the drilling is completed, remove the side-grips or C-clamps and reattach the stiffeners to their respective ribs with two or three Clecos inserted from the rib (outboard) side.

Completed: [ ]





(MARK MIRROR-IMAGE PATTERN ON OUTBOARD WEB OF RIB B)

Figure 6: Trim Cable Bracket Rivet Hole Locations on Ribs A and B

Step 10: Mark Holes on the Control Horn Attach Angles

Each elevator **control horn** [12] is riveted to its respective **attach angle** [13] in seven places, and then the attach angle in turn is riveted to the underside of the elevator in five places. In this step, you will mark these hole locations.

The dimensions of the hole pattern are shown in Figure 7. Mark and lightly center punch the five attach angle/elevator hole locations as precisely as possible **inside** one flange of **each** attach angle. Then mark and punch the seven attach angle/control horn holes on the other flange of **one** angle only. Do not drill any of the holes at this time.

> **Note** Be careful to maintain a minimum distance of **1/4"** (twice the rivet diameter) from the centers of all holes to the edges of all parts. Shift the locations of holes, if necessary, to satisfy this condition.

Completed: [ ]

Step 11: Drill Index Holes in the Attach Angles

In this step, three index holes are drilled in each attach angle—two to locate it on the underside of the elevator and one to locate the control horn on the angle. These holes are labeled A, B and C, respectively, in Figure 7. Clamp the two angles together back to back with side-grips and drill Holes A and B through both with a **#40** bit. Re-clamp them with their other flanges together and drill Hole C through both with a **#30** bit. Remove the clamps

Completed: [ ]

Step 12: Mark and Drill Index Holes in the Control Horns

One hole is drilled in each control horn to locate it on its attach angle. Mark and center punch this hole on one horn according to the dimensions shown in Figure 7. Clamp the two horns together back to back with side-grips and drill through both at the marked location with a **#30** bit. Remove the side-grips.

Completed: [ ]

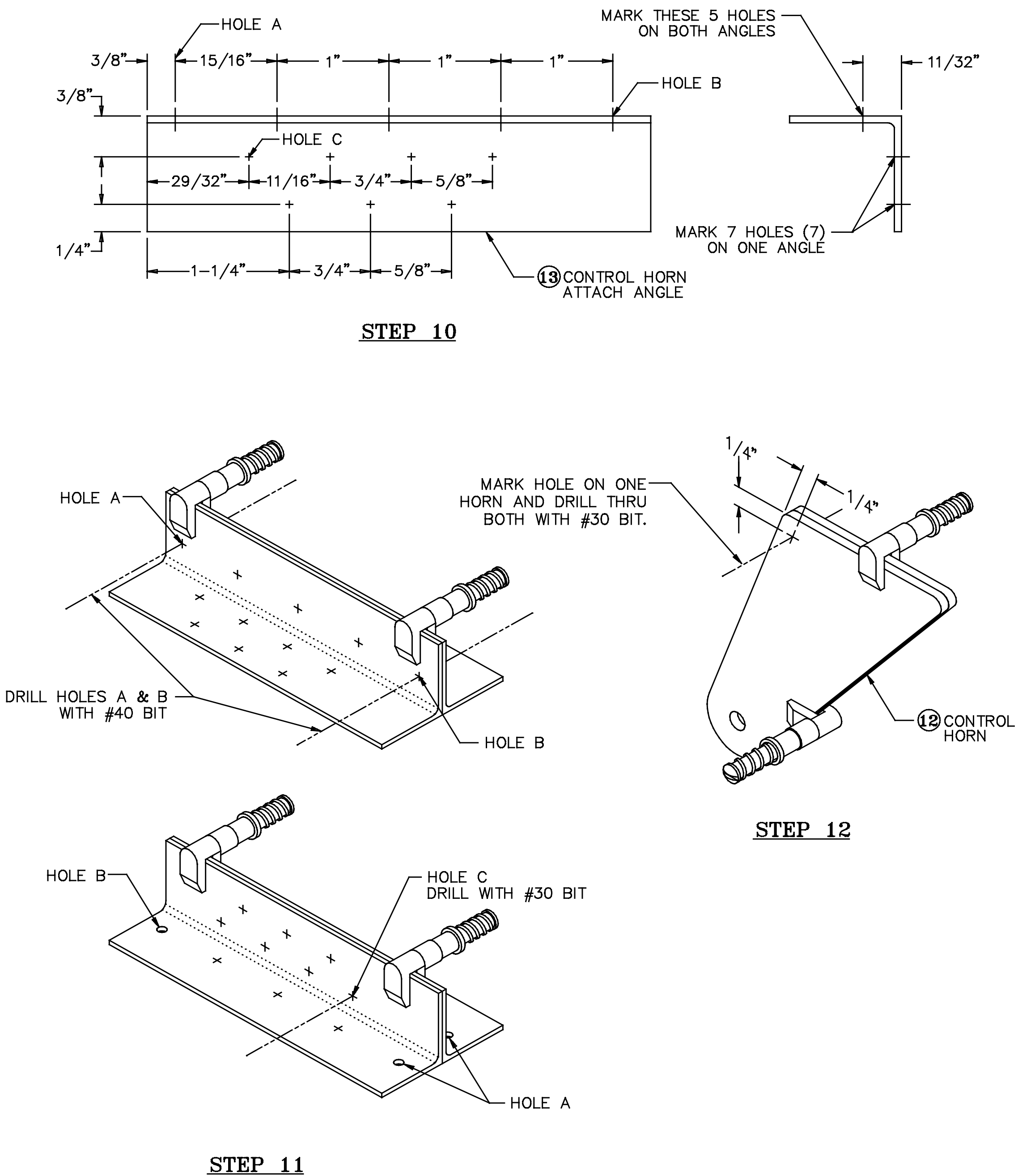


Figure 7: Marking and Index Drilling the Control Horns and Attach Angles

Step 13: Finish Drilling the Attach Angles and the Control Horns

Stack up both control horns and their respective attach angles and insert a Cleco through the common hole in all four pieces—the only hole in each horn and Hole C in the angles. Refer to Figure 8 to ensure that you have each part properly oriented.

Align the horns so they are flush with each other and clamp them together with a side-grip near the tips. Rotate the horns and the angles around the Cleco as necessary until the upper edges of the horns and the upper flanges of the angles are all parallel and then clamp the entire assembly together with a C-clamp opposite the Cleco.

With the horns and angle securely clamped together, drill the six undrilled holes through the angle and the horn with a **#30** bit. After drilling one hole, remove the side-grips and insert a Cleco for the remainder of the drilling. When the drilling is completed, mark each horn and angle to distinguish left from right. Leave the horns and angles Clecoed together.

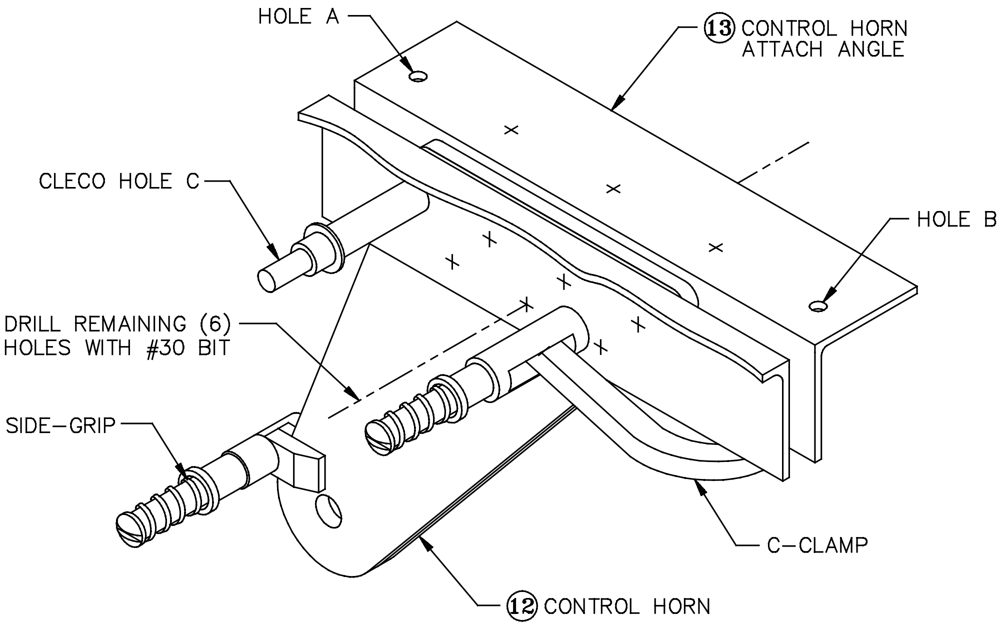
Completed: [ ]

Step 14: Trim the Corners Off the Attach Angles

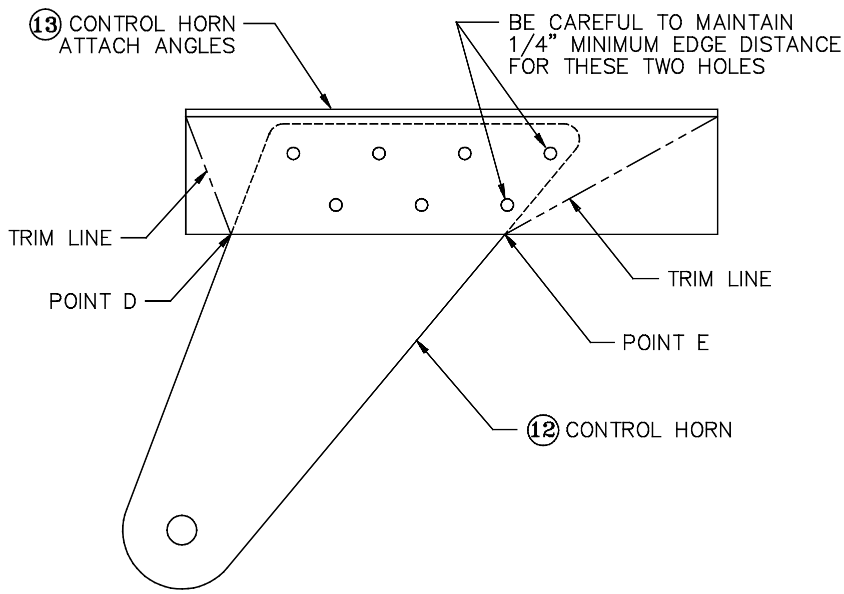
The solid lines in Figure 8 show the original shape of the attach angles. Trim off the corners as indicated by the dashed lines in the figure. While each set of horns and angles is still attached, make a mark on one of the angles where the forward and aft edges of the horn intersect it. (These points are labeled D and E in Figure 8.) Then remove the Clecos. Clean and deburr the control horns and set them aside. Trim the end of the attach angle to within 2d (1/4") edge margin to Hole A.

Draw lines on the angle from the points you marked to the upper corners of the angle as illustrated by the dashed trim lines in Figure 8. Re-Cleco the two angles together back to back, and use a hacksaw to trim off the corners. Un-Cleco the angles, smooth the cut edges, round the corners and deburr the holes.

Completed: [ ]



STEP 13



STEP 14

Figure 8: Final Drilling and Finishing the Control Horns and Attach Angles

Step 15: Cut Out the Trim Cable Bracket Parts (Manual Trim Only)

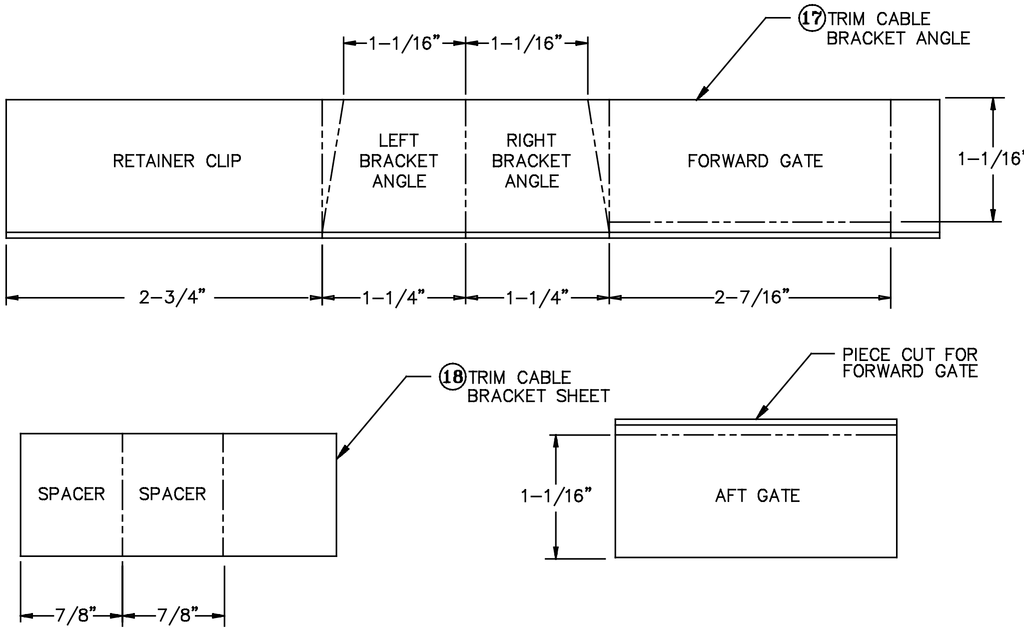
Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions*.** Return to **Step 20** of this *Assembly Manual* when the specified option steps have been completed. ☞

The elevator trim tab is actuated by a sheathed cable that exits the fuselage through the fairing beneath the rudder, enters the elevator through a slot in the upper skin and exits the elevator to connect to the trim tab control horn through a slot in the lower skin. A bracket assembly installed in the interior of the elevator secures the end of the cable sheath. This assembly is made of six small parts that you must fabricate from the **trim cable bracket angle** [17] and **sheet** [18] supplied with the kit.

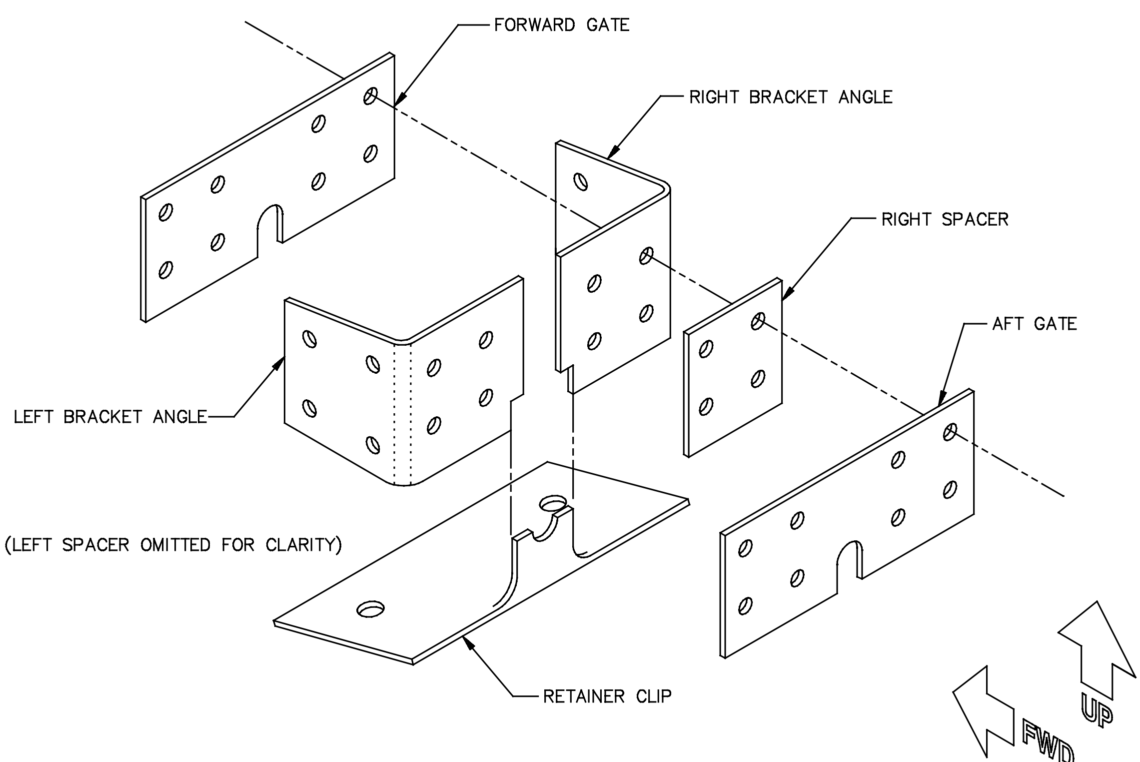
Figure 9 shows the final arrangement of the six finished parts in the bracket assembly as well as the dimensions for cutting each part from the raw stock. Use aviation snips or a bandsaw to make these cuts; the material is too thin to cut cleanly with a hacksaw. After you've cut all the parts to the designated length and width, cut the slanted edges of the two bracket angles. Refer to Figure 9 to ensure that you make the bracket angles mirror images of one another.

Finally, smooth and deburr the edges and round the corners of the bracket halves, gates and spacers and set them aside. Don't clean up the retainer clip piece yet, because it still requires some work in a subsequent step.

Completed: [ ]



CUTTING THE PARTS FROM RAW STOCK – STEP 15



FINAL ARRANGEMENT OF THE FINISHED PARTS

Figure 9: Cutting the Trim Cable Bracket Parts

Step 16: Fabricate the Trim Cable Gates *(Manual Trim Only)*

A) MARK AND CENTER PUNCH HOLE LOCATIONS ON THE FORWARD GATE

Figure 10a shows the locations of the holes for the eight rivets that hold the trim cable bracket assembly together. Mark and lightly center punch these locations on the forward gate **only**. The figure also shows the centerpoint location of the 1/4" cable hole. Mark and punch this location as well—once again on the forward gate **only**. **Do not** drill any holes at this time.

B) DRILL THE CABLE HOLE

Clamp the forward and aft gates together back to back with a pair of side-grips, as shown in Figure 10b. Be sure the hole locations you marked on the forward gate are visible. Drill through both gates at the cable hole location with a 1/4" bit.

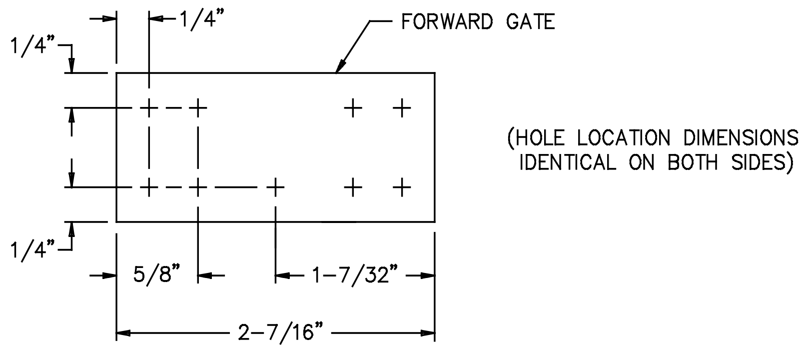
C) CUT THE CABLE SLOT

With the gates still clamped together (as shown in Figure 10c), draw lines on the forward gate perpendicular to the lower edge and tangent to the edges of the cable hole. Use a fine-toothed saw to cut out the material between the lines.

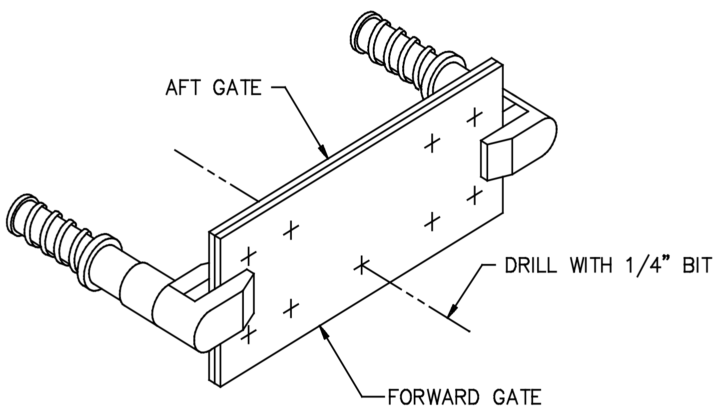
D) FINISH THE GATES

Remove the clamps. With fine toothed round and flat files, deburr the arc and smooth the cut edges of the cable slot in each gate. Avoid enlarging the slot either vertically or horizontally.

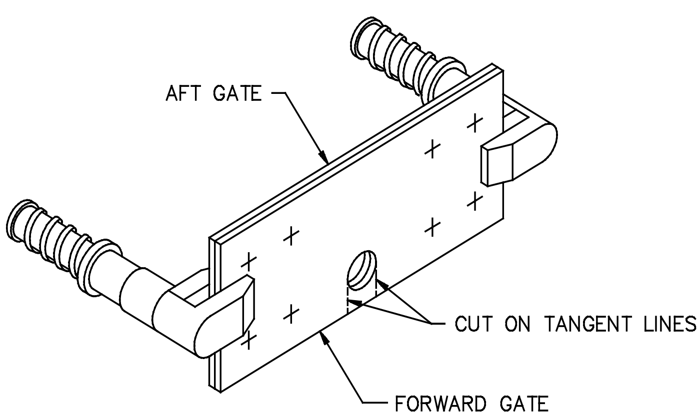
Completed: [ ]



STEP A



STEP B



STEP C

Figure 10: Fabricating the Trim Cable Gates

Step 17: Notch the Trim Cable Bracket Angles (Manual Trim Only)

As shown in Figure 9, the lower, inboard corners of the two bracket angles must be slightly notched to accommodate the tongue of the retainer clip.

A) MARK THE NOTCH CORNER LOCATION

The notches in the two bracket angles are mirror images of each other. Figure 10a shows the location of the corner of the notch in the **right-hand** bracket angle. Mark and lightly center punch this location according to the dimensions in the figure on the right angle **only**. Refer to the orientation of the slanted edge in the figure to make sure that you are marking the right-hand angle.

B) DRILL THE CORNER HOLE

To avoid a square corner (which could serve as a stress riser, leading to cracking), you will drill a small hole where the corner of the notch will fall. Clamp the bracket angles together back to back, as shown in Figure 10b, and drill through both with a 1/16" bit.

C) CUT THE NOTCHES

With the angle still clamped together, use a fine-toothed saw to cut out the notch on lines perpendicular to the edges of the angles and tangential to the edges of the corner hole

D) FINISH THE ANGLES

Unclamp the angles and smooth the cut edges with a file.

Completed: [ ]

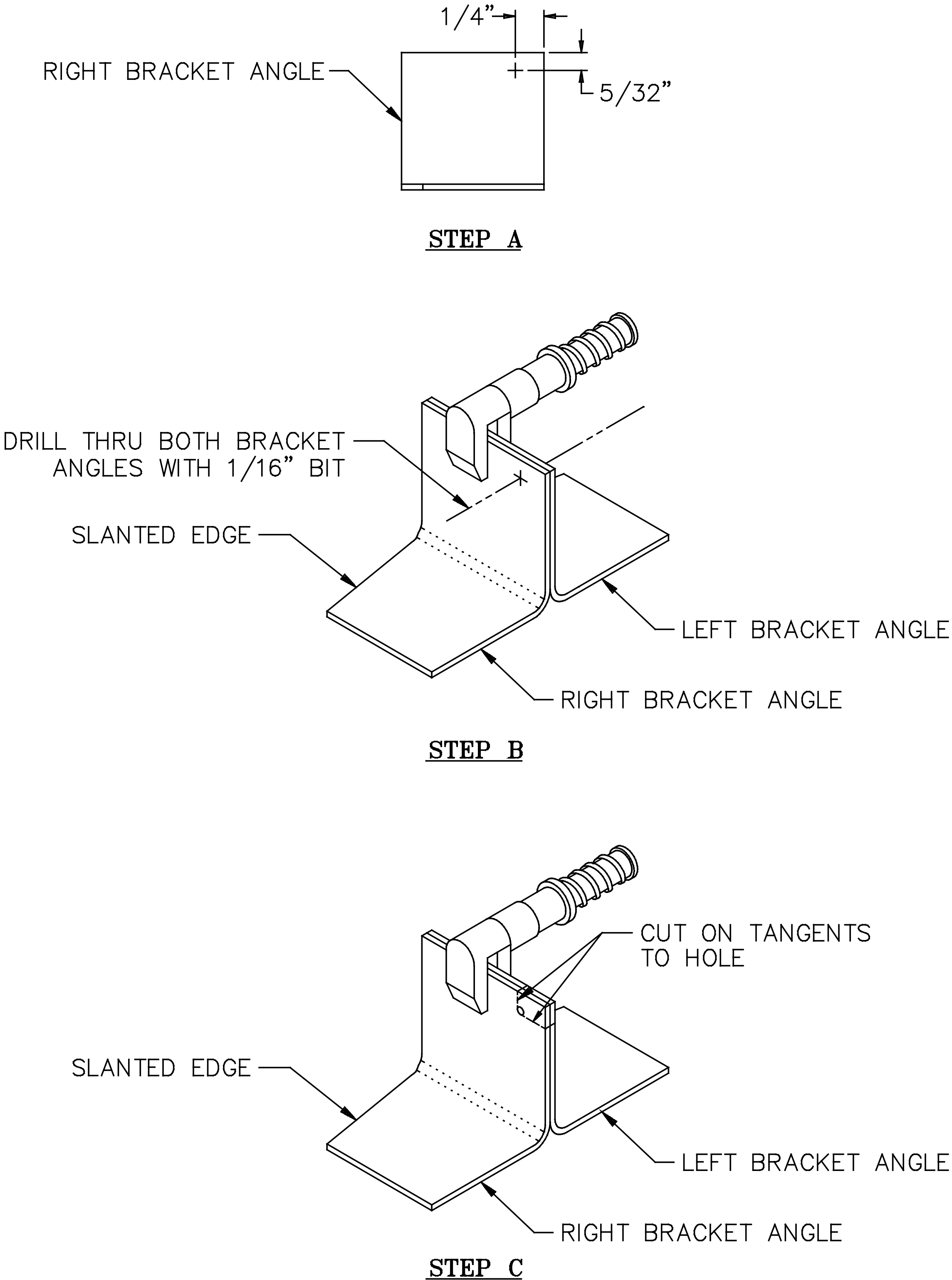


Figure 11: Notching the Trim Cable Bracket Angles

Step 18: Drill the Left-Side Rivet Holes in the Bracket Parts (Manual Trim Only)

In this step you will clamp together all the left-side bracket parts and drill the holes that will be used to rivet them together.

Begin by marking a reference line on the forward face of the left bracket angle. This line will be used to align the outboard edges of the forward and aft gates and the left spacer. As shown in Figure 12, this line should be marked **1-1/32"** outboard of the inboard edge of the angle.

When the line has been marked, align the gates and spacer horizontally on the line and vertically on the lower edge of the angle, as shown in Figure 12. Clamp all the parts in place with a pair of side-grips.

When all the parts are secured, drill through each of the four left-side holes with a #30 bit. After drilling the first hole, insert a Cleco from the aft side; after drilling the second, Cleco it (also from the aft side) and remove the side-grips before finishing up the third and fourth holes. Leave the Clecos in place for the moment.

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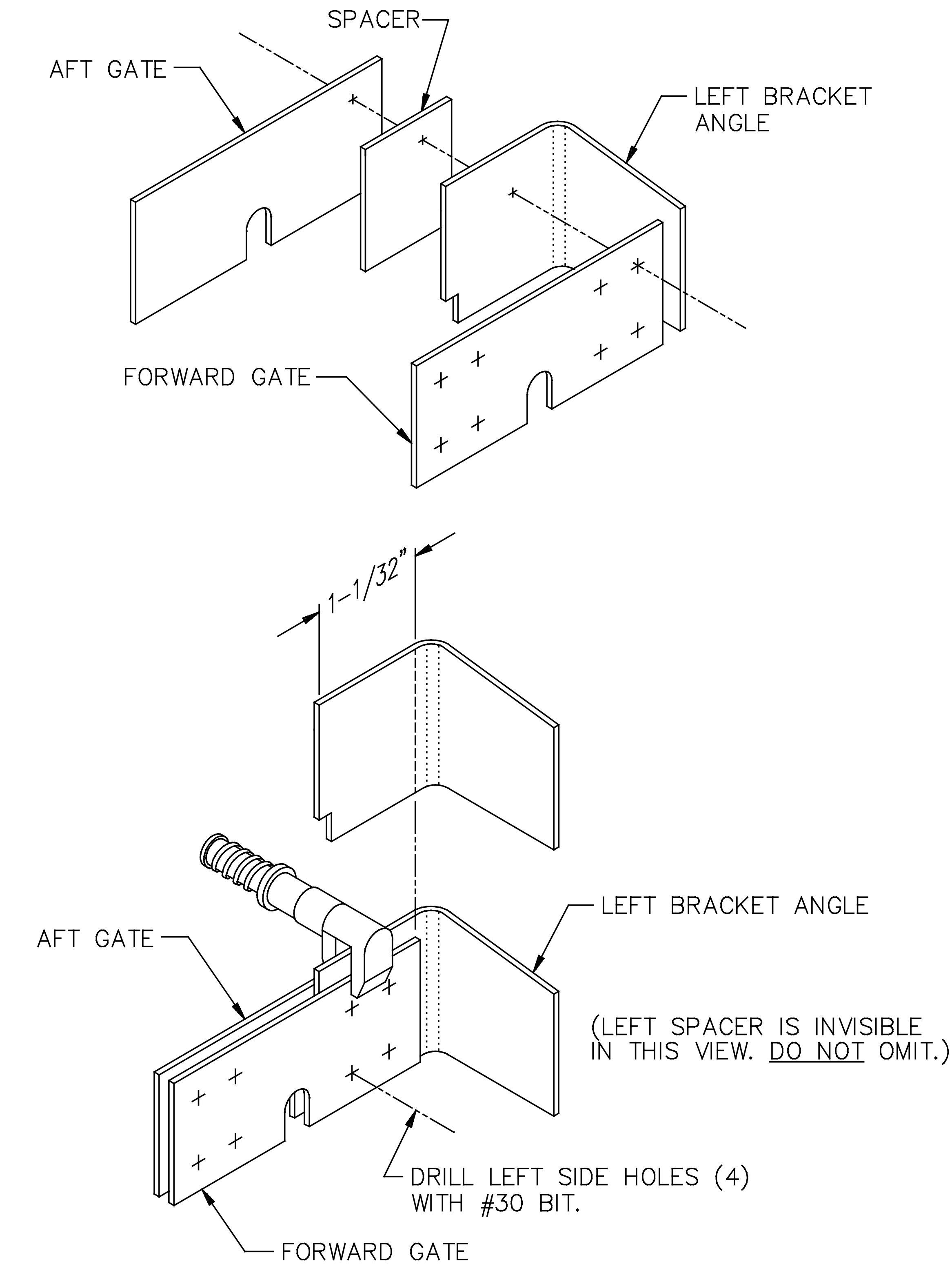

Figure 12: Drilling the Left-Side Trim Cable Bracket Rivet Holes

Step 19: Fabricate the Trim Cable Retainer Clip (Manual Trim Only)

Final drilling of the trim cable bracket angles, gates and spacers must be done in later steps, but you can finish up the retainer clip now. Figure 13 illustrates the additional drilling and cutting that's required.

A) MARK AND DRILL THE CABLE HOLE

Mark and lightly punch a centerpoint at the location on the vertical flange shown in Figure 13a and drill the hole with a 1/4" bit.

B) MARK AND PILOT DRILL THE SCREW HOLE LOCATIONS

Mark and lightly punch centerpoints at the locations on the horizontal flange shown in Figure 13b. Drill these holes with a #40 bit.

C) CUT OFF THE TOP OF THE VERTICAL FLANGE

As shown in Figure 13c, cut off the top of the vertical flange **1/2"** from the bottom (through the centerpoint of the cable hole).

D) CUT THE RETAINER TONGUE TO FINAL WIDTH

Cut away the remaining vertical flange material **1-3/32"** from each end of the clip, as shown in Figure 13d.

E) BEND THE RETAINER TONGUE

Using a pair of duck bill pliers, bend the retainer tongue to 105°. Check the angle with the cardboard angle template, as shown in Figure 13e.

F) SMOOTH, DEBURR AND ROUND THE CORNERS

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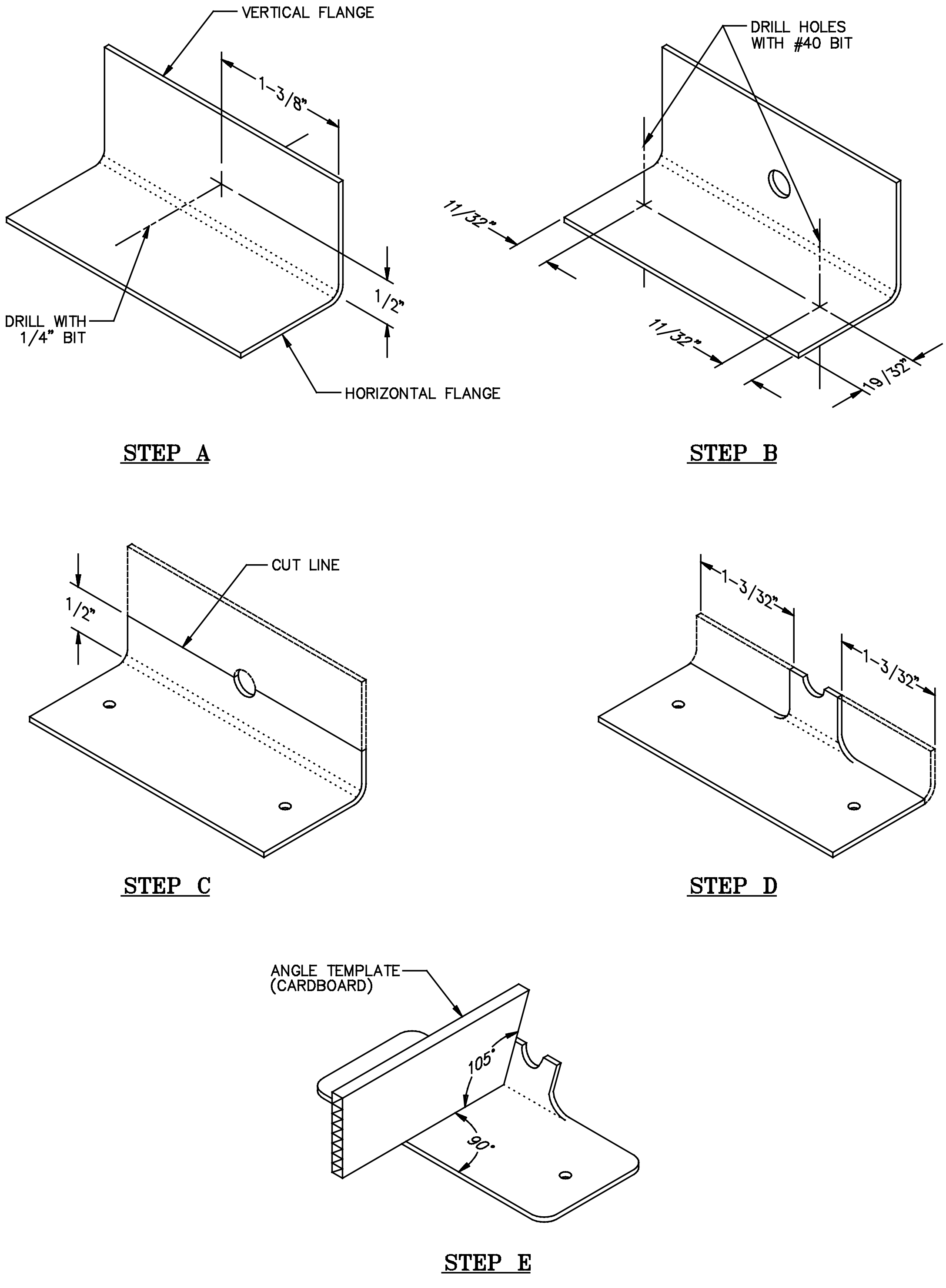

Figure 13: Fabricating the Trim Cable Retainer Clip

Step 20: Mark Rivet Lines on the Forward Spar and the Ribs

Using a marking pen, mark a centerline on the upper and lower flanges of all the ribs. Rivet lines must also be marked on both the upper and lower flanges of the forward spar, but these are not strictly centerlines: as shown in Figure 14, the **upper flange line** should be marked **5/16"** in from the edge; the **lower flange line** should be marked **1/4"** in from the edge of the flange on all parts.

Note The lower flange of the forward spar is the narrower of the two flanges.

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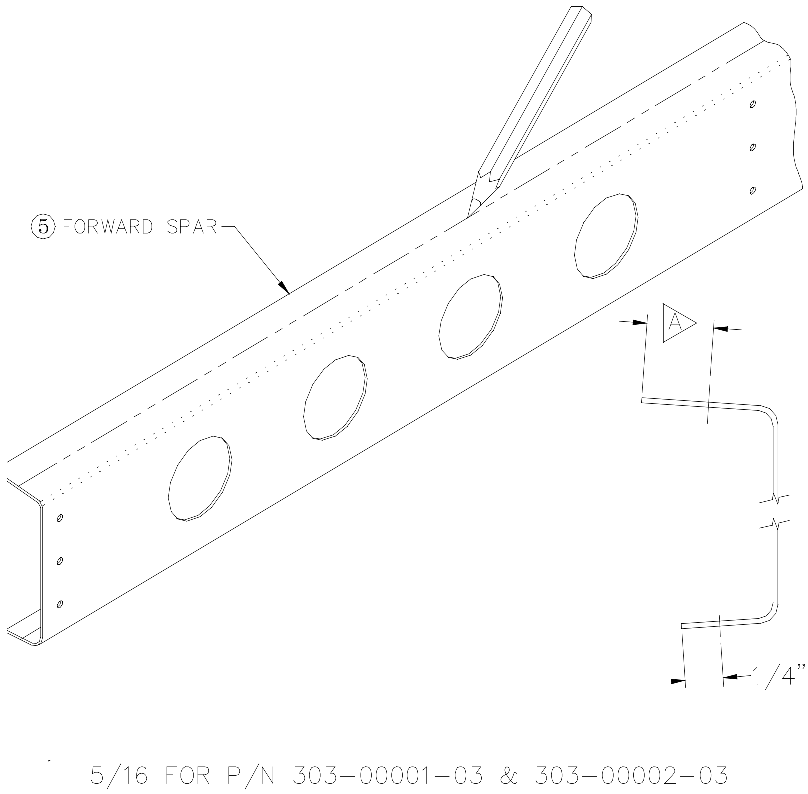

Figure 14: Marking the Forward Spar Rivet Lines

MAIN STRUCTURE

Step 21: Cleco the Ribs to the Forward Spar

Using two Clecos per rib through the pre-punched holes, clamp the inboard and outboard ribs to the forward spar, as shown in Figure 15. Make sure that the spar is properly oriented with the **larger flange on top**. Also note that the shorter, inboard ribs occupy the first position to the left of center and the first three positions to the right of center. Finally, it is vital that the rib and spar flanges be oriented properly, as shown in Figure 1; the spar flanges should point **forward**, and all inboard and outboard ribs should point **inboard**, **except** for Ribs C and D, which should point **outboard**.

After all the ribs are Clecoed in place and you have confirmed that the flanges are properly oriented, mark each rib, specifying its location on the spar. Use any numbering or lettering system that makes sense to you; the important thing is simply that you be able to return each rib to its original position on the spar after repeated disassembly and reassembly.

Finally, use a **#30** bit to drill all the spar/rib rivet holes up to final size. Juggle the Clecos as necessary, replacing the 3/32" ones with 1/8" ones after drilling.

Completed: [ ]

Step 22: Cleco the Aft Partial Spar to the Inboard Ribs and Drill the Rivet Holes to Final Size

Cleco the **aft partial spar** [6] to the aft end of the four inboard ribs. Note that the aft spar has a definite left and right determined by the locations of the rivet holes; if the holes in the spar don't line up with the four inboard ribs, then it's backwards! Be sure that the flanges of the aft spar point aft. Refer to Figure 15.

Finally, remove individual Clecos as necessary, drill through the aft flanges of each rib and the corresponding partial spar web holes with a **#40** bit. Replace each Cleco after drilling.

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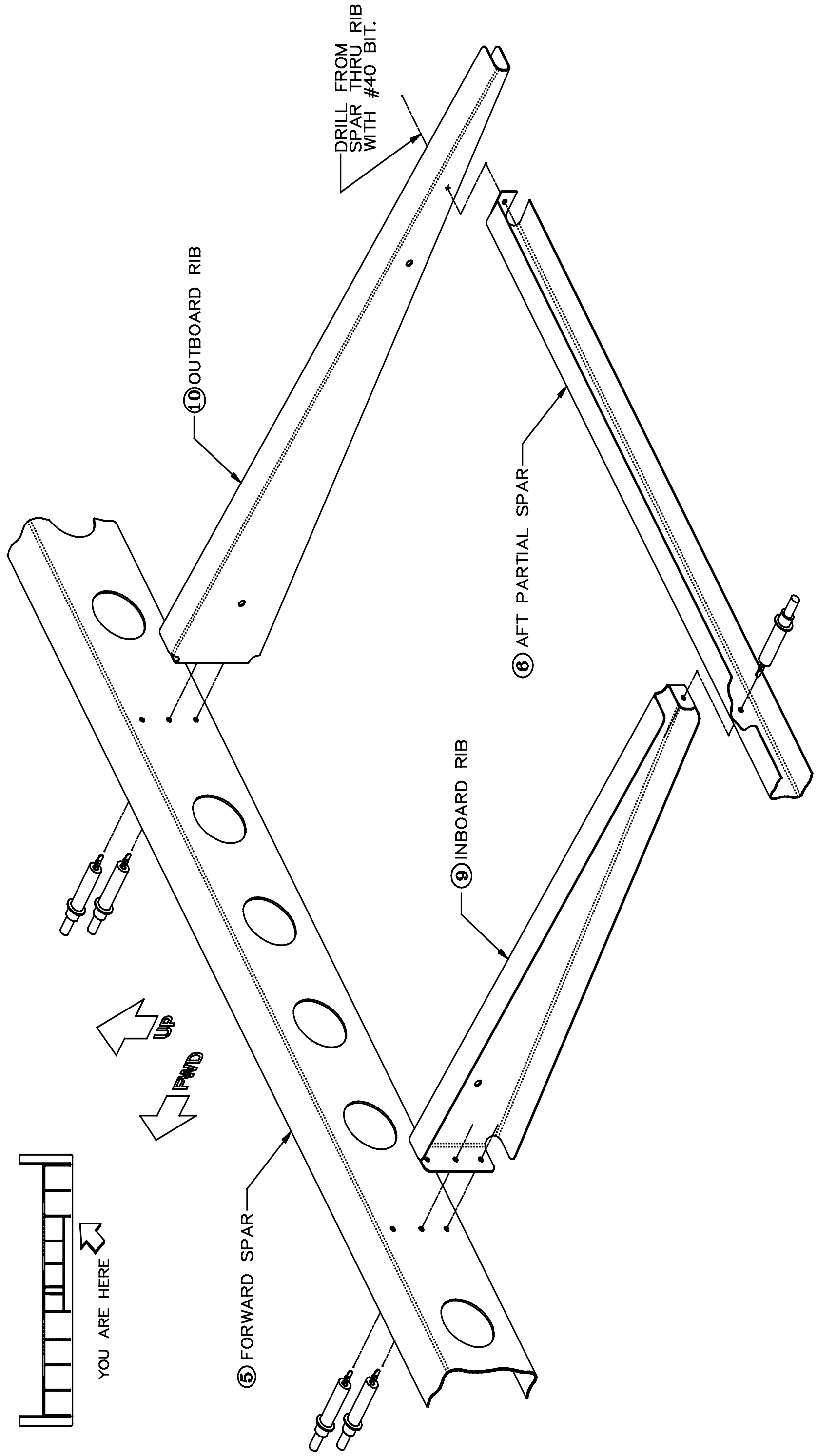

Figure 15: Clecoing the Spar/Rib Assembly

Step 23: Drill the End Flanges of the Aft Partial Spar

The aft partial spar will be riveted to the adjoining outboard rib at each end. The flanges on the spar ends are pre-punched for this purpose, but you must drill through the ribs with a #40 bit (see Figure 15). Because of the close quarters inside the spar, this is a tricky hole to drill. If you have a 12" extension bit, you can use your fingers as a guide and flex the bit enough to get inside the spar cove. If you don't have such a bit, you'll have to mark the hole on the inboard web of each rib and drill the rib by itself after disassembling the spar/rib assembly. Also, don't forget to drill the spar flange itself—the pre-punched hole is slightly undersized.

Regardless of whether you're drilling through the spar and rib together or simply marking the rib through the spar, use a square to make sure that the spar and rib are perpendicular to one another.

Completed: [ ]

Step 24: Mark and Cut the Tip Rib Notches in the Lower Skins

As shown in Figure 16, small notches must be cut in the outboard, leading edge corners of both the **left** [3] and **right** [4] **lower skins** to accommodate the tip ribs, which extend forward of the skins' leading edges.

Begin each notch by marking a corner hole centerpoint **21/32"** in from the outboard edge of the skin and **1/4"** forward of the forward spar rivet line (see Figure 16). Lightly center punch this hole and drill it with a #40 bit.

Cut the notch with aviation snips and smooth the edges with a file.

> **Note** You can cut toward the **center** of each hole along the lines you marked to locate the holes, or you can cut along lines tangent to the aft and inboard edges of the hole. If you choose the latter, just be sure you leave a radius in the corner. A square corner will invite cracking.

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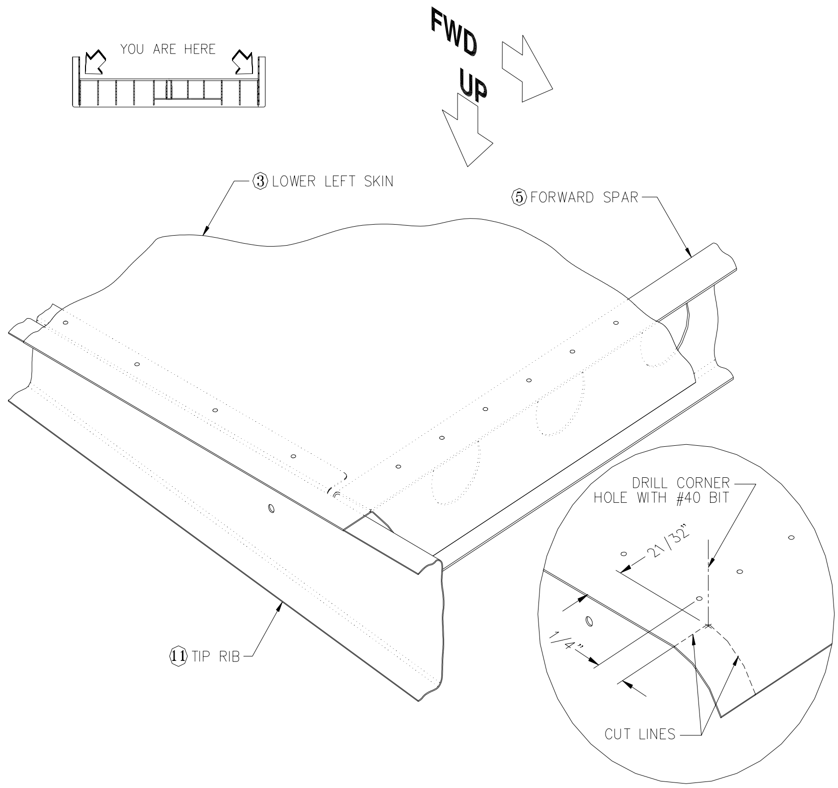

Figure 16: Cutting the Tip Rib Notches in the Lower Skins

Step 25: Position the Lower Right Skin

Lay the spar/rib assembly upside down on the bench with the upper spar flange flush with the edge of the bench. Use spring clamps (preferably with padded jaws) or large C-clamps to clamp the spar flange to the bench top. As you clamp, use a long straightedge along the spar web to make sure the spar is straight.

Caution In handling the elevator skins—especially the lower ones—be careful not to allow any more lengthwise flexing than necessary. Excessive bending in this direction will put kinks in the curved leading edges of the lower skins and the trailing edge joggles of all four skins. These kinks are almost impossible to remove and will spoil the appearance of an otherwise well-built elevator.

Note Because Figure 17 and subsequent diagrams of the spar/rib assembly place the trailing edge nearest to you, all right-side parts will naturally be on the left from your vantage point when the assembly is shown upside-down. Pay careful attention to the directional arrows in each figure!

Lay the lower right skin on top of the assembly, as shown in Figure 17. This is the skin with the curved leading edge and the longer trim tab cutout. Ultimately, of course, you want the skin aligned so that the rivet lines you marked on the spar and rib flanges are centered under the pre-punched skin holes. However, because the outboard ribs are only anchored at one end, things are likely to be somewhat skewed initially.

Begin, therefore, by aligning the skin on the forward spar rivet line. Use a framing square to make sure that the outermost rib is exactly perpendicular to the spar, and then move the skin left and right until the rivet line on that rib is centered under the line of holes along the outboard edge of the skin.

Note When the elevator skins are aligned properly, they extend beyond the outboard ends of the forward spar and the webs of the outermost ribs. Don't be alarmed! This overhang accommodates the tip ribs.

When the skin and the outermost rib are in alignment, clamp the skin in place to the spar. The curved leading edge of the lower skins prevents the use of side-grips along the length of the spar, but, as shown in Figure 17, you can use a C-clamp at the outboard end if you come in from the side, rather than from the forward edge.

With this clamp in place, move to the inboard end and align the rivet line on Rib A under the pre-punched skin holes. When it is aligned, clamp the skin to the aft partial spar near the inboard end with a pair of side-grips, as shown in the figure.

With the skin clamped in two places, drill through the skin and spar at the **innermost** hole along the forward spar line with a #40 bit (see Figure 17). Insert a Cleco. Then move outboard along the spar, repeating the drilling (#40) and Clecoing once at each rib location until you reach the outboard end of the spar. As you go, check to make sure that the spar rivet line remains centered under the pre-punched skin holes.

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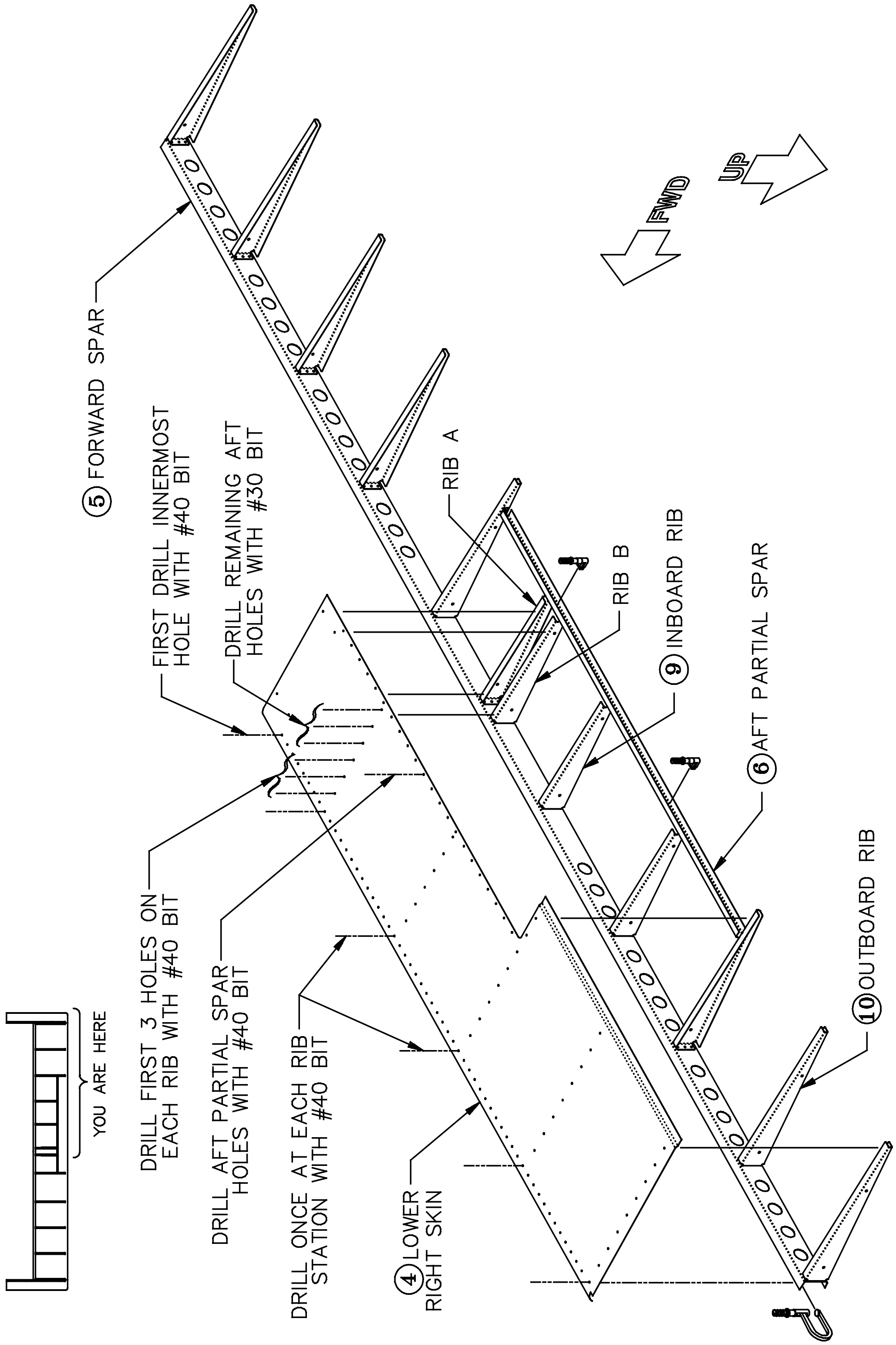

Figure 17: Positioning and Drilling the Lower Right Skin

Step 26: Drill the Remaining Lower Right-Side Holes in the Spars and Ribs

With the leading edge of the lower right skin Clecoed in place along the forward spar, drill all the remaining spar and rib holes. Finish the ones through the forward spar first using a **#40** bit, and then move on to the outboard ribs. As with the nose ribs in the last section, the outboard ribs may have to be moved left or right to bring them into alignment under the pre-punched holes. In this case, however, you won't need to use a tool; simply reach under the trailing edge and move the ribs by hand as necessary.

Due to limited space for maneuvering the bucking bar during final riveting, driven rivets can be used only in the first three holes in each rib (counting fore-to-aft); the remainder will take blind rivets. Use a **#40** bit to drill the first three holes for the driven rivets. The solid-shank, structural blind rivets are only available in 1/8" diameter, so drill **#30** holes from the fourth hole aft. Start drilling at the forward end of each rib and move aft, Clecoing as you go.

The inboard ribs may also need to be aligned left-and-right, but since they are anchored to both the forward and aft spars, they should move as a unit and all come into alignment at the same time. Drill them in a forward-to-aft sequence with a **#40** bit for the first three holes and a **#30** subsequently. Cleco as you go.

> **Note** The right skin has only four pre-punched holes over Ribs A and B. Drill **only** those four at this time; the remainder will be drilled after the left skin has been lapped over the right.

Finally, drill the aft spar with a number **#40** bit and Cleco.

> **Note** There are no pre-punched aft spar rivet holes in the area where the left skin overlaps. These holes will be drilled after the left skin is positioned in a subsequent step.

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Step 27: Mark and Cut the Trim Tab Pushrod Slot in the Lower Left Skin (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions***. Return to **Step 28** of this *Assembly Manual* when the specified option steps have been completed.

☞

The pushrod that actuates the elevator trim tab exits the elevator through a tapered slot in the lower skins, as shown in Figure 18. The wide end of this slot also accommodates the trim cable retainer clip. In this step, you will mark and cut this slot in the lower left skin; you will duplicate the slot in the lower right skin, in a subsequent step.

You will make the slot by drilling three holes and then cutting out the material between them. The first step is to locate the centerline of these holes. On the lower left skin, mark a parallel line **1-13/32"** in from the inboard edge of the skin. Then measure forward from the trailing edge of the skin and make marks at **3-5/8"**, **5-7/8"** and **6-5/8"** to locate the centerpoints of the three holes. Because of the curved leading edge of the lower skin, you will find it much easier to lay out these slot dimensions on the **inside** surface of the skin.

Lightly center punch these holes. Drill the aft hole with a **1/4"** bit and the two forward holes with a **9/16"** hole cutter. Draw tangent lines connecting the holes and cut out the material between them with a rotary cutting tool. Finish the slot with appropriate round and flat files, making sure that all the interior edges are smooth and deburred.

Note Do not try to drill the forward hole with a standard 9/16" bit. If you attempt to drill such a large hole in such thin sheet, the bit will almost certainly grab the material, and you will not get a clean hole. If you don't have a hole cutter, step drill the hole—that is, begin with a small hole (1/4" or smaller) and work up to final size in 1/16" increments.

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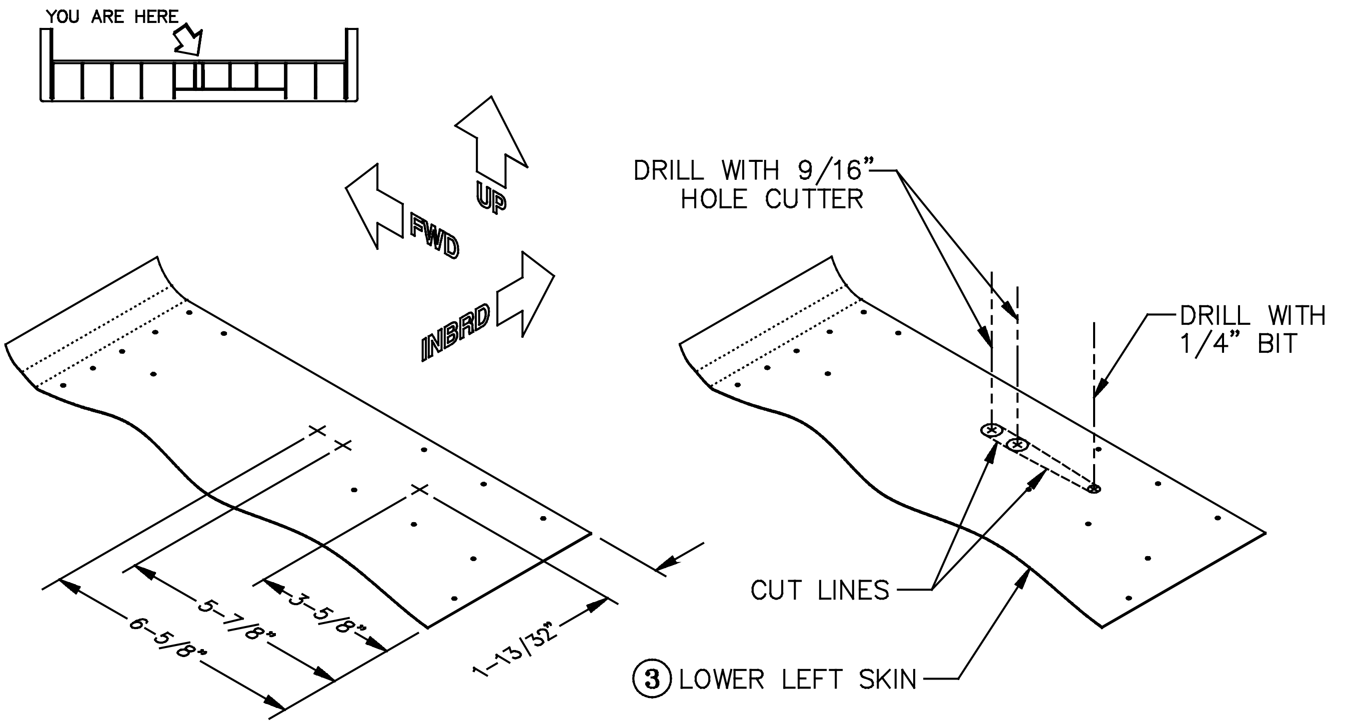

Figure 18: Cutting the Trim Tab Pushrod Slot

Step 28: Position and Drill the Lower Left Skin

The procedures for positioning and drilling the lower left skin essentially repeat those used to position and drill the lower right skin, as shown in Figure 19. In particular, before drilling any holes, make sure that the forward spar is straight from end to end, that the end ribs are square to the spar and that, as always, all the rivet holes in the skin are aligned with lines marked on the spar/rib framework.

Begin by drilling the forwardmost and aftmost Rib B holes along the inboard edge of the skin up to **#40** size so they will accept Clecos. Then lay the left skin in place overlapping the right skin and clamping it to the spar/rib assembly at the inboard end with a pair of Clecos through the common, Rib B holes. Drill (**#40**) and Cleco outboard from the center along the spar, checking as you go to see that the rivet line you marked on the forward spar flange is centered under the leading edge skin holes.

When the spar has been drilled and Clecoed, move on to the ribs, drilling in a forward-to-aft sequence with a **#40 or #30** bit as appropriate. Don't forget to drill both skins along Ribs A and B. Finally drill the aft spar with a **#40** bit and Cleco.

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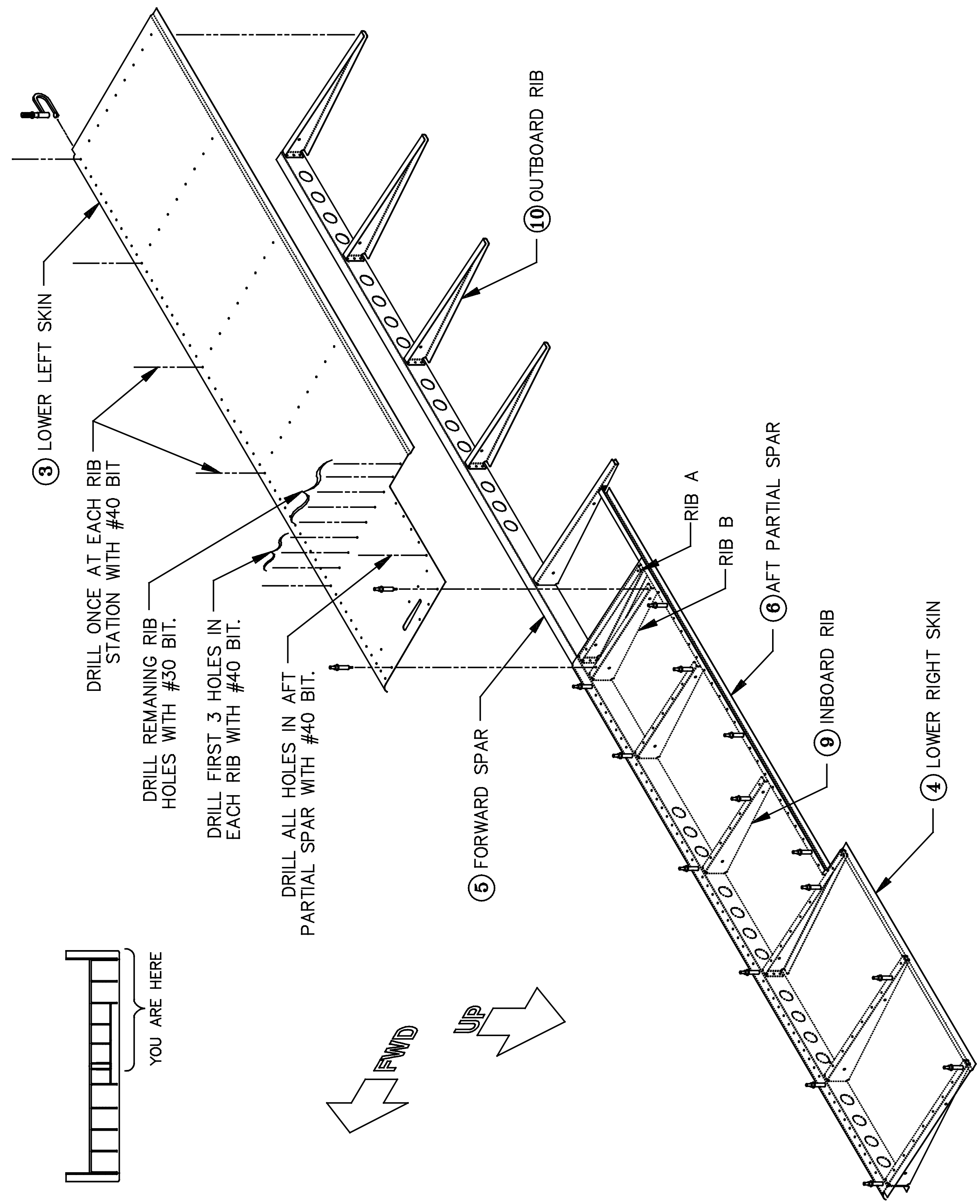

Figure 19: Positioning and Drilling the Lower Left Skin

Step 29: Mark and Cut the Trim Tab Pushrod Slot in the Lower Right Skin

With the lower left skin Clecoed in place overlapping the lower right skin, use a scriber to trace the circumference of the trim cable slot on the lower right skin.

Remove both lower skins and cut out the right-skin pushrod slot using the same techniques you used to make the left one. Make the right-skin slot slightly oversized—say, an extra 1/32" all around. Finish the slot with fine-toothed files and re-Cleco the skins to the spar/rib assembly.

Completed: [ ]

Step 30: Position and Drill the Control Horn Attach Angles

The control horn attach angles are riveted to Ribs A and B and the forward spar flange. The first step in positioning them is to remove the Clecos holding the skins to Rib A. Lay a straightedge on the lower left skin along this rib and mark a chordwise centerline through the rivet holes. Replace the Rib A Clecos and repeat the procedure on Rib B but do not replace those Clecos.

Next, clamp the right-side attach angle to the underside of the elevator assembly by inserting a Cleco through Hole A on the angle and the corresponding skin hole—the forwardmost hole on the Rib B line you just marked. **Note:** Hole 'A' lies **over the spar flange,** not aft of it. Refer to Figure 20 to ensure that you have used the proper skin hole and have oriented the angle correctly.

With the Cleco in place, rotate the angle until the centerline you just marked on the lower left skin comes into alignment under Hole B (see Figure 20) at the aft of the attach angle. Holding the angle firmly in place with your fingers, use a **#30** bit to drill through Hole B, the overlapped skins, the rib and the stiffener.

> **Note** The rib/control horn stiffeners should still be Clecoed to Ribs A and B from earlier steps. If you disassembled them, Cleco them back together before drilling these holes.

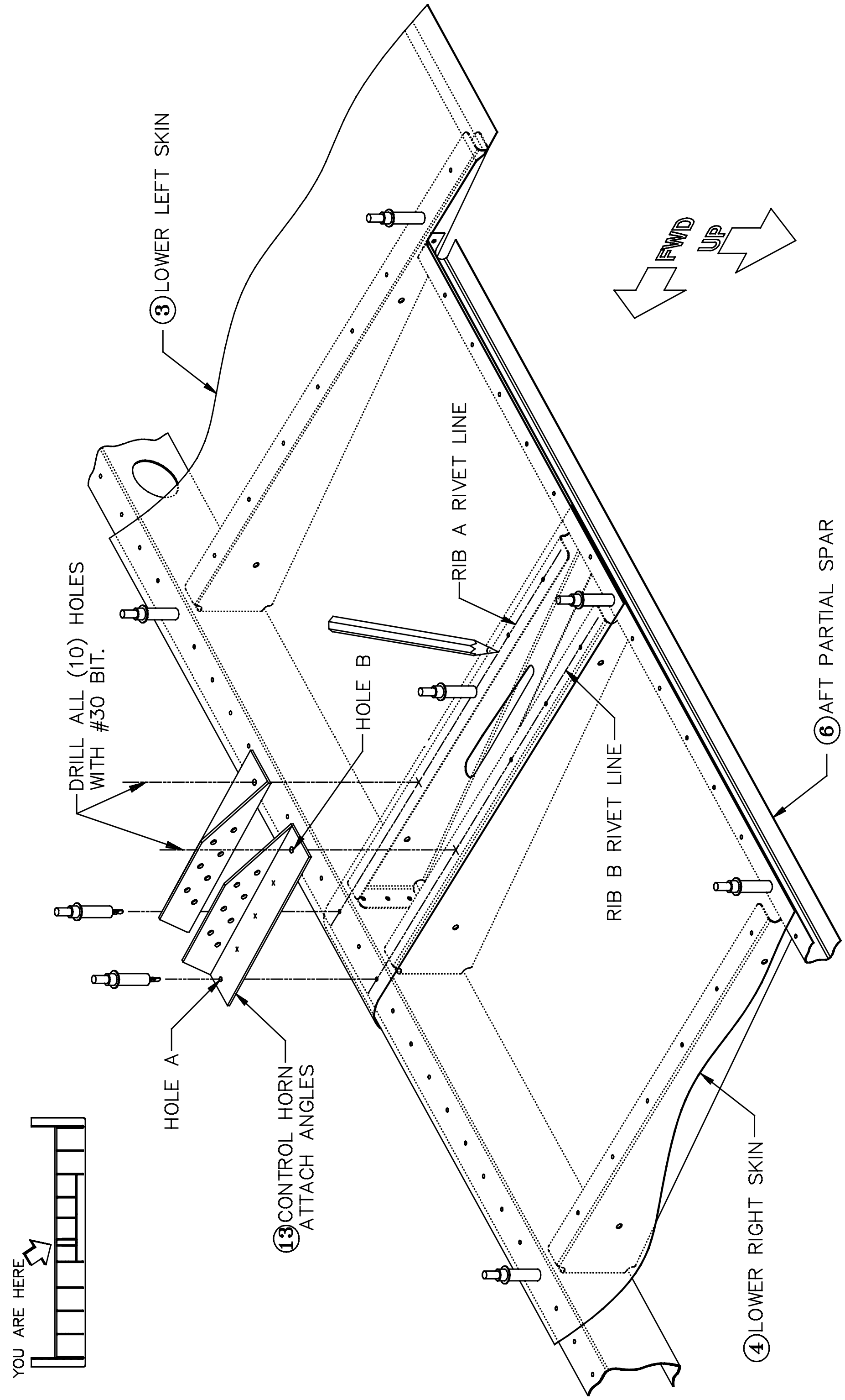

Figure 20: Positioning and Drilling the Control Horn Attach Angles

Insert a Cleco in Hole B and then drill through the angle, skins, rib and stiffener at the three undrilled hole positions with a **#30** bit. Finally, insert a Cleco in one of these holes, remove the Cleco from Hole A, and drill Hole A with a **#30** bit. Repeat the process for the left-side angle. Leave the angles Clecoed in place for the moment.

Completed: [ ]

Step 31: Position and Drill the Right Trim Cable Bracket Angle (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip to Step 35**.

In this step you will position the right trim cable bracket angle against the web of Rib B and drill the four holes through which it will be riveted in place. Figure 21 shows how the angle should be C-clamped in place: with its forward edge on the 105° reference line you marked on the rib/control horn stiffener and its top edge parallel to and **1/16"** down from the upper flange of the rib.

Note Because of the overhanging rib flange and the narrow space between Ribs A and B, a conventional C-clamp cannot be used here. We recommend the Vise-Grip-type locking C-clamp, as depicted in Figure 22.

When the angle is securely clamped in position, drill through the rib web, the stiffener and the angle at the four locations you marked on the outboard side of the rib web with a **#30** bit. Cleco after drilling the first and second holes and then remove the C-clamp to finish up. The Clecos should be inserted from the outboard side of the rib.

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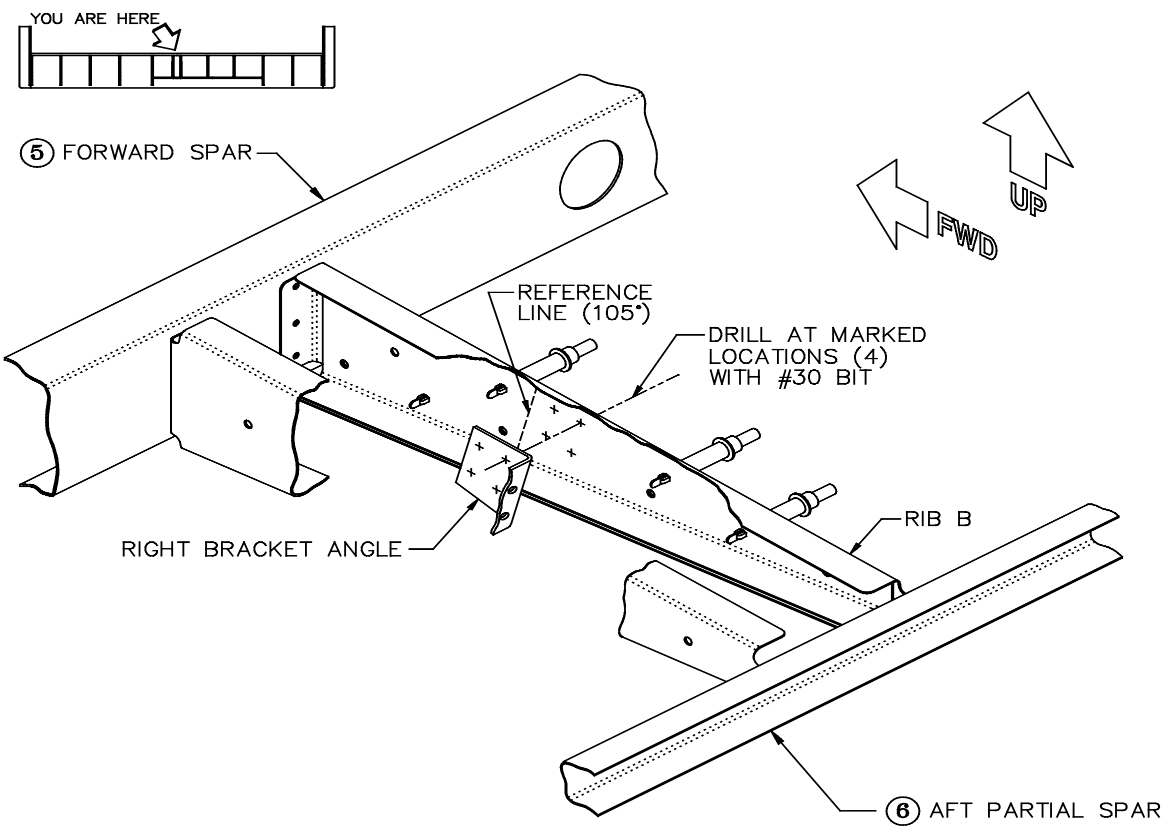
Figure 21: Positioning and Drilling the Right Trim Cable Bracket Angle



Step 32: Position and Drill the Left Trim Cable Bracket Half (Manual Trim Only)

The left bracket half (the two gates, left angle and left spacer you already Clecoed together) is positioned exactly as the right angle was in the previous step. Align the left angle's forward edge on the 105° reference line and its top edge parallel to and **1/16"** down from the upper flange of Rib A.

You have additional help in achieving the proper position, because the flange of the right-hand angle that projects inboard from Rib B will be sandwiched between the forward and aft gates when the left half is in place. The forward gate should lie flat against the forward face of the right angle, and there should be space between the aft face of the angle and the aft gate, since the right spacer is absent. Figure 22 shows these relationships.

With the left half clamped in place, drill through the rib web, stiffener and angle at the four marked locations with a **#30** bit. Cleco as you go.

Completed: [ ]

Step 33: Drill the Right-Side Holes in the Trim Cable Bracket Assembly (Manual Trim Only)

As shown in Figure 23, once the left bracket half is Clecoed in place on Rib A, drill the rivet holes through the right half of the assembly. First insert and align the right spacer, and then clamp the four parts (forward gate, right bracket angle, right spacer, aft gate) together with side-grips. Then drill at the four locations marked on the forward gate with a **#30** bit. Cleco after the first and second holes are drilled.

> **Note** Because the upper flange of Rib B overhangs the right bracket angle, it may be difficult to drill the outboard pair of holes. If so, simply drill and Cleco the inboard pair and remove the entire bracket assembly. Then you can drill the final two holes.

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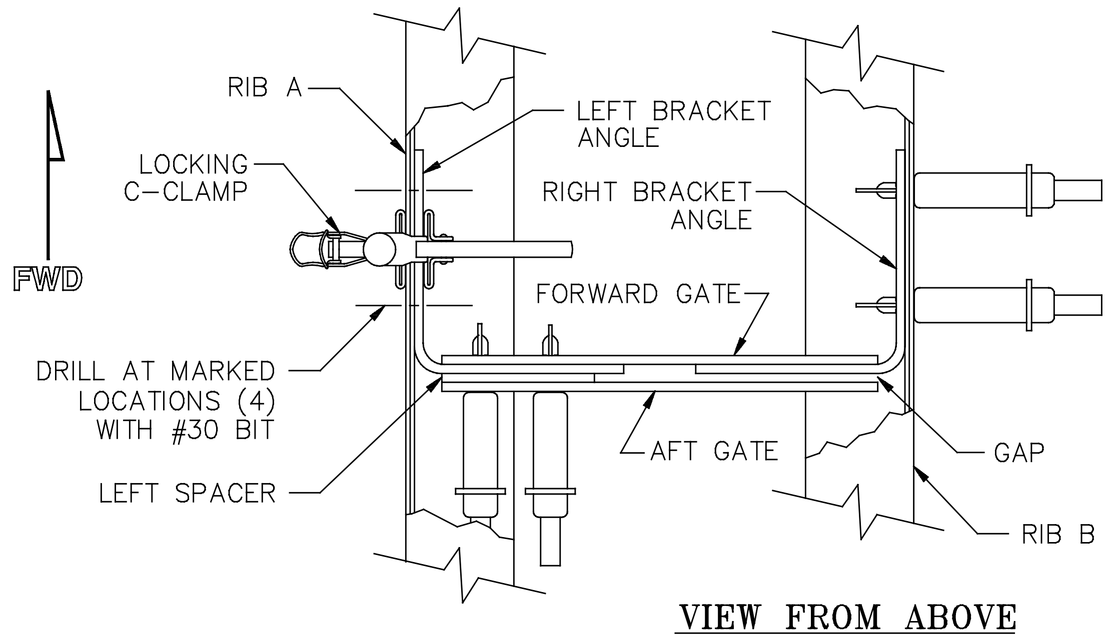

Figure 22: Positioning and Drilling the Left Trim Cable Bracket Half

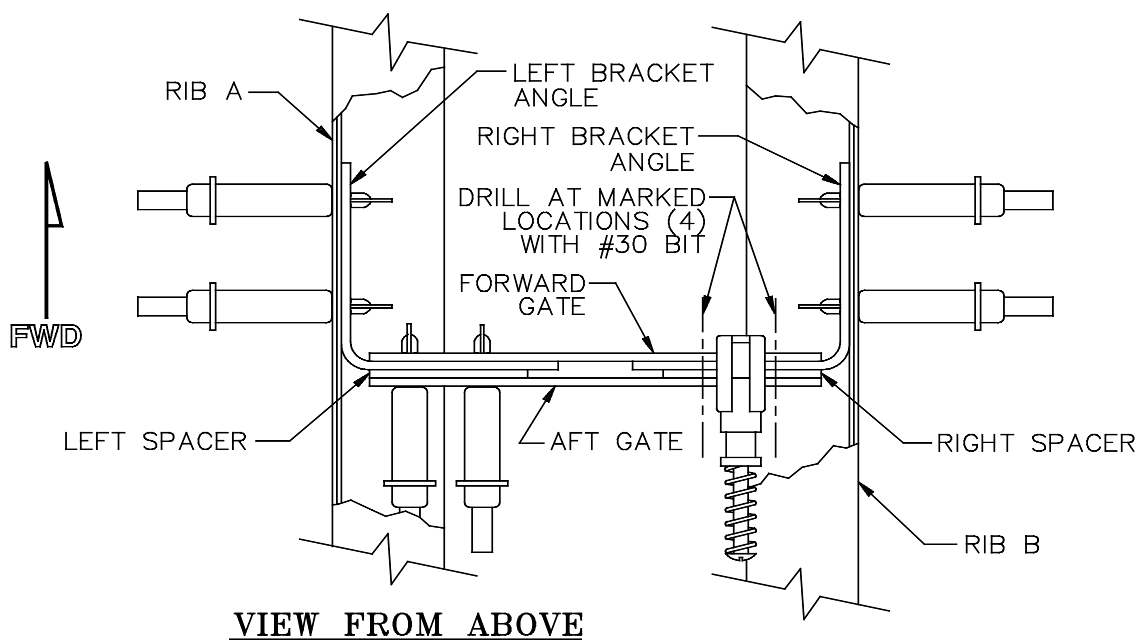

Figure 23: Drilling the Right-Side Trim Cable Bracket Rivet Holes

Step 34: Position and Drill the Trim Cable Retainer Clip
(Manual Trim Only)

As shown in Figure 24, the trim cable retainer clip mounts to the lower skins immediately aft of the control horn attach angles. The retainer tongue enters the interior of the elevator through the trim tab pushrod slot and slides inside the slot in the cable bracket assembly.

Place the clip in position and slide it forward and aft until the tongue is approximately centered in the bracket slot. To help position it left and right, slide a piece of 3/16" dowel or a 3/16" bolt into the cable hole.

Holding the clip firmly in place with your fingers, drill through one of the two pilot holes with a **#19** bit. Use an AN526-8R6 **round-head machine screw** [31] and a K1000-8 **nutplate** [34] in this hole to hold the clip in alignment while you drill the second hole. After drilling the second hole, remove the clip and deburr the holes.

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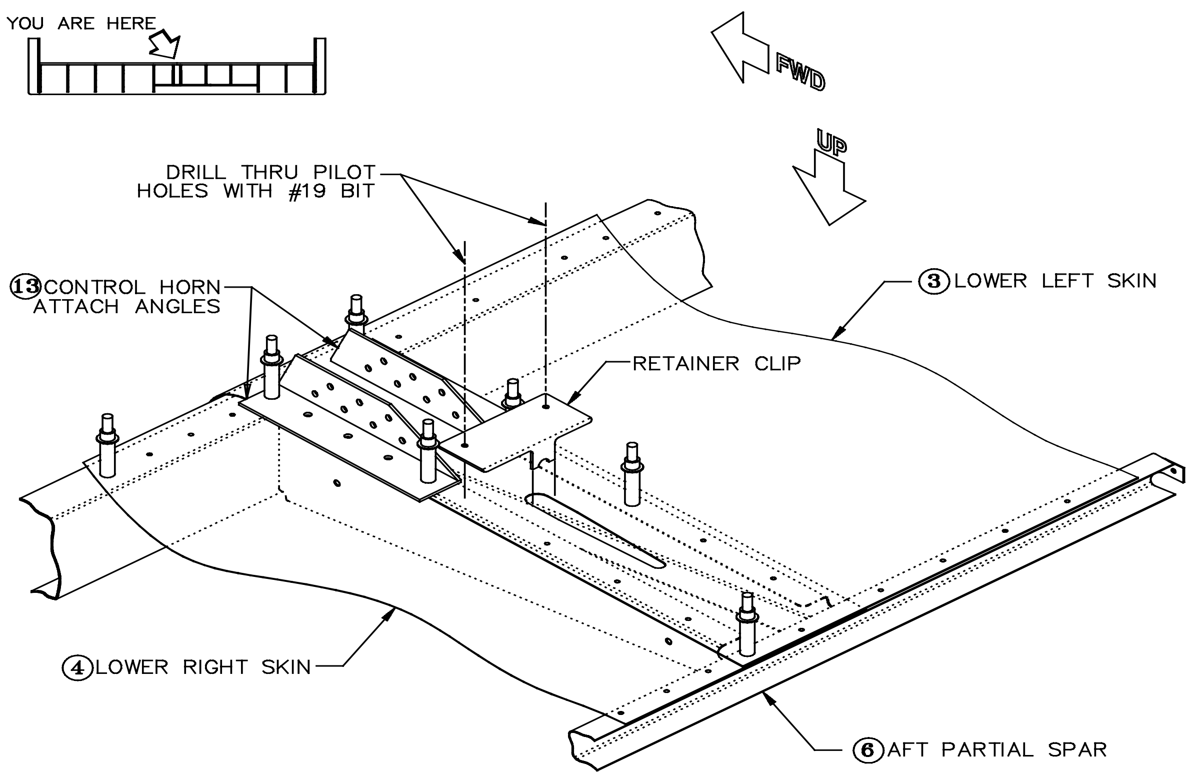

Figure 24: Positioning and Drilling the Trim Cable Retainer Clip

Step 35: Position and Drill the Upper Right Skin

Lay the **upper right skin** [2] over the assembly, aligning its trailing edge with the trailing edge of the lower right skin and the two rivet holes along Rib A with the Rib A flange centerline. Clamp the skin in place with side-grips or C-clamps along the aft partial spar flange, as shown in Figure 25. Drill the two Rib A holes with a **#40** bit and Cleco them. Remove the side-grips or C-clamps.

Next, align and drill the forward spar. Begin at the innermost hole, and work outboard, drilling (**#40**) and Clecoing once at each rib station. For the time being, **do not** drill the intervening holes; these will be drilled when the elevator hinges are installed.

> **Note** Drill only where there are pre-punched pilot holes in the skin. If there isn't a pre-punched hole precisely at a rib station, simply drill the nearest one. Also, don't drill any holes at Ribs A or B until the left skin is lapped over the right in a subsequent step.

Move on to drill the ribs with a **#40** bit, beginning inboard at the forward spar and moving aft and outboard. Next, drill (**#40**) and Cleco the trailing edge joggle.

> **Note** To avoid producing a wavy trailing edge, it's very important that the trailing edge joggle be supported from underneath while it's being drilled. Use a block of wood held at right angles to the joggle to provide this support.

Finally, align and drill the aft partial spar with a **#40** bit once at each rib station. **Do not** drill the remaining aft spar holes at this time; these will be drilled when the trim tab hinge is installed.

> **Note** Do **not** drill holes through the aft spar at the Rib A or B stations. These will be drilled after the left skin is positioned in a subsequent step.

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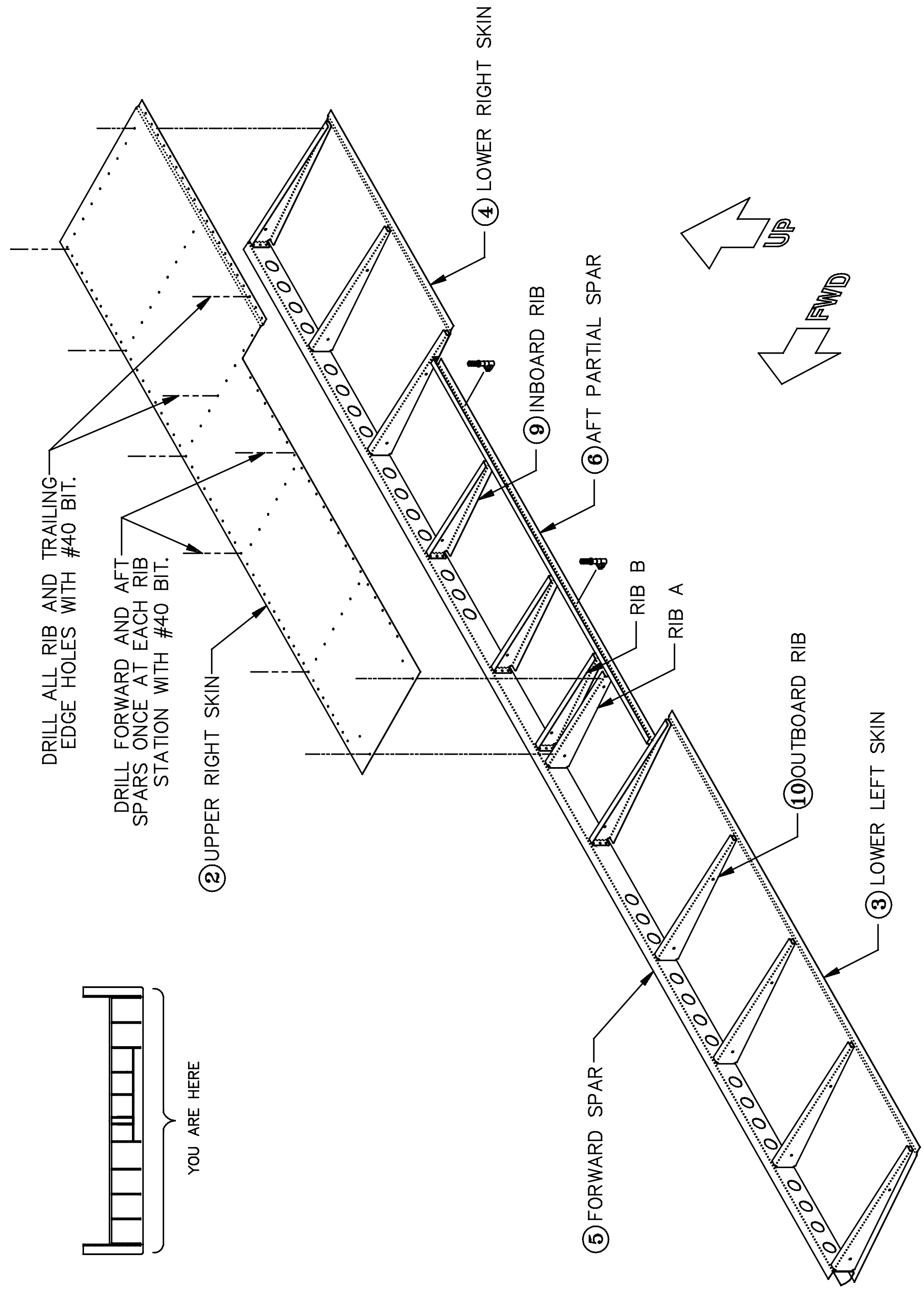

Figure 25: Positioning and Drilling the Upper Right Skin

Step 36: Mark and Cut the Trim Cable Slot in the Upper Left Skin (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step**.

The trim cable exits the fuselage through the fairing under the rudder and enters the elevator through a slot, as shown in Figure 26.

As with the pushrod slot in the lower skin, begin by marking a hole centerline on the top of the **upper left skin** [1] **1-13/32"** in from and parallel to the inboard edge of the skin. Mark the two hole centerpoints on this line by measuring aft from the leading edge of the skin **1-23/32"** and **2-17/32"**.

Drill these holes with a **9/16"** hole cutter, cut out the material between them and smooth and deburr as you did for the lower slot.

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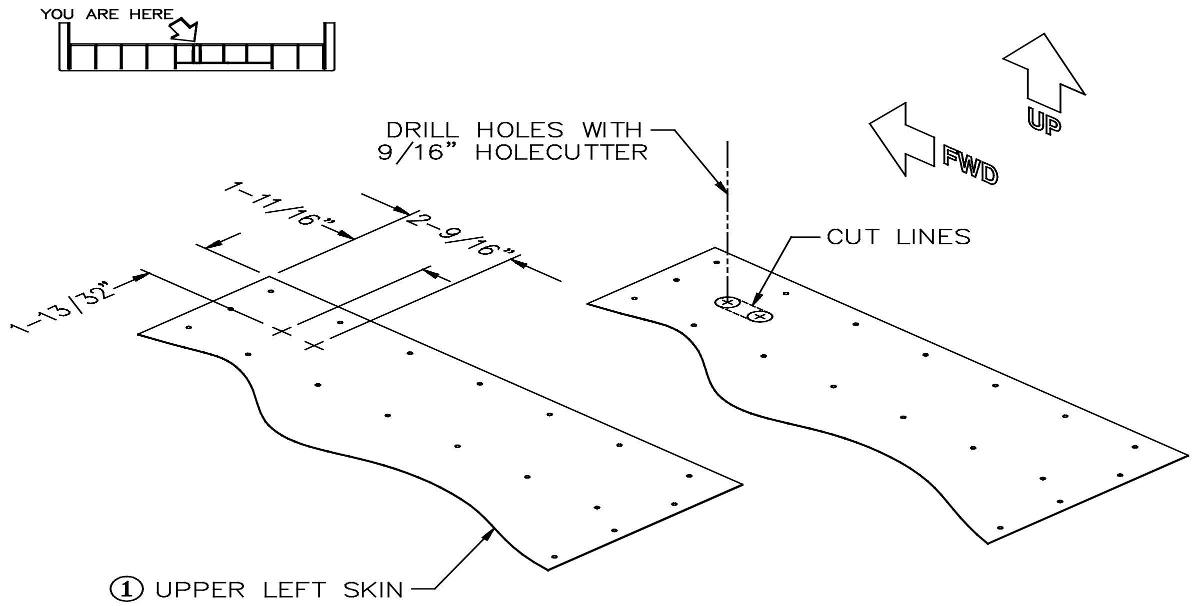

Figure 26: Cutting the Trim Cable Slot

Step 37: Position and Drill the Upper Left Skin

The procedures for positioning and drilling the upper left skin should be familiar by now. Begin by drilling the forwardmost and aftmost Rib B holes along the inboard edge of the skin up to **#40** size to accept Clecos. Then lay the skin in place overlapping the right skin and clamp along the inboard edge with a pair of Clecos through the common, Rib B holes and along the trailing edge joggles with three or four side-grips (see Figure 27). Check to see that the rivet line you marked on the forward spar flange is centered under the leading edge skin holes and drill (**#40**) and Cleco outboard from the center along the spar once at each rib station. **Do not** drill the remaining spar holes at this time; they will be drilled when the elevator hinge is installed.

When the forward spar has been drilled and Clecoed, move on to the ribs, drilling all holes inboard -to-outboard and forward-to-aft with a **#40** bit. Don't forget to drill both skins along Ribs A and B.

> **Note** If you are installing electric trim, **do not** drill the forwardmost two holes in Rib A or B. The skins will be secured in this area with the rivets that also secure the trim servo mounting nutplates.

Finally, as with the right skin, drill all holes along the trailing edge joggle and one hole at each rib station along the aft partial spar with a **#40** bit.

Completed: [ ]

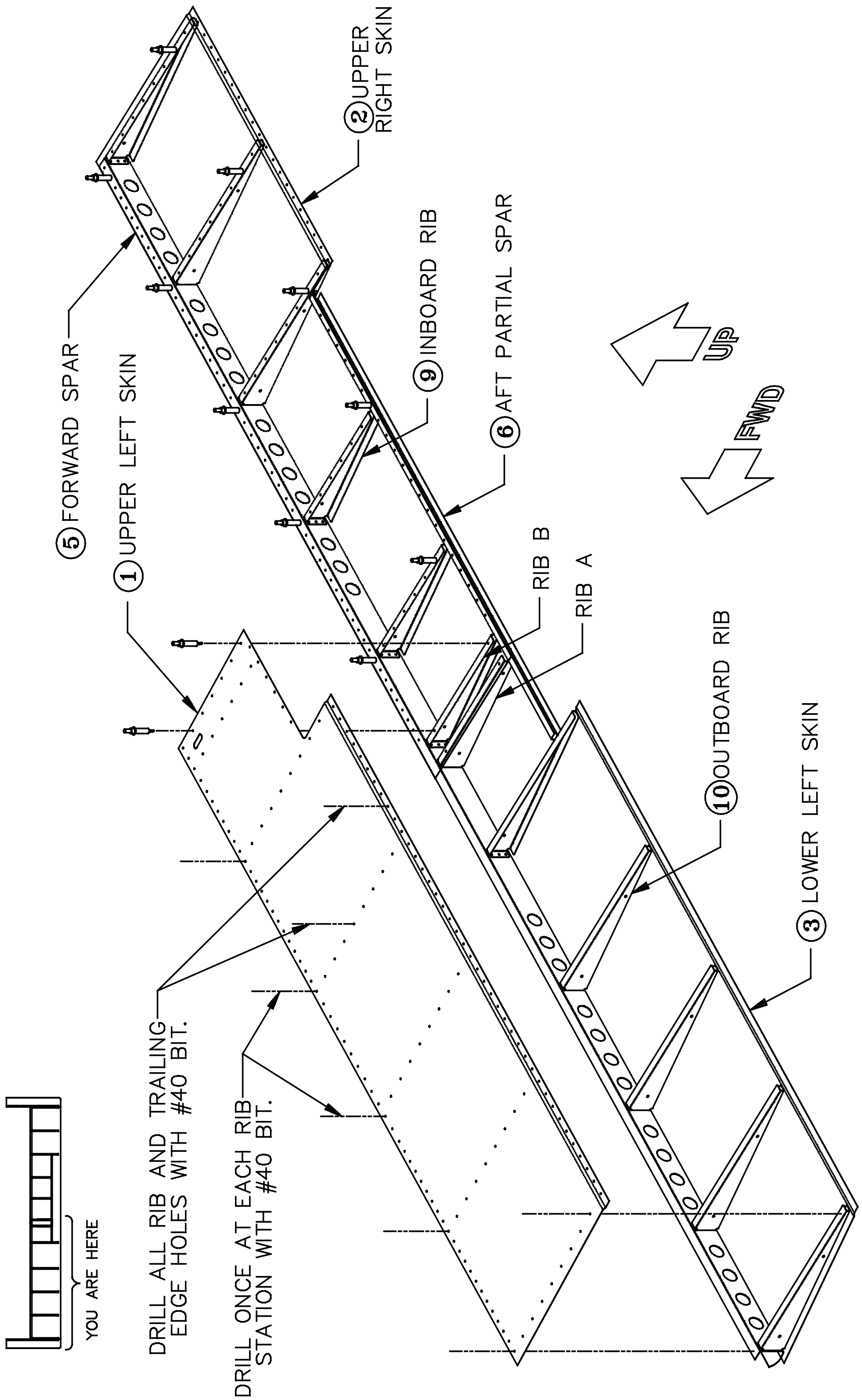

Figure 27: Positioning and Drilling the Upper Left Skin

Step 38: Mark the Trim Cable Slot in the Upper Right Skin (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step**.

With the upper left skin Clecoed in place overlapping the upper right skin, use a scriber to trace the circumference of the trim cable slot on the upper right skin. Don't cut it out at this point; you'll do that a few steps down the road.

Completed: [ ]

Step 39: Install Flange Reinforcement and Mark the Hole Positions on the Tip Ribs

Cut four 10" pieces of angle from the **Flange Doubler [16]** stock. Nest the pieces inside the upper and lower flanges of the tip rib [11] as shown in Figure 28. You may have to crimp the flanges of the doubler as well as slightly flatten the crimp in the rib in order to get them to nest properly. Mark the holes according the dimensions shown in Figure 28 **inside** the flanges of each tip rib. These dimensions are not critical (i.e., dimensional tolerance ±1/16").

Note The locations of the holes and flange doubler are referenced to the forward end of the main elevator rib to which the tip rib will be riveted; this is shown by the dashed line in the plan view portion of Figure 28. You might want to position the tip rib (as mentioned in the next step) first between the skins and mark the position of the forward spar.

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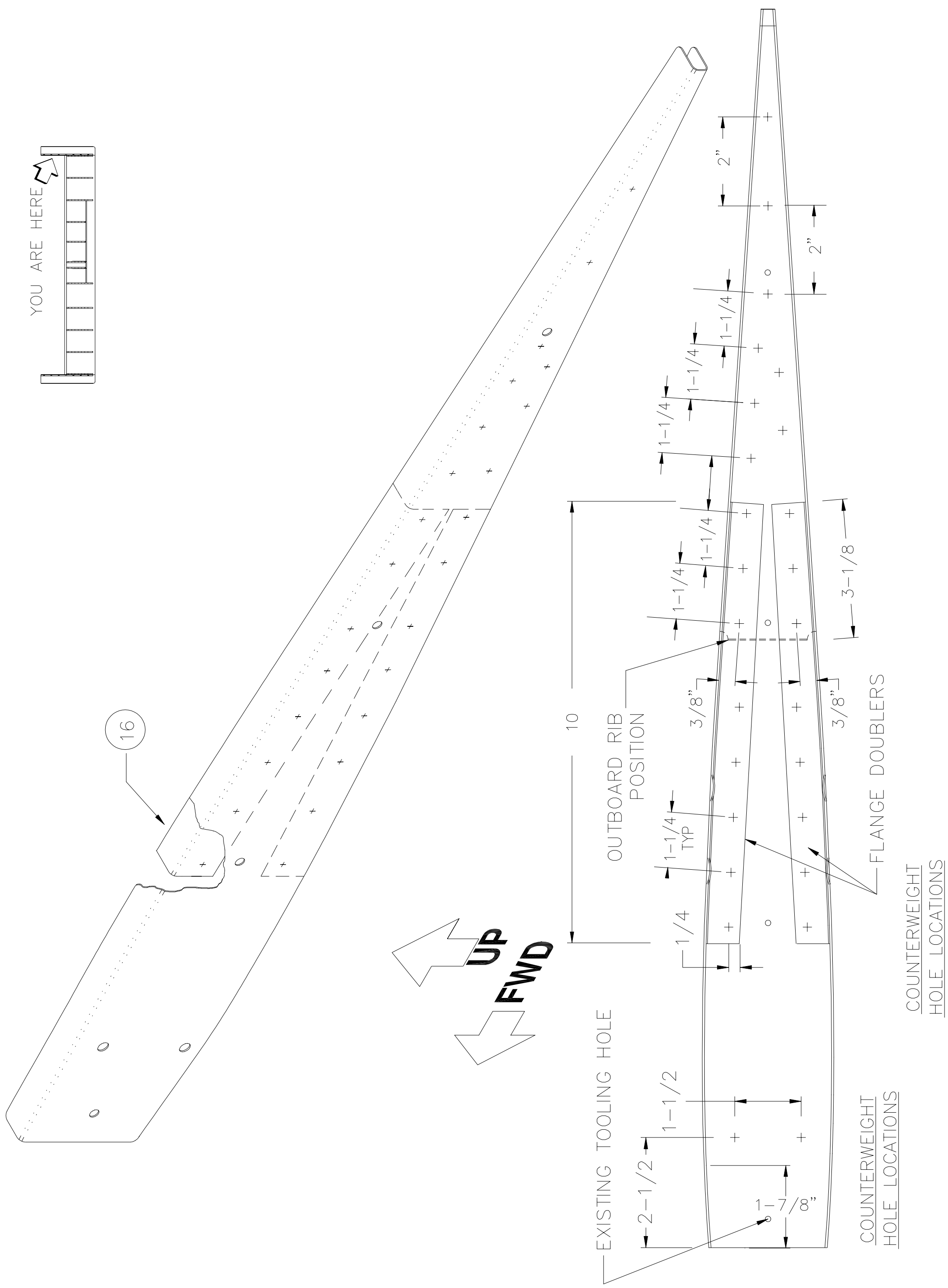

Figure 28: Tip Rib Hole Locations

Step 40: Position and Drill the Tip Ribs

Position the tip ribs inside the overhanging upper and lower skins, as shown in Figure 29. Note that the tip rib flanges are oriented **outboard** and that the tip rib webs are flat against the webs of the outermost main ribs. The skins determine the fore-and-aft position of the tip ribs; slide them aft as far as you can without distending the skins. **Do not** try to line up the aft ends of the tip rib and the adjacent main rib, because when properly positioned, the tip rib will extend slightly aft of the main rib. When you have the tip ribs in position, clamp them to the upper and lower skins as shown in Figure 29 with side-grips along the flanges.

When the tip ribs are clamped in place, drill through each tip rib and its corresponding main rib with a **#40** bit at each common location. Then remove the tip ribs from the elevator assembly and drill the counterweight mounting holes with a **#10** bit.

Clean and deburr both tip ribs.

Completed: [ ]

Step 41: Cut the Trim Cable Slot in the Upper Right Skin (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions*.** Return to **Step 43** of this *Assembly Manual* when the specified option steps have been completed.
☞

Remove all the Clecos and completely disassemble the entire elevator. Using the same techniques you used to cut the trim cable slot in the upper left-hand skin (Step 36), cut the slot in the upper right-hand skin. Make the right-skin slot slightly oversized—say an extra **1/32"** all around.

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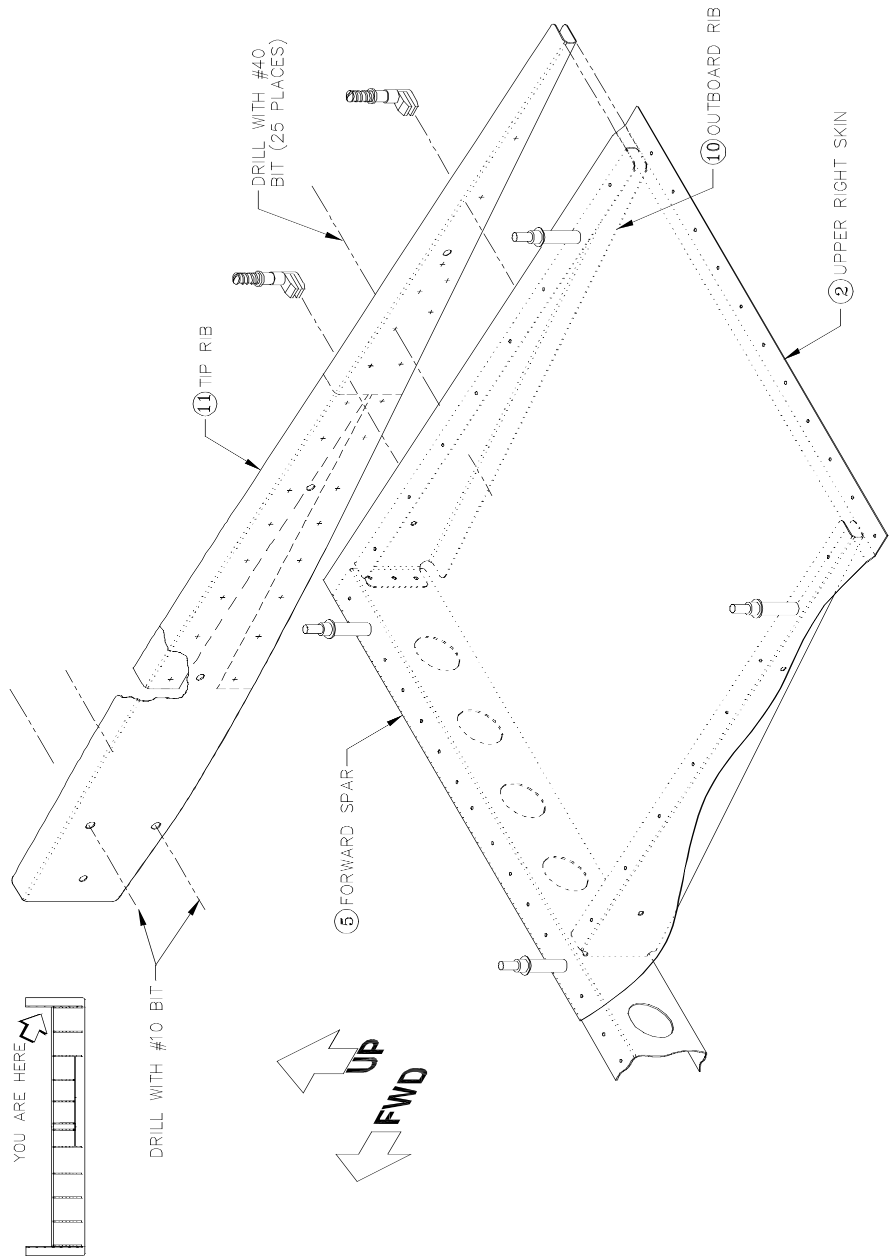

Figure 29: Positioning and Drilling the Tip Ribs

Step 42: Drill and Dimple the Rivet Holes for the Trim Cable Retainer Clip Nutplates (Manual Trim Only)

The nutplates that hold the trim cable retainer clip in place are riveted to the rib/control horn stiffeners only. Referring to the subsection on "INSTALLING NUT PLATES" in "SECTION II: TOOLS AND TECHNIQUES," drill the rivet holes in the flanges of the stiffeners necessary to accommodate the nutplates. Because this material is so thin (.025), you must dimple it and the nutplates themselves to accommodate the flush rivet heads.

> **Hint** In order to dimple nutplates—a procedure you will be called on to do many times—you may have to grind the corner off the die to relieve interference between the die and the body of the nutplate.

Completed: [ ]

Step 43: Clean and Deburr All the Parts

Carefully clean and deburr all cut edges and all holes of all the elevator parts.

Completed: [ ]

Step 44: Corrosion-Proof the Elevator Interior

Corrosion-proof all interior parts as you deem necessary (see the subsection on "INTERIOR CORROSION PROTECTION" in "SECTION II: TOOLS AND TECHNIQUES"). Minimally, you should apply an aluminum cleaner and then alodize all interior parts. In addition to interior corrosion protection, we strongly recommend treating such exterior components as the control horns and attach angles, especially if you'll be operating your Sportsman as a floatplane.

Completed: [ ]

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MAIN STRUCTURE RIVETING

Step 45: Rivet the Doublers to the Forward Spar

Using 3/32" AN470AD3 universal-head rivets of the appropriate length, rivet the spar/hinge doublers to the forward spar web. **Do not rivet the holes at the rib stations.** As shown in Figure 30, the manufactured heads should be on the spar side (aft). Sequence the driving of these rivets as described in the section on "ALUMINUM SHEET METAL WORK, *Installing a Line of Rivets*" in "SECTION II: TOOLS AND TECHNIQUES."

Completed: [ ]

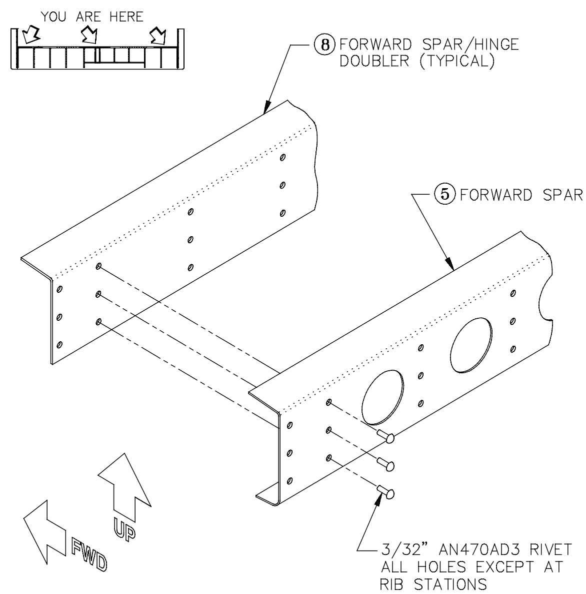

Figure 30: Riveting the Forward Spar Web Doublers

Step 46: Rivet the Trim Cable Retainer Clip Nutplates to the Rib/Control Horn Stiffeners (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions***. Return to **Step 50** in this *Assembly Manual* when the specified option steps have been completed.

Using 3/32" AN426AD3 flush-head rivets, rivet the trim cable retainer clip nutplates to the inside of the flanges of the rib/control horn stiffeners. The rivet heads should be on the stiffener side.

Completed: [ ]

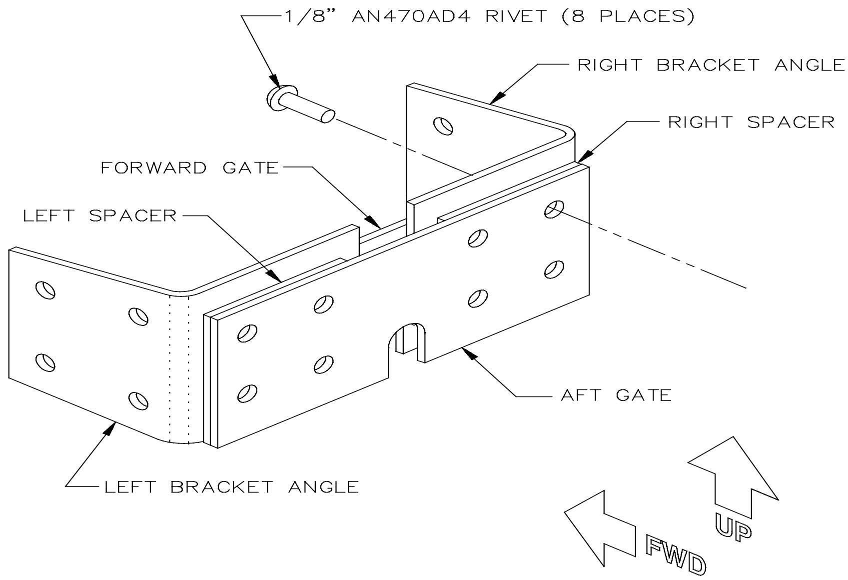

Figure 31: Riveting the Trim Cable Bracket Assembly

Step 47: Rivet the Trim Cable Bracket Assembly

(Manual Trim Only)

Using 1/8" AN470AD4 universal-head rivets, rivet together the six parts of the trim cable bracket assembly, as shown in Figure 31.

Completed: [ ]

Step 48: Rivet the Control Horn Stiffeners and Trim Cable Bracket Assembly to Ribs A and B

(Manual Trim Only)

Rivet the rib/control horn stiffeners and the trim cable bracket assembly to Ribs A and B through the four holes in each bracket angle. Use 1/8" AN470AD4 universal-head rivets. The manufactured heads should be on the outboard (rib web) side, as shown in Figure 32.

Completed: [ ]

Step 49: Finish Riveting the Control Horn Stiffeners to Ribs A and B (Manual Trim Only)

With 1/8" AN470AD4 universal-head rivets, finish riveting the control horn stiffeners to Ribs A and B through the holes forward and aft of the trim cable bracket. The rivet heads should be outboard, as shown in Figure 32.

Completed: [ ]

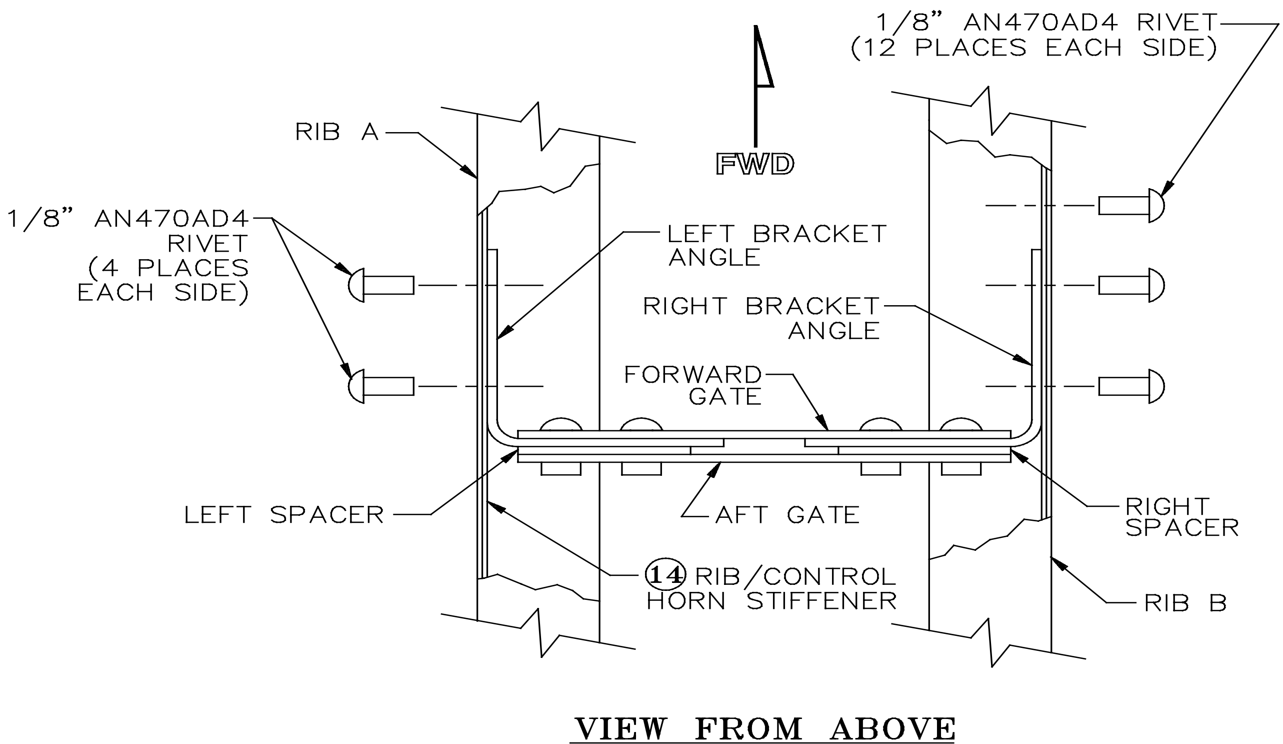

Figure 32: Riveting the Control Horn Stiffeners and Trim Cable Bracket Halves

Step 50: Rivet the Attach Angles to the Control Horns

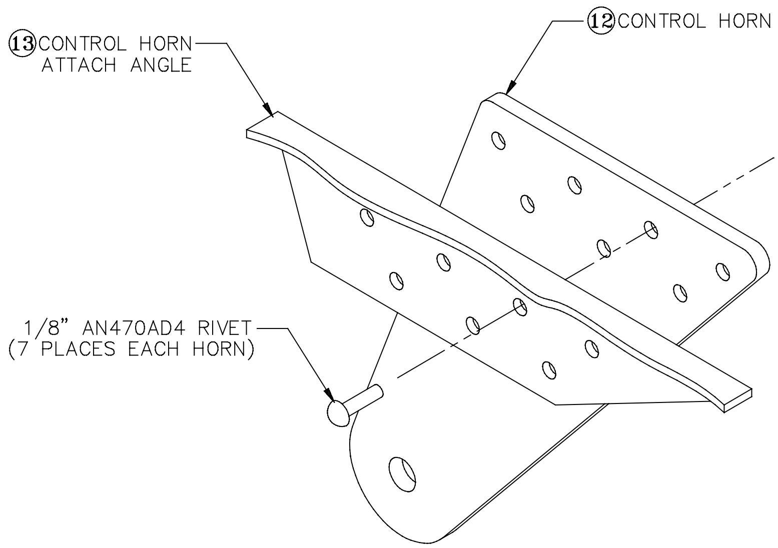

Figure 33: Riveting the Attach Angles to the Control Horns

Use 1/8" AN470AD4 universal-head rivets to rivet the attach angles to the control horns. Make sure you rivet the horns inboard of the angles. As shown in Figure 33, the manufactured heads should be on the angle side (outboard).

Completed: [ ]

Step 51: Rivet the Inboard Ribs to the Aft Partial Spar

Using 3/32" AN470AD3 universal-head rivets, rivet the four inboard ribs to the aft partial spar. Refer to Figure 1 to confirm the proper orientation of the rib flanges. As shown in Figure 34, the manufactured heads should be on the spar side (aft).

Completed: [ ]

Step 52: Rivet Ribs C and D to the Aft Partial Spar

Rivet Ribs C and D to the ends of the aft partial spar with 3/32" AN470AD3 universal-head rivets. Be sure the rib flanges point outboard at each end. As shown in Figure 34, the manufactured heads should be on the spar side (inboard).

Completed: [ ]

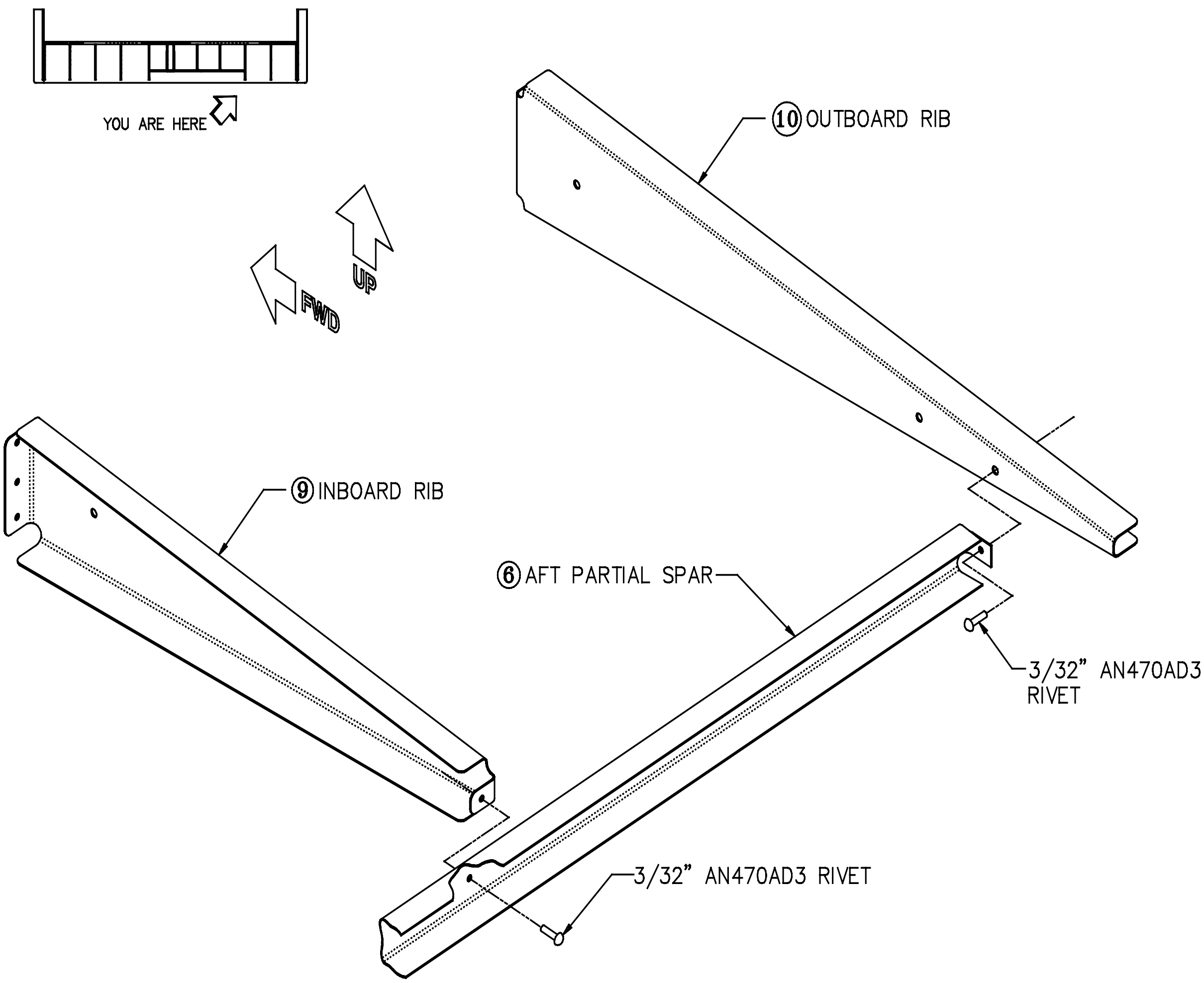

Figure 34: Riveting the Ribs to the Aft Partial Spar

Step 53: Rivet the Upper Skins to the Ribs (Manual Trim Only)

Electric Trim Option If you are installing electric trim, **skip this step and turn to the *Electric Trim Option Instructions*.** Return to **Step 54** in this *Assembly Manual* when the specified option steps have been completed.

☞

Rivet the upper skins to the ribs using 3/32" AN470AD3 universal-head rivets. In the areas where the ribs have been riveted to the partial spar, follow procedures for riveting control surface skins to their underlying framework: begin with a rivet in one corner, then a rivet in the opposite corner, then a rivet somewhere in the middle. Establish a pattern in which you are always riveting approximately in the middle of the remaining unriveted area. When you get to the outboard ribs that are not attached to the aft partial spar, pay careful attention to the orientation of the flanges, as shown in Figure 1. For each of the unattached outboard ribs, follow procedures for installing a line of rivets: rivet at the ends and the middle of the line, and then rivet in the middle of unriveted areas until the line is finished.

Note At this time **do not** rivet the skins to the aft partial spar. These rivets also secure the trim tab hinges, and will be driven in subsequent steps.

Completed: [ ]

Step 54: Rivet the Tip Ribs to the Outermost Ribs

Slide the tip ribs into position against the outermost ribs and rivet them in place with 3/32" AN470AD3 universal-head rivets, as shown in Figure 35.

Completed: [ ]

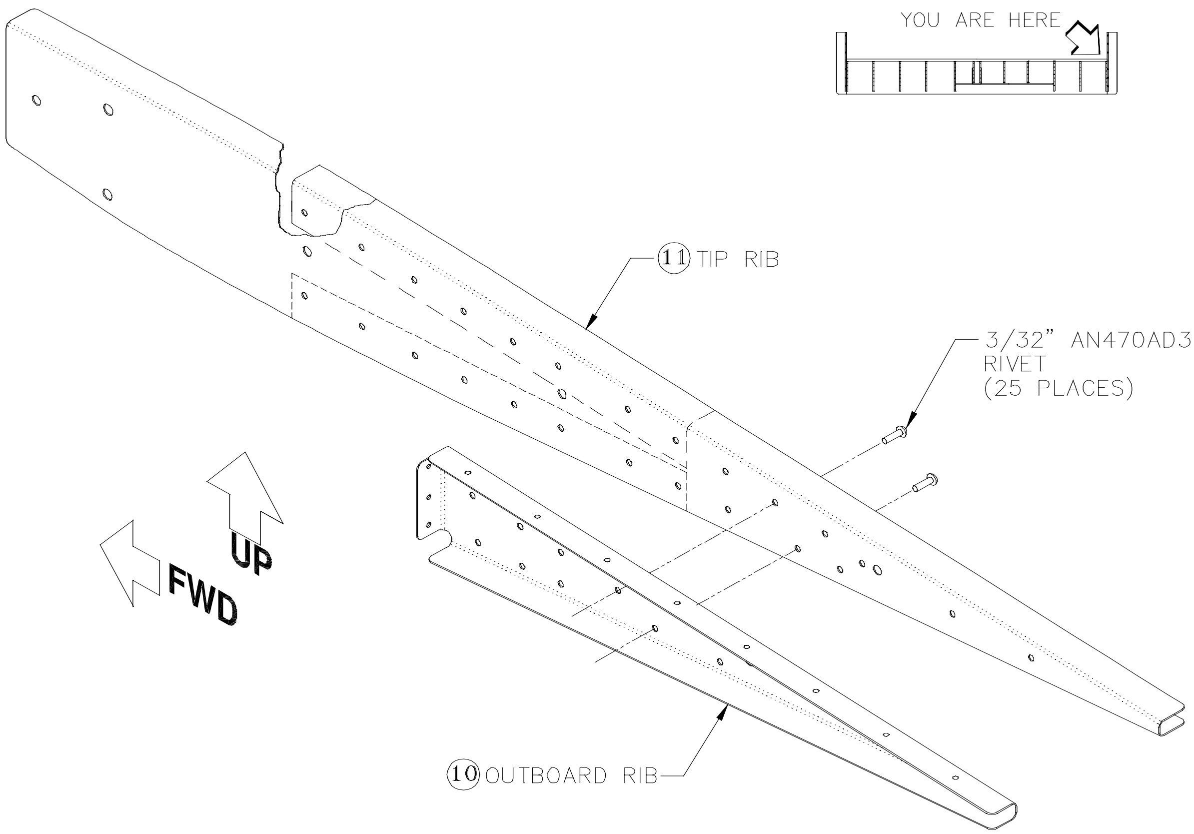

Figure 35: Riveting the Tip Ribs

Step 55: Rivet the Control Horn Assemblies and the Lower Skins to Ribs A and B

Use 1/8" AN470AD4 universal-head rivets to rivet the overlapped lower skins and the control horn assemblies to the forward ends of Ribs A and B. The forward spar need not be in place at this time. Refer to Figure 36 to ensure that you have the horn assemblies properly oriented.

> **Note** The forward-most hole in each attach angle goes through the skins and the forward spar. Since the spar will not be riveted into place for another few steps, rivet **only the aft four holes** on each attach angle at this time.

Riveting this area requires placing the bucking bar in a relatively tight space. You will have to reach inside the elevator structure to hold the bar in place with your fingertips. Remember, however, to use as heavy a bar as is practical. For each rib, follow standard procedures for installing a line of rivets.

Completed: [ ]

Step 56: Rivet the Lower Skins to the Aft Partial Spar and the Ribs

As shown in Figure 36, use 3/32" AN470AD3 universal-head rivets to rivet the skins to the remaining ribs at the first three holes on each rib. Rivet the remaining holes with 1/8" AAPQ-42 blind rivets. At the same time, use 3/32" AN470AD3 universal-head rivets to rivet the skins to the aft partial spar. Use a rivet squeezer here if you have one. Sequence the driving of these rivets as discussed in "SECTION II: TOOLS AND TECHNIQUES" under the heading "ALUMINUM SHEET METAL WORK, *Installing a Line of Rivets*": begin with a rivet in one corner of the area to be riveted, then a rivet in the opposite corner and one somewhere in the middle. Continue riveting approximately in the middle of unriveted areas until finished.

> **Note** Don't forget to blind rivet the unriveted aft holes in Ribs A and B.

Completed: [ ]

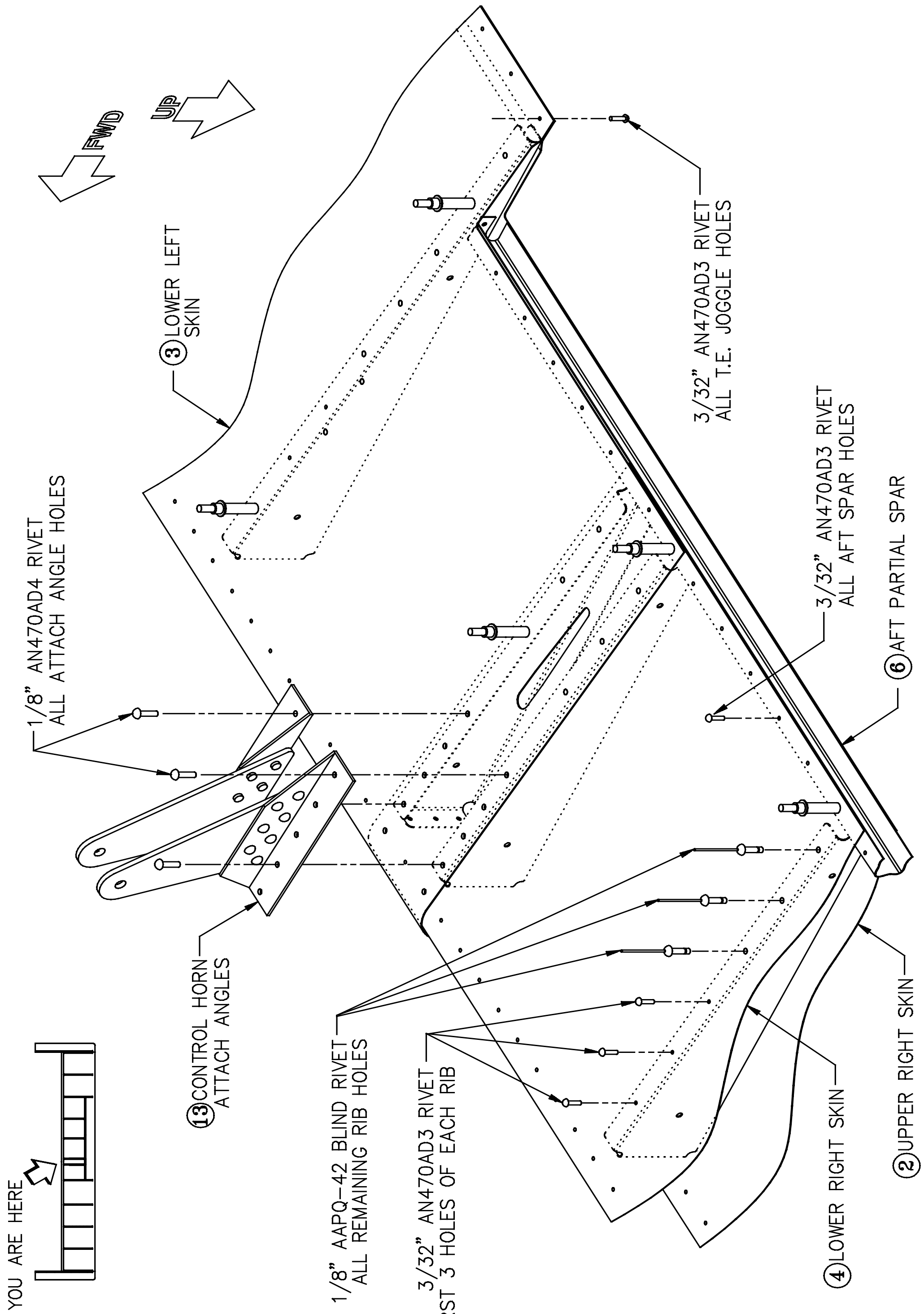

Figure 36: Riveting the Control Horn Assemblies and Lower Skins to the Ribs and Aft Partial Spar

Step 57: Rivet the Trailing Edge Joggles

Use 3/32" AN470AD3 universal-head rivets to rivet the upper and lower skins together along the trailing edge. As shown in Figure 36, the manufactured heads should be on the upper skin. Carefully avoid overdriving these rivets, as this will result in a wavy trailing edge. Two long angles and an epoxy adhesive as mentioned in the rudder section can be used here as well! It really helps in keeping a straight line across the gap where the trim tab will go. Do not overdrive!

Completed: [ ]

Step 58: Rivet the Forward Spar to the Ribs

Finish the basic elevator assembly by riveting the forward spar to the ribs with 1/8" AAPQ-42 blind rivets, as shown in Figure 37. The same length rivet is used whether you are riveting through both the spar and a hinge doubler or just through the spar. Be sure the spar is right-side up before you slide it between the upper and lower skins, and be careful to avoid crimping the skin leading edges.

Completed: [ ]

Step 59: Rivet the Lower Skins and Control Horn Attach Angles to the Forward Spar

Now that the forward spar is riveted in place, rivet the lower skins to the spar using 3/32" AN470AD3 universal-head rivets. Observe proper sequencing procedures in driving these rivets.

> **Note** The two holes in this line that go through the control horn attach angles require **1/8"** AN470AD4 universal-head rivets.

Completed: [ ]

Step 60: Tape the Lightening Holes in the Forward Spar

Apply strips of **2"-wide aluminum tape** [24] to the web of the forward spar to seal the lightening holes.

Completed: [ ]

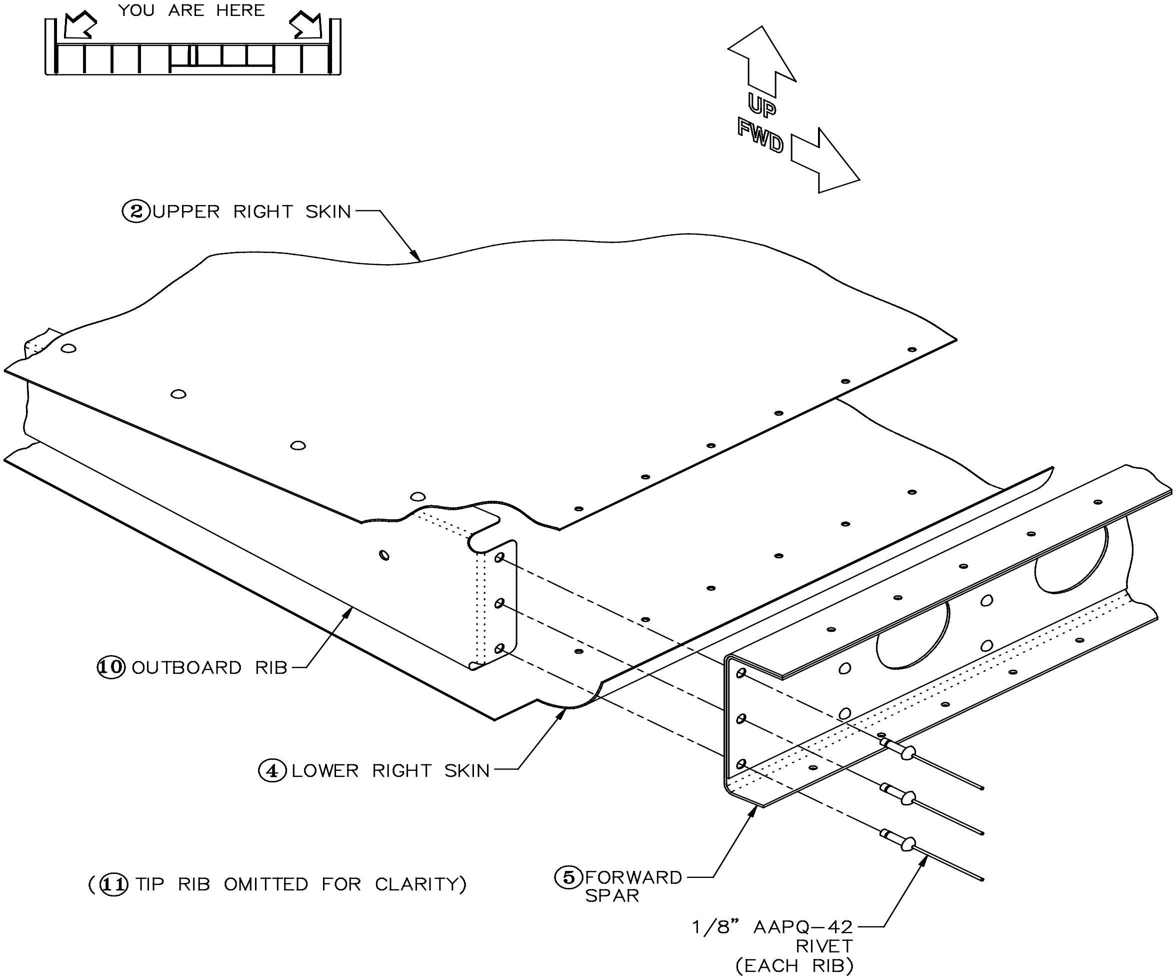

Figure 37: Riveting the Forward spar to the Ribs

Trim Tab

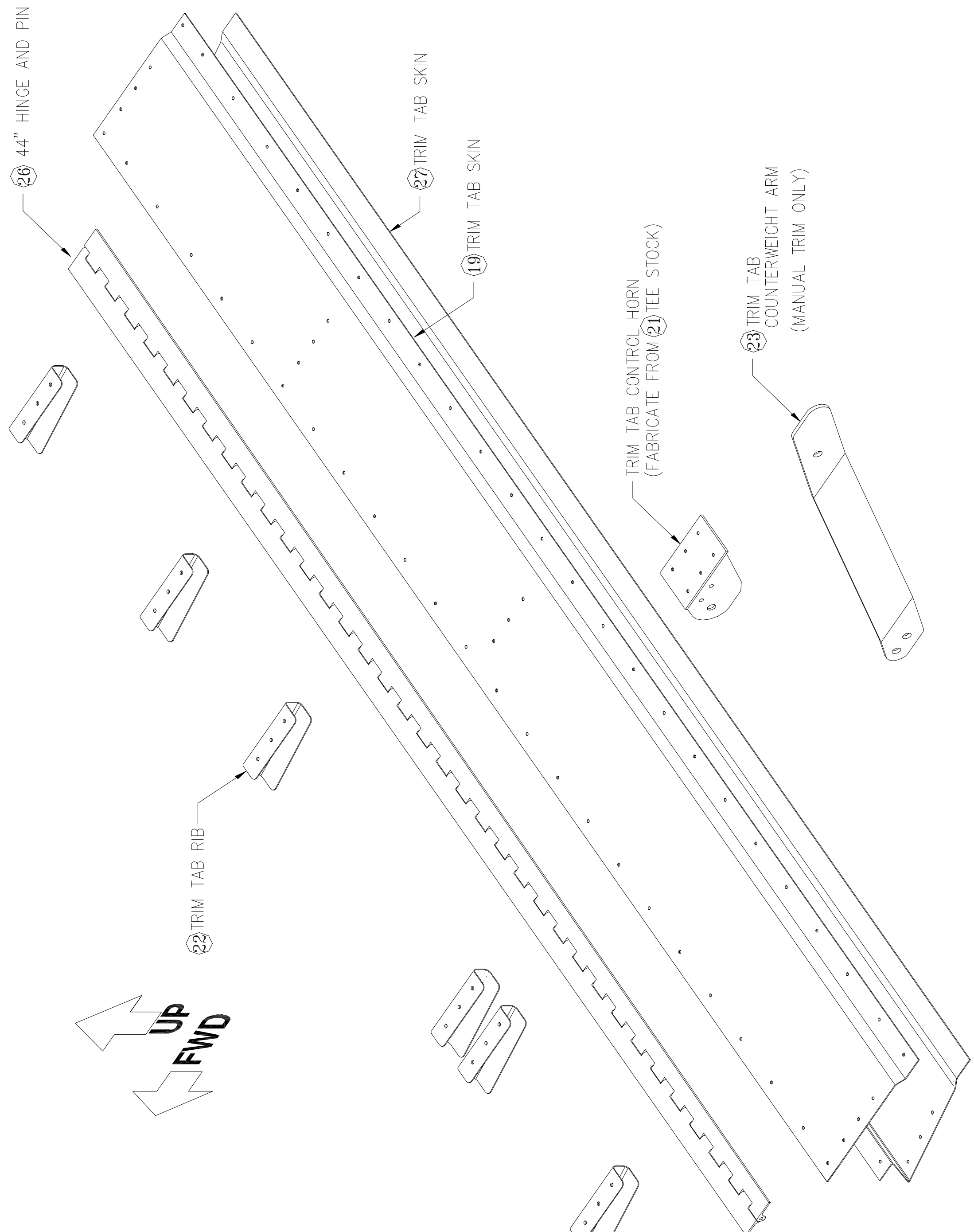

Figure 38: Trim Tab Assembly

Step 61: Fabricate the Control Horn and Counterweight Arm

Note The trim tab counter weight arm is necessary for **manual trim installations only.** Builders installing electric elevator trim omit all work involving the **trim tab counterweight arm.** See Fig. 40 for fabrication of the Electric Trim Tab Control horn.

Next, fabricate the trim tab control horn from the 3-1/2" length of **.050" X 1-1/4" X 1-1/2" aluminum tee** [21] stock according to the dimensions shown in Figure 39.1a. Use a bandsaw to cut out the basic shape, and then finish the rough edges with a file and/or a belt sander.

Hint To hold the part perpendicular to the saw blade, place it over a scrap of 2X4 with the wider flange flat against the wood and the narrower flange hanging over the edge.

Mark and drill the six holes on the wider flange, as shown in Figures 39.1a and 39.1b; the single **#10** hole will accommodate the pushrod bolt, while the five **#40** holes will be used to rivet the **trim tab counterweight arm** [23] to the horn. Finally, mark and drill the six hole locations shown in Figure 39.1c with a **#40 bit**.

The counterweight arm comes pre-bent, but you must drill holes for the pushrod and counterweight attach bolts, as well as radius the corners of the arm. Figure 39.2 shows the locations of the three **#10** holes. Note that the **longer** of the two parallel faces of the arm is the **upper** one, and this is where the pushrod hole should be drilled.

Completed: [ ]

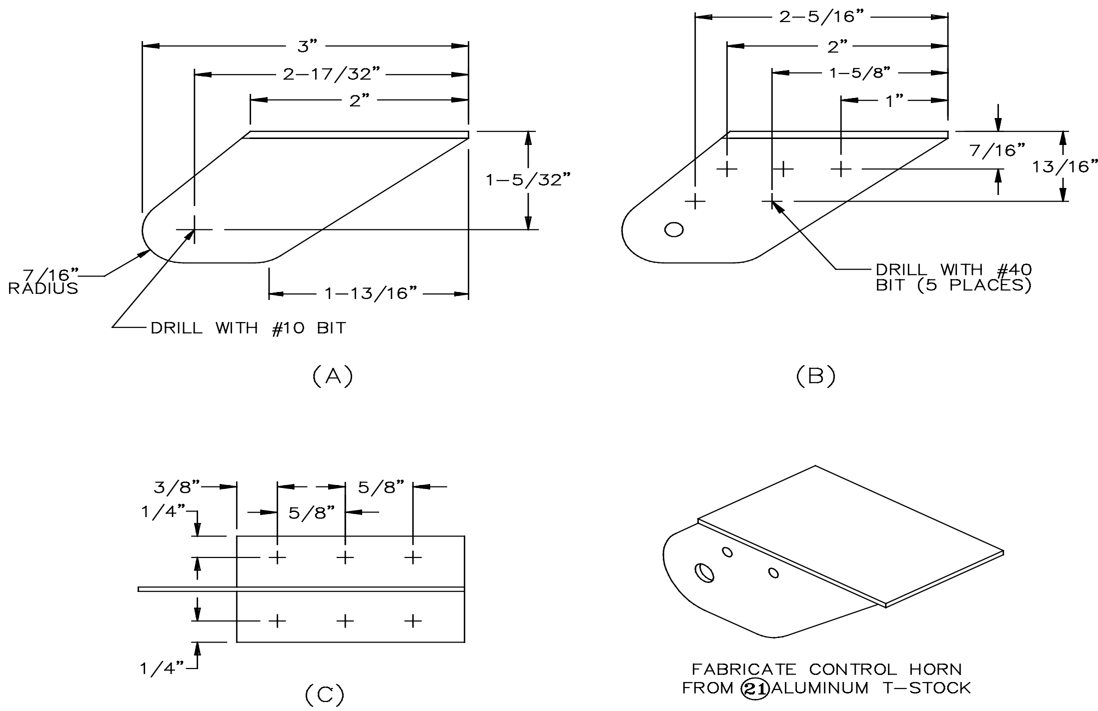

Figure 39.1: Fabricating the Trim Tab Control Horn-Manual Trim

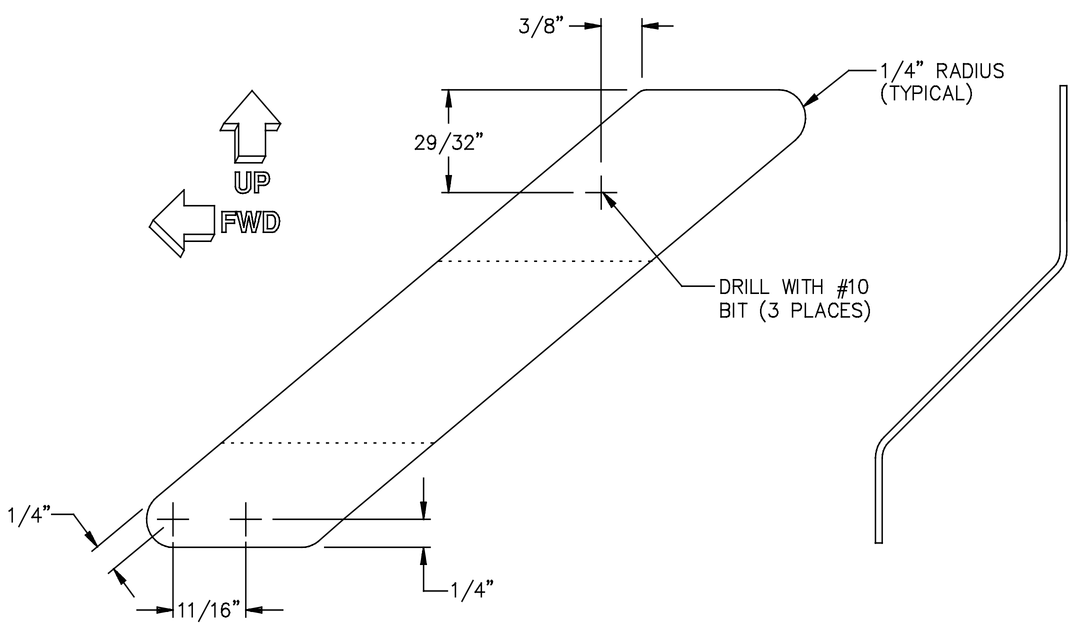

Figure 39.2: Fabricating the Trim Tab Counterweight Arm-Manual trim

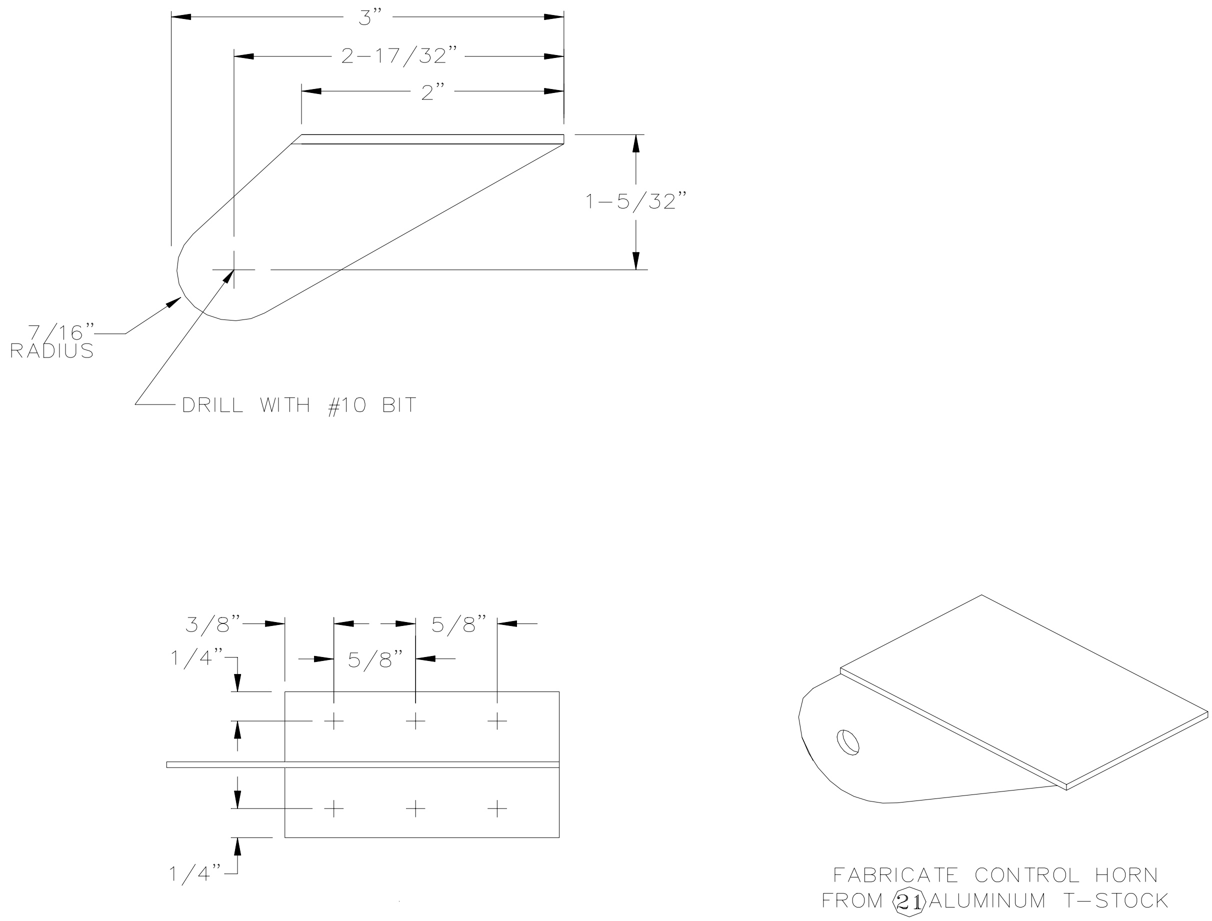

Figure 40: Electric trim Horn

Step 62: Position and Drill the Ribs and Skins

Because there are no pre-punched skin holes in the **ribs**, you have to assemble the skins together and position the ribs for a best fit. Start by Clecoing the upper and lower skins together using the matched holes on the hinge line. Lay the assembly on a flat table. Position a rib between the two skins on the outboard end and move it until you are satisfied with the profile match. Pass drill through each rib flange from the upper skin and then repeat from the lower skin. Repeat this procedure for all the ribs with the exception of the two ribs which are common to the control horn.

On the upper skin, mark two centerlines at 9.25 and 10.0 inches in from the left end of the skin for two more rivet centerlines. These are the rivet locations for the upper half of the ribs for the control horn. Make small tick marks at the same hole locations as the other rib locations. Do the same on the lower skin again at the same 9.25 and 10.0 inch dimensions. Additionally, mark a line at 10.25 inches in from the left end.

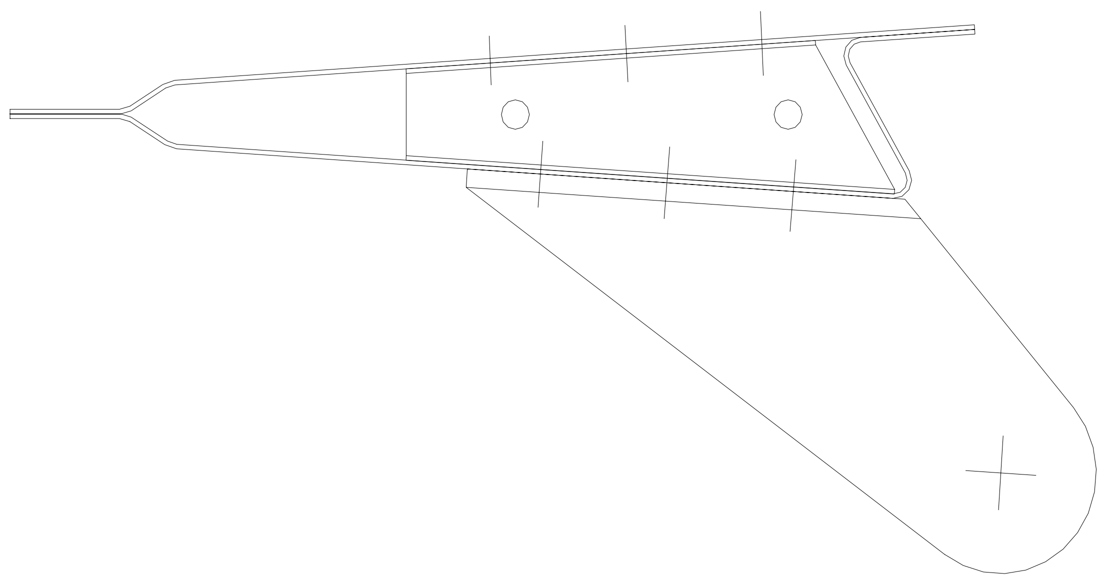

Figure 41: Trim Tab Assembly

Step 63: Position and Drill the Control Horn

Two ribs sit above the control horn as shown in Figure 41 and these are located no differently than the previous ribs. But because you drill from the horn side first, you cannot see the hole locations in the skin. Drill through the upper skin with a **#30** bit at each of the six rivet locations you marked. Set the ribs at the same fore and aft location as the other ribs while lining up the rib centerlines, pass drill through the ribs. When the holes have been drilled through the upper skin and the upper half of the rib, clamp them together with a pair of Clecos.

Next, turn over the assembly and position the horn until the corner is flush with the corner of the trim tab as shown in Figure 41 and the two centerlines you marked in the previous step are visible through the six holes or the edge of the tee is aligned with the line at 10.25". When all is in position, drill the six locations with a **#40** bit.

Completed: [ ]

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Step 64: Drill the Trim Tab Counterweight Arm

Note Step 64 applies to **m**anual trim installations only

To eliminate the possibility of dangerous trim tab flutter in the event that the trim control linkage is severed, it is necessary that the tab be balanced by means of a counterweight hung forward of the hinge line. This weight is suspended from the **trim tab counterweight arm** [23], which is riveted to the trim horn.

Use a standard, hardware-store 3/16" hex bolt and nut to temporarily fasten the counterweight arm to the trim horn, as shown in Figure 42. Be certain to attach the arm to the **right** side of the horn. Pivot the arm around the bolt as necessary to make the top edge of the arm parallel to the flange of the horn, and then tighten the nut and bolt to secure it in place. Drill each of the five rivet holes through both the arm and the horn with a **#30** bit.

Completed: [ ]

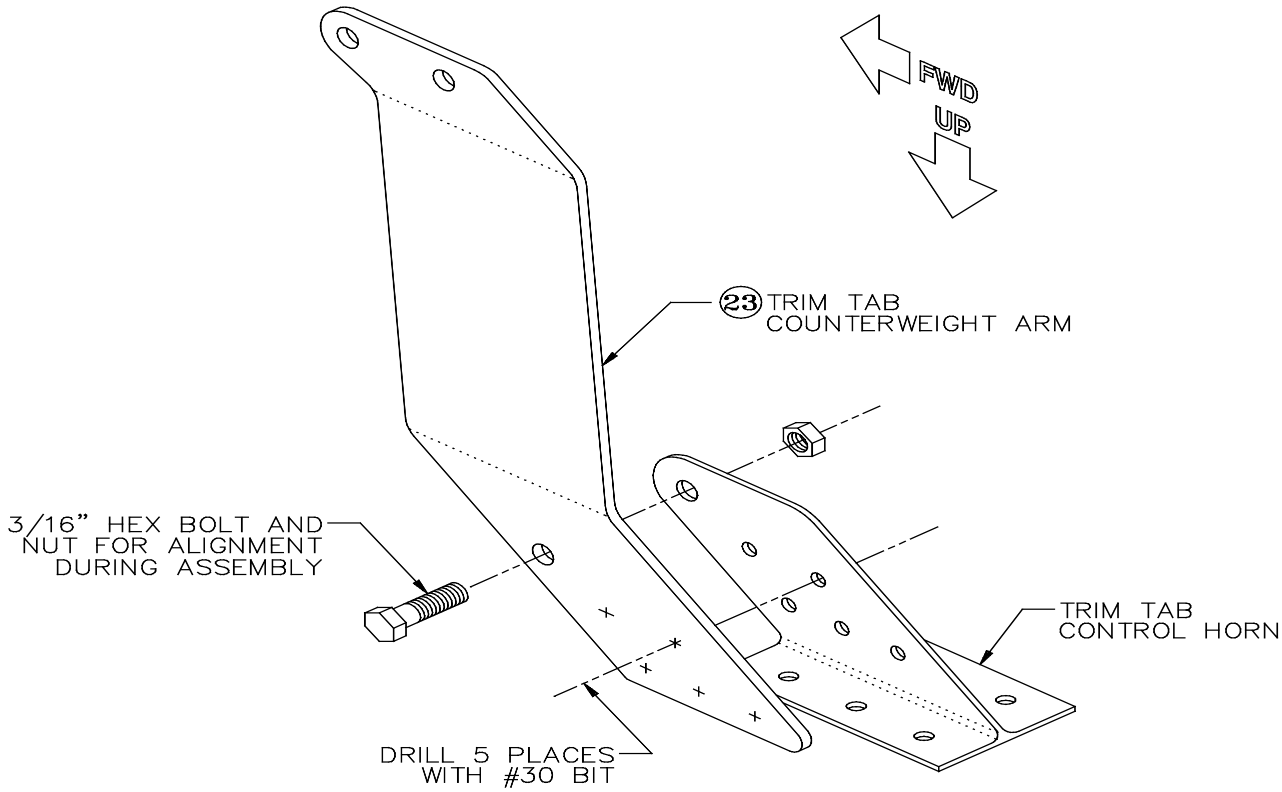

Figure 42: Drilling the Trim Tab Counterweight Arm

Step 65: Clean and Deburr All the Parts

Disassemble the trim tab and carefully clean and deburr all cut edges and all holes of all the parts. If you are planning on flush riveting the trim tab, the skins and ribs will have to be dimpled at this time. The control horn can be countersunk.

Completed: [ ]

Step 66: Corrosion-Proof the Trim Tab Interior

Corrosion-proof all interior parts as you deem necessary (see "INTERIOR CORROSION PROTECTION" in "SECTION II: TOOLS AND TECHNIQUES"). Minimally, we recommend treating the rib flanges and the zee rib webs.

Completed: [ ]

TRIM TAB RIVETING

Step 67: Rivet the Trim Tab Ribs to the Upper Surface

Rivet all the trim tab ribs to the upper skin with 3/32" AN470AD3 universal-head rivets with the exception of the two ribs common to the control horn. Do not rivet these at this time.

Completed: [ ]

Step 68: Rivet the Control Horn and Ribs to the Lower Skin

Install the control horn and the two ribs to the lower skin. Rivet these with 3/32" AN470AD3 universal-head rivets.

Completed: [ ]

Step 69: Rivet the Remaining Rib/Skin Holes

Assemble the lower skin to the upper skin and cleco the matching holes along the hinge line and trailing edge and the remaining rib locations. . Then use 1/8" AAPQ-42 blind rivets to rivet the remaining holes in the rib locations.

Note To make sure that it remains straight and untwisted, hold the trim tab against a flat surface while riveting.

Completed: [ ]

Step 70: Rivet the Trailing Edge of the Trim Tab Skin

Place the upper surface on a flat table with the trailing edge overhanging the edge of the table. Use the epoxy adhesive method and two aluminum angles to clamp the trailing edge straight if you choose. After that has cured, rivet the trailing edge with 3/32" AN470AD3 universal-head rivets.

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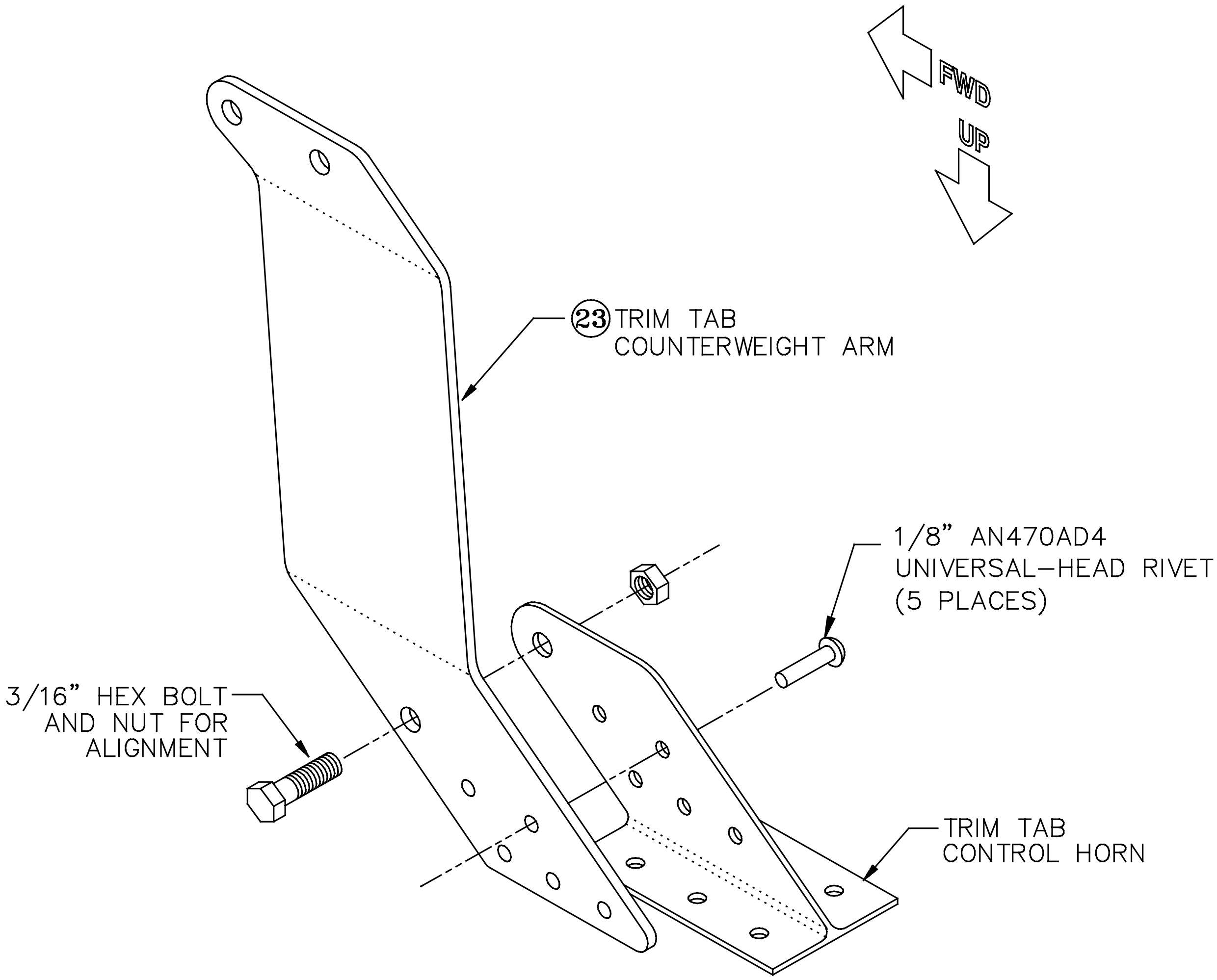

Figure 43: Riveting the Counterweight Arm to the Trim Horn

Step 71: Rivet the Counterweight Arm to the Trim Horn

With 1/8" AN470AD4 universal-head rivets, rivet the counterweight arm to the **right** side of the trim horn. As shown in Figure 43, the rivet heads should be on the horn side.

Completed: [ ]

ELEVATOR HINGES

Warning There are two types of piano hinge supplied in the Sportsman kit, "rolled" and "extruded"; they are **not** interchangeable. Make sure that you use the **rolled** hinge material for the **trim tab hinge** and the **extruded** hinge material for the **elevator hinges**. The two different types of hinge can easily be distinguished by noting the part numbers marked or stamped on them, or by observing the hinge knuckles. The **rolled** hinge is marked with P/N **MS20257**; furthermore, it will be obvious upon inspection that the hinge knuckle was formed by rolling up a flat piece of metal. The **extruded** hinge is marked with P/N **MS20001** and looks like the hinge shown in Figure 43: the knuckles flow smoothly into the flat part of the hinge without gaps.

Step 72: Cut the Elevator and Trim Tab Hinges to Length

Remove the pin from the **44" length of rolled hinge** [26] stock and separate the halves; the hinges will be cut one half at a time. As shown in Figure 44, each end of each hinge should fall roughly in the middle of one of the "knuckles." So, first, select one half of the hinge stock and cut off one end in the middle of the first "knuckle." From that freshly cut end, measure, mark and cut off a **40"** length. This will be the trim tab hinge.

Hint The hinge stock can be cut easily with a hacksaw if the stock is held in a bench vise. A bandsaw or scroll saw with a fine-toothed wood-cutting blade will also do a smooth job of cutting the aluminum hinge stock. But don't try using it on the hardened steel hinge pin—the pin will win!

Next, lay the 40" half flat on the bench and slide it together with its mate (the remaining 44" half), with the loops up on both halves. Mark the 40" length on the second half, using the cut 40" half as a guide. Cut the second half to the marked length.

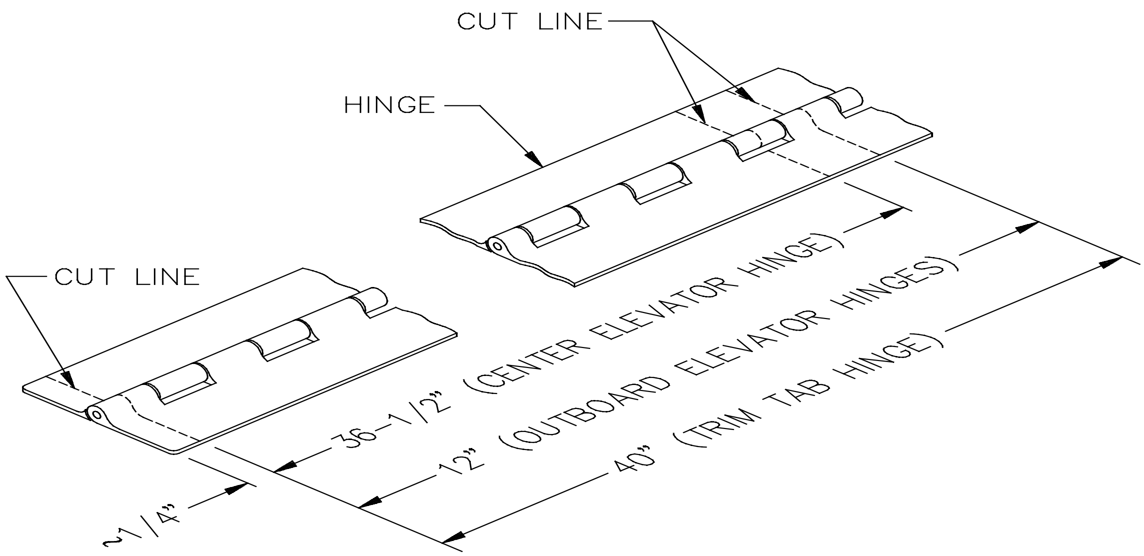

Figure 44: Cutting the Hinges

Repeat this process on the **72" length of extruded hinge stock** [25], cutting one **36-1/2"** hinge (elevator center) and two **12"** hinges (elevator outboard). (The 36-1/2" length will begin in the middle of the knuckle of one hinge half and end in the middle of the knuckle of the opposite half.) Be sure to mark both halves of both 12" pairs so that each half can be reunited with its original mate.

After all four hinge pairs have been cut to length, use a fine file to smooth the cut ends and, if necessary, a deburring tool to deburr the inside of the pin hole. Also, round each sharp corner slightly, as shown in Figure 43.

Completed: [ ]

Step 73: Cut and Bend the Hinge Pins

From the 44" length of hinge pin, cut a piece **41-1/2"** long. Use a pair of heavy-duty wire cutters to make the cut. From the 72" length, cut two pieces **13-1/2"** long and two pieces **19-1/4"** long. Use a fine file or a bench grinder to smooth the cut ends; bringing them to a slight point is fine and will make it easier to reinsert them into the hinges.

A 90° bend must be put in one end of each pin to fit the hinge-pin retainers. Tighten each pin securely in a bench vise with **3/4"** of it protruding perpendicularly above the jaws. Using a small hammer as close to the top of the jaws as possible, pound the end of the pin over until it is parallel with the floor. Try to keep the radius of the bend as small as possible, i.e. keep the bent end of the pin as straight as possible.

Completed: [ ]

Step 74: Position the Elevator Hinges and Drill Index Holes

In positioning the hinges there are a number of goals to be met, as follows:

A) Adequate edge margins must be maintained for all rivet holes with respect to the skins, the spar flanges, the doubler (in the case of the elevator) and the hinge stock.

B) The gap between the upper stabilizer skin and the upper elevator skin must be kept as small as is practical, but neither skin can come closer than **1/16"** to the hinge centerline (for a total minimum gap of **1/8"**). Gaps smaller than this will impede full elevator up travel.

Achievement of these two goals takes precedence over any particular dimension given in the manual.

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Make marks along the upper leading edge of the elevator **3/16"** from each end of the forward spar. These marks indicate the outboard end points of the outboard hinges. Make an additional mark **41-7/8"** from one end of the forward spar; it doesn't matter which end you measure from. This mark indicates the end point of the center hinge.

Figure 45 shows how the elevator hinges are aligned fore-and-aft, with the bottoms of the "knuckle" slots approximately **1/32"** aft of the leading edge of the elevator skin. Position half of each elevator hinge under the upper spar flange, aligning it spanwise on the reference mark you just drew and fore-and-aft on the leading edge of the skin, as shown in the figure. Clamp in place with a side-grip at each end, as shown in the figure.

Caution This is one of the most critical alignments in the entire Sportsman empennage. With the hinges clamped at each end, double check to make sure that they are all aligned as precisely as possible on the elevator leading edge and—even more importantly—with one another. You may find it useful to stretch a string along the hinge line to detect any small misalignments. Readjust the clamps as necessary.

When you are satisfied with the alignment of the hinges, use a **#30** bit to drill **one** hole near the center of each hinge, using the nearest pre-punched skin hole as a guide. Insert a Cleco in each hole and remove the side-grips.

With the elevator-side hinge halves Clecoed in place, mount the stabilizer-side hinge halves on their respective mates using the pins you cut in the preceding step.

Completed: [ ]

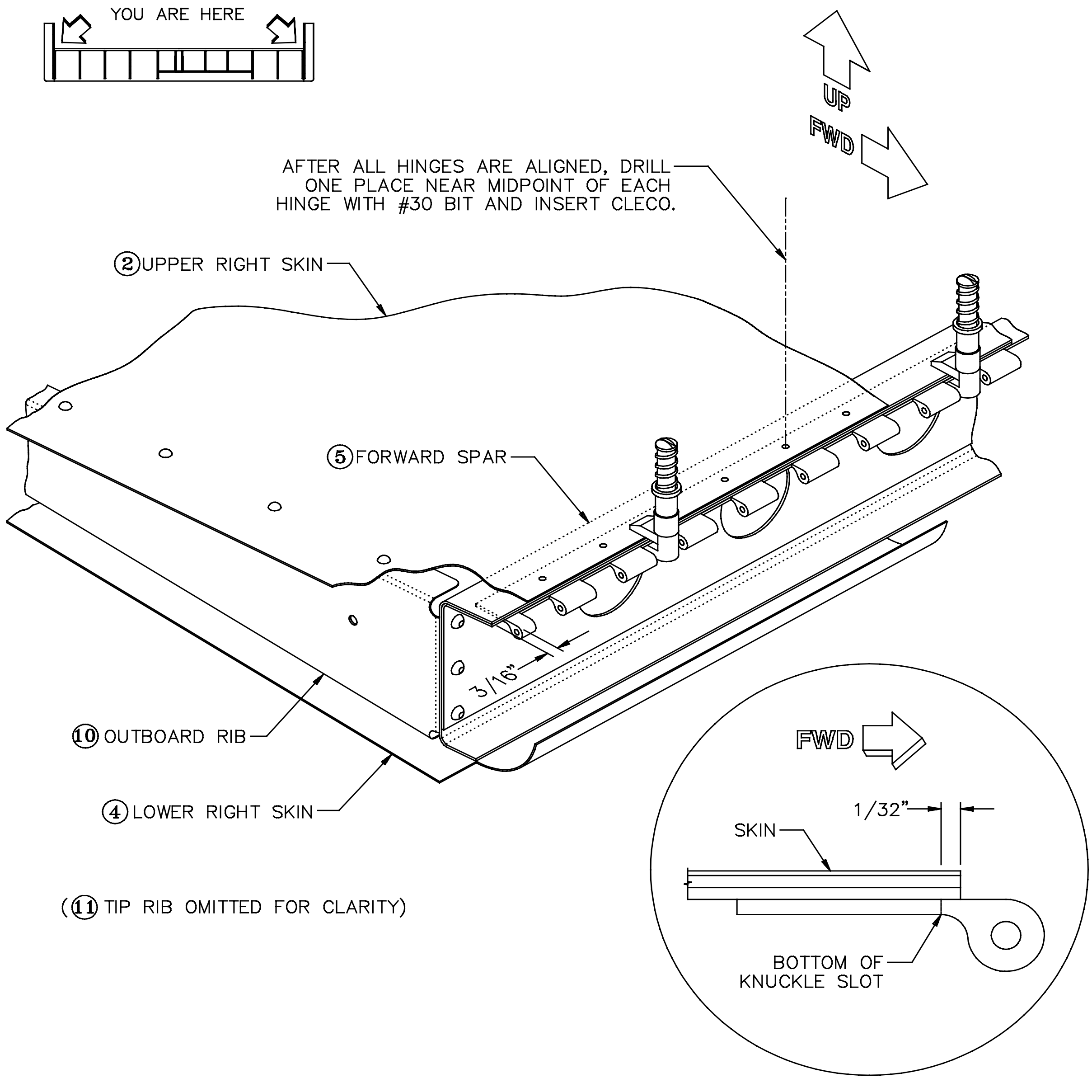


Figure 45: Aligning and Drilling the Elevator-Side Hinge Halves

Step 75: Position the Elevator Behind the Stabilizer and Align the Hinges on the Aft Spar

In this step, you will temporarily mount the elevator on the horizontal stabilizer. This and the subsequent couple steps are somewhat tricky, but the most important requirements are simply patience and diligence.

First, you need to arrange some supports that will hold the stabilizer and elevator flat and right-side up above the bench, providing clearance underneath for the elevator control horns. A pair of 24" long 2 X 6s—one at each end of the stabilizer—oriented chordwise will do the trick nicely. It's not important that the stabilizer be precisely level, only that it be firmly supported a couple inches off the bench top.

With the stabilizer supported on the bench, ease the elevator into position behind the stabilizer with the elevator tip ribs projecting forward alongside the outermost stabilizer ribs. Note that the elevator is 3/8" longer than the stabilizer. However, because you set the outboard elevator hinges 3/16" from each end, the outboard ends of the hinges should align with the outboard ends of the stabilizer. As shown in Figure 46, place the flanges of the stabilizer-side hinge halves against the **underside** of the stabilizer upper aft spar flange.

Make final adjustments as necessary to bring all three hinges into precise alignment with the trailing edge of the stabilizer. As on the elevator side, the bottoms of the stabilizer-side "knuckle" slots will, ideally, fall approximately **1/32" forward** of the trailing edge of the upper skin of the stabilizer, thus leaving a gap between the stabilizer and elevator of approximately **3/16"**.

Hint A good way to align the hinges is to insert a 3/16" piece of wood or metal into the gap between the stabilizer and elevator just inboard of the outboard hinges and then push the elevator forward until the gap closes tightly on the pieces at both ends. Also, the stabilizer hinge halves must be held tightly against the underside of the spar flange for drilling the initial index holes (described in the following step). One way to do this is to cut small blocks of wood just the right length to wedge between the hinge halves and the lower spar flange. Place the blocks near the center of each hinge.

Completed: [ ]

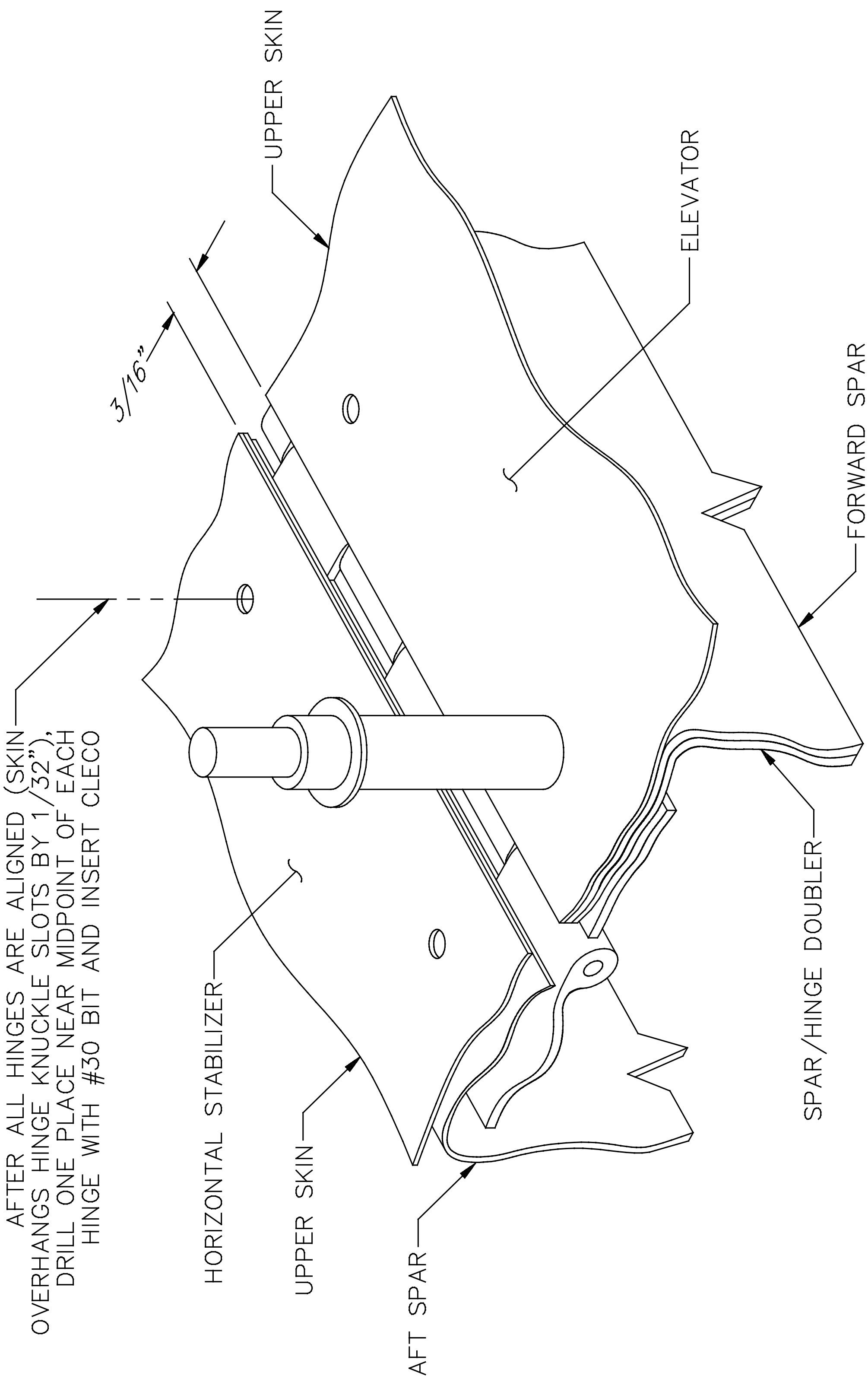


Figure 46: Aligning and Drilling the Stabilizer-Side Hinge Halves

Step 76: Drill Index Holes in the Stabilizer-Side Hinge Halves

When you are satisfied that the outboard hinges are aligned, use a **#30** bit to drill **one** hole through the skin, hinge and spar near the center of each hinge. Make sure that the location you pick is staggered at least a Cleco's width from its opposite number on the elevator-side.

Completed: [ ]

Step 77: Drill the Final Hinge Alignment Holes

With each hinge held to the stabilizer with one Cleco, fold the elevator upward until it is in a near-vertical position (approximately perpendicular to the stabilizer. This motion will cause the hinges to pivot minutely around the Clecos as necessary to bring the hinges into final alignment.

With the elevator in this vertical position, drill **one** stabilizer-side hole at **each** end of each hinge with a **#30** bit. Cleco after drilling. With Clecos at each end of each hinge on the stabilizer side, you can lower the elevator to rest on supports.

> **Note** Firm contact must be maintained between the hinge halves and the underside of the spar flange while drilling these holes. Have a helper insert a wooden stick into the hinge gap from below and push against the stabilizer hinge half to support it while drilling. Or use the wedges described in the hint in Step 75 to support the hinge halves against the pressure of your drill.

Completed: [ ]

Step 78: Drill the Remaining Holes

With each hinge Clecoed at three points on the stabilizer side and one point on the elevator side, they are effectively locked into position. Now you can go ahead and drill all the remaining holes along the stabilizer trailing edge and the elevator leading edge with a **#30** bit. Don't forget to re-drill the holes you drilled previously at each rib location; these were drilled with a #40 and must now be brought up to final size. Cleco these holes as you go.

When all the drilling is completed, remove the Clecos, separating the elevator from the stabilizer and removing both halves of each hinge from their respective assemblies. Thoroughly clean and deburr all the holes in the hinge parts and in the stabilizer and elevator assemblies.

Completed: [ ]

TRIM TAB HINGE

Step 79: Position the Trim Tab Hinge and Drill an Index Hole

The main goals in positioning the trim tab hinge are as follows:

A) It is most important to maintain proper edge margins for all rivet holes with respect to all parts.

B) The gap between the upper elevator skin and the trim tab skin must be as small as is practical, but neither skin can come closer than **1/16"** to the hinge centerline (for a total minimum gap of **1/8"**). Gaps smaller than this will impede full trim tab travel.

C) The trim tab must be held straight and untwisted while drilling the hinge rivet holes.

Achievement of these three goals takes precedence over any particular dimension given in the manual.

As shown in Figure 47, make a mark along the upper leading edge of the trim tab **3/4" outboard** of the **fourth hole from the right-hand end**. This mark indicates the outboard end point of the trim tab hinge.

The trim tab hinge is aligned just like the elevator hinge. Position half of the hinge under the upper surface overhang, as shown in Figure 47, aligning it spanwise with its outboard end on the reference mark and fore-and-aft with the bottom of its "knuckle" slots about **1/32" aft** of the leading edge of the skin. Clamp in place with side-grips or small C-clamps near each end. Double check to make sure that the hinge is aligned as precisely as possible on the trim tab leading edge. Readjust the clamps as necessary.

When you are satisfied with the alignment of the hinge, use a **#40** bit to drill **one** hole near the center of the hinge. Insert a Cleco in the hole and remove the side-grips or C-clamps.

With the trim tab-side hinge half Clecoed in place, mount the elevator-side half on its mate using the pin you cut previously.

Completed: [ ]

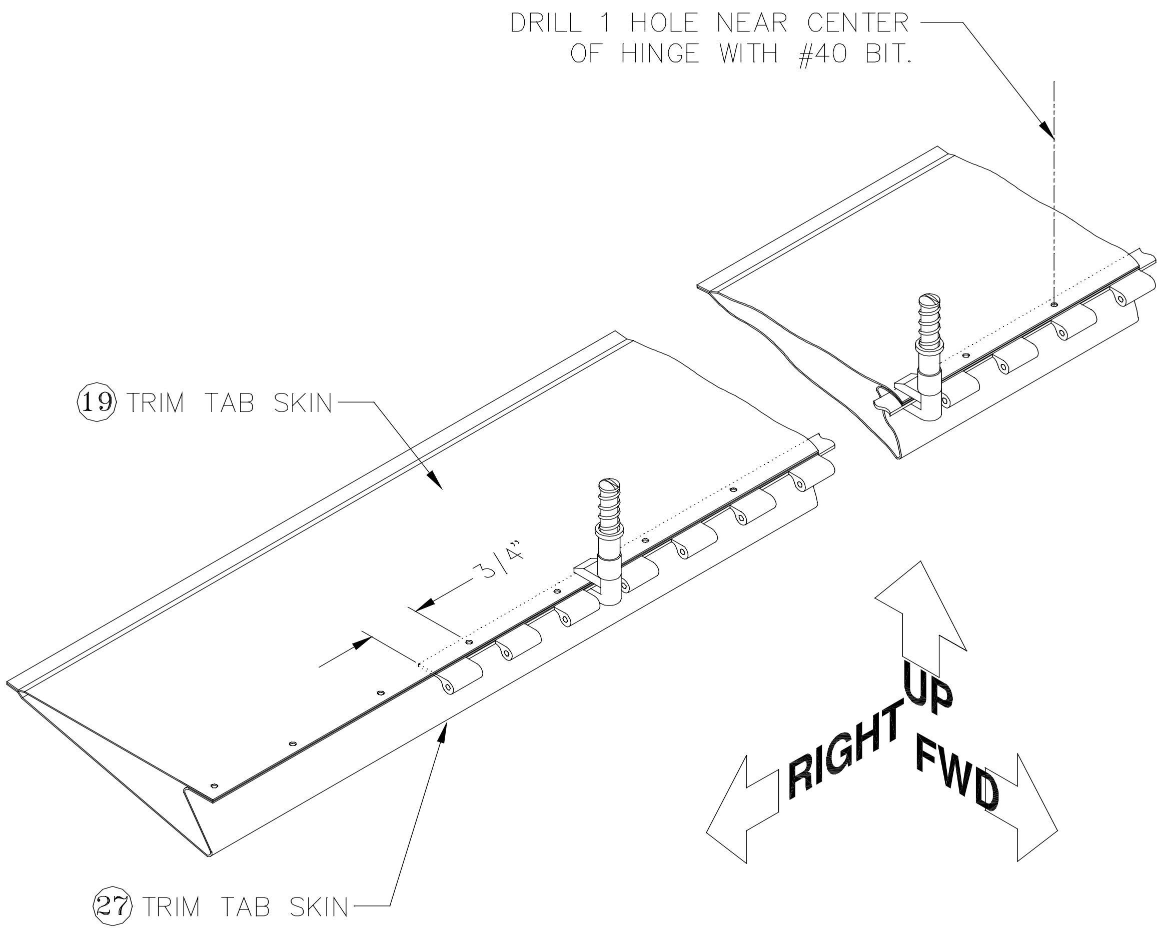


Figure 47: Aligning and Index Drilling the Trim Tab Hinge

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99:

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Step 80: Align the Hinge on the Elevator Side and Drill an Index Hole

To align the elevator-side trim tab hinge half for drilling an index hole, insert the flange of the hinge **between** the upper skin and the upper flange of the aft partial spar. (This is not where the hinge will ultimately go—it will be riveted to the **underside** of the partial spar flange—but the clamping action provided by the upper elevator skin makes final adjustment of the hinge much easier.) Adjust the hinge as necessary to even the gap. Once again, the bottoms of the "knuckle" slots will, ideally, fall approximately **1/32"** forward of the trailing edge of the upper skin of the elevator, leaving a total gap of about **3/16"**.

When you are satisfied that the hinges are aligned, use a **#40** bit to drill through the skin, spar and hinge at **one** location near the center of the hinge, using the nearest pre-punched hole for a guide. As with the elevator, make sure that the location you choose is offset at least a Cleco's width from the trim tab-side Cleco. After drilling, insert a Cleco in the hole.

Completed: [ ]

Step 81: Drill the Final Alignment Holes

With the hinge held to the elevator with one Cleco, fold the trim tab upward until it is in a near-vertical position (approximately perpendicular to the elevator), just as you did with the elevator.

With the trim tab in this vertical position, drill **one** hole near **each** end of the hinge with a **#40** bit. Cleco these holes and then lower the trim tab.

Completed: [ ]

Step 82: Drill the Remaining Holes

With the hinge Clecoed to the elevator in three places, it is locked into position. You can now drill all the remaining holes with a **#40** bit. Cleco these holes as you go. Also, with the same bit, drill the remaining holes along the aft partial spar outboard of the hinge ends. Finally, drill the holes through the leading edge of the trim tab that fall outboard of the hinge.

When all the drilling is completed, remove the Clecos, separating the trim tab from the elevator and removing both halves of each hinge from their respective assemblies. Thoroughly clean and deburr all the holes in the hinge parts and in the elevator and trim tab assemblies.

Note The hinges are made of anodized aluminum; they require no additional corrosion protection, although you may paint them if you wish. Do **not** acid-etch or alodize the hinges, however.

Completed: [ ]

HINGE RIVETING

Step 83: Rivet the Elevator Hinge Halves to the Stabilizer

Use 1/8" AN470AD4 universal-head rivets to rivet the stabilizer-side halves of the elevator hinges to the upper flange of the stabilizer aft spar. Also, use rivets of the same diameter (but different length, as appropriate) to rivet the upper stabilizer skins to the spar flange between the hinges, **with the following exceptions: do not** put a rivet in the holes immediately inboard of the outboard hinges or on either side of the center hinge (see Figure 48). These holes will accommodate the hinge pin retainers.

Sequence the riveting as discussed in "SECTION II: TOOLS AND TECHNIQUES."

Note In this and the subsequent three steps, note that the thickness of the stack-up is less between the hinges than it is on the hinges. Be sure to choose rivet length accordingly, as discussed in "SECTION II: TOOLS AND TECHNIQUES."

Completed: [ ]

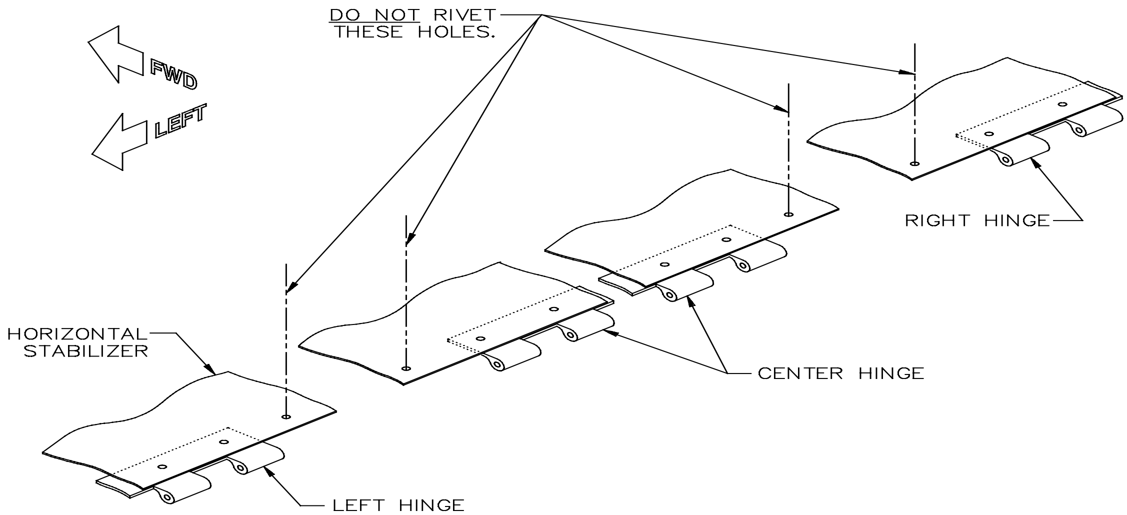


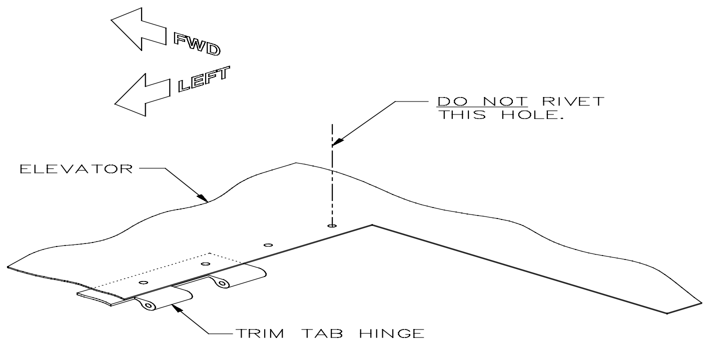
Figure 48: Stabilizer-Side, Hingeline Rivet Holes to Be Left Empty

Step 84: Rivet the Elevator-Side Hinge Halves to the Elevator

With 1/8" AN470AD4 universal-head rivets, rivet the elevator-side halves of the elevator hinges to the upper flange of the elevator forward spar. Also, rivet the upper elevator skins to the spar flange between the hinges using rivets of the same diameter but appropriate length.

Completed: [ ]

Step 85: Rivet the Trim Tab Hinge Half to the Elevator



Rivet the elevator-side half of the trim tab hinges to the upper flange of the elevator aft spar with 3/32" AN470AD3 universal-head rivets. In the holes outboard of the hinge, use rivets of the same diameter but appropriate length to rivet the upper elevator skins to the aft partial spar flange, **with the following exception: do not** put a rivet in the outermost hole at the right end of the aft partial spar, as shown in Figure 49. This hole will accommodate the hinge pin retainer.

Completed: [ ]

Figure 49: Elevator-Side, Hingeline Rivet Holes to Be Left Empty

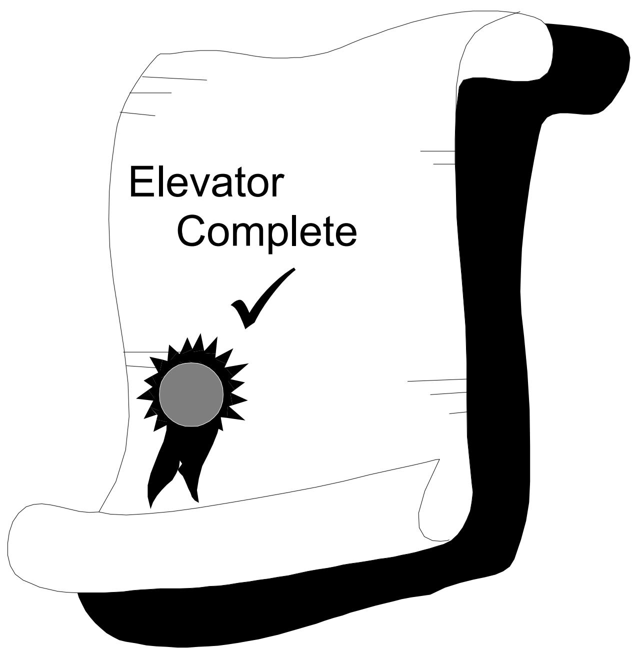
Step 86: Rivet the Trim Tab Hinge Half to the Trim Tab

Using 3/32" AN470AD3 universal-head rivets, rivet the trim tab-side half of the trim tab hinge to the trim tab leading edge overhang. Using rivets of the same diameter but appropriate length, rivet the upper and lower surfaces of the trim tab hinge together outboard of the hinge.

Completed: [ ]

CONGRATULATIONS!

You've completed the elevator assembly, and with it, the entire empennage! Your Sportsman is really beginning to take shape. Now, it's time to apply all you've learned on a bigger project—the wing!



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SECTION VI: WING ASSEMBLY

PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Rib, root main, left	1	201-00001-01
2	Rib, root main, right	1	201-00001-02
3	Rib, outboard main, left-flange	4	201-00002-01
4	Rib, outboard main, right-flange	4	201-00002-02
5	Rib, root nose, left	1	201-00003-01
6	Rib, root nose, right	1	201-00003-02
7	Rib, outboard nose, left-flange	16	201-00004-01
8	Rib, outboard nose, right-flange	16	201-00004-02
9	Rib, flap cove root, left	1	201-00005-03
10	Rib, flap cove root, right	1	201-00005-04
11	Rib, flap cove, left-flange	13	201-00056-01
12	Rib, flap cove, right-flange	13	201-00056-02
13	Rib, aileron cove, left-flange	9	201-00007-01
14	Rib, aileron cove, right-flange	9	201-00007-02
15	Hat section, upper	7	201-00008-01
16	Hat section, lower	7	201-00009-01
17	Skin, leading edge, inboard, left	1	201-00011-03
18	Skin, leading edge, inboard, right	1	201-00011-04
19	Skin, leading edge, center, left	1	201-00012-01
20	Skin, leading edge, center, right	1	201-00012-02
21	Skin, leading edge, outboard, left	1	201-00013-01
22	Skin, leading edge, outboard, right	1	201-00013-02
23	Skin, upper inboard, left	1	201-00014-03
24	Skin, upper inboard, right	1	201-00014-04
25	Skin, upper center, left	1	201-00015-03
26	Skin, upper center, right	1	201-00015-04
27	Skin, upper outboard, left	1	201-00016-03
28	Skin, upper outboard, right	1	201-00016-04
29	Skin, lower inboard, left	1	201-00017-03

30	Skin, lower inboard, right	1	201-00017-04
31	Skin, lower center, left	1	201-00018-03
32	Skin, lower center, right	1	201-00018-04
33	Skin, lower outboard, left	1	201-00019-03
34	Skin, lower outboard, right	1	201-00019-04
35	Stringer channel	2	201-00027-02
36	Cap strip, 72"	2	201-00028-02
37	Reserved		
38	Reserved		
39	Doubler, root rib, upper, left	1	201-00031-01
40	Doubler, root rib, upper, right	1	201-00031-02
41	Doubler, root rib, lower, left	1	201-00032-01
42	Doubler, root rib, lower, right	1	201-00032-02
43	Reinforcement Angle, Root Rib	1	201-00105-01
44	Spar, forward, left	1	201-01000-05
45	Spar, forward, right	1	201-01000-06
46	Rib, Main, Mid Bay Left	5	201-00035-01
47	Rib, Main, Mid Bay Right	5	201-00035-02
48	Stringer channel	8	201-00027-03
49	Stringer channel	2	201-00027-04
50	Reserved		
51	Reserved		
52	Spar, aft, left	1	201-02000-05
53	Spar, aft, right	1	201-02000-06
54	Reserved		
55	Stringer channel	2	201-00027-05
56	Stringer channel	4	201-00027-06
57	Spacer, Clamp-up, 1/4" diameter	12	201-04010-01
58	Spacer, Clamp-up, 3/8" diameter	2	201-04010-03
59	Bracket, flap bellcrank	4	201-02006-01
60	Angle, flap bellcrank attach, upper	2	201-02008-03
61	Angle, flap bellcrank attach, lower	2	201-02008-04
62	Bracket, aileron bellcrank	2	201-02010-01
63	Bracket, aileron bellcrank, opposite	2	201-02010-02
64	Angle, aileron bellcrank upper attach, left	1	201-02012-01

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3:

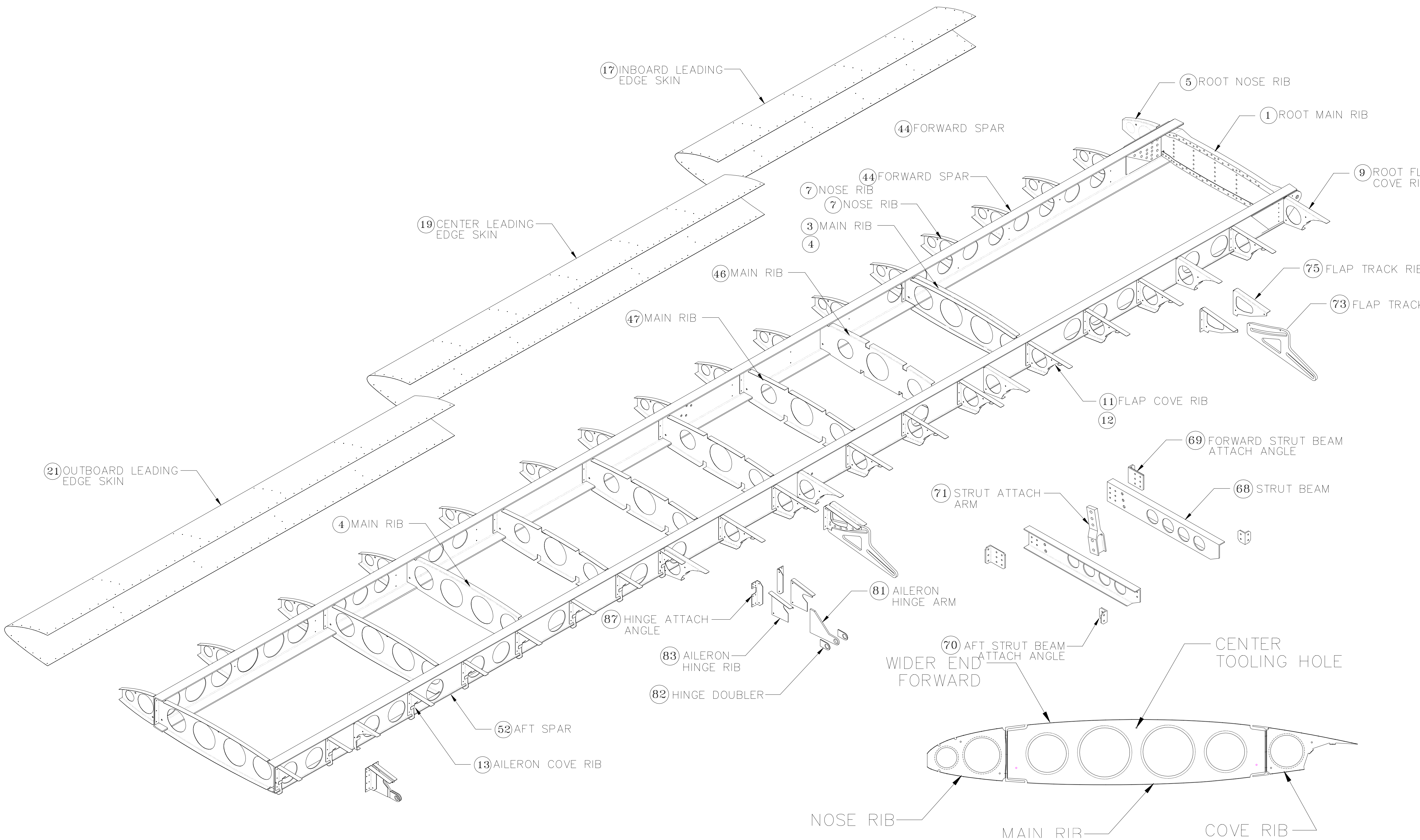
Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

65	Angle, aileron bellcrank upper attach, right	1	201-02012-02
66	Angle, aileron bellcrank attach, lower	2	201-02013-01
67	Beam, strut, left-flange	2	201-04001-03
68	Beam, strut, right-flange	2	201-04001-04
69	Angle, strut beam attach, forward	4	201-04002-01
70	Angle, strut beam attach, aft	4	201-04003-03
71	Arm, strut attach, left	1	201-04004-03
72	Arm, strut attach, right	1	201-04004-04
73	Flap track	4	201-05051-01
74	Rib, flap track, left-flange	4	201-05002-01
75	Rib, flap track, right-flange	4	201-05002-02
76	Pulley, flap bellcrank	2	201-05501-01
77	Arm, flap bellcrank, upper left/lower right	2	201-05502-01
78	Arm, flap bellcrank, lower left/upper right	2	201-05502-02
79	Bearing housing, flap bellcrank	2	201-05503-01
80	Spacer, flap bellcrank	4	201-05505-01
81	Arm, aileron hinge	4	201-06001-01
82	Doubler, bearing arm	8	201-06002-01
83	Rib, aileron hinge, left-flange	4	201-06003-01
84	Rib, aileron hinge, right-flange	4	201-06003-02
85	Angle, aileron hinge attach, left-flange	3	201-06004-01
86	Angle, aileron hinge attach, right-flange	3	201-06004-02
87	Angle, inboard aileron hinge attach, left	1	201-06005-01
88	Angle, inboard aileron hinge attach, right	1	201-06005-02
89	Horn, Antiservo Tab	1	201-15019-03
90	Angle, flap pulley bracket	1	602-01001-03
91	Angle, outboard aileron pulley bracket	1	602-04101-03
92	Bellcrank, aileron	2	602-06001-01
93	Bellcrank, aileron, opposite	2	602-06001-02
94	Bearing	8	017-00001-01
95	Angle, 6061-T6, .063" X 1/2" X 1/2"	60"	100-0640-002
96	Angle, 6061-T6, .063" X 1" X 1"	72"	100-0640-003
97	Angle, 6061-T6, .063" X 1" X 1-1/4"	24"	100-0640-011
98	Bearing, bellcrank	2	170-0134-001
99	Pulley	4	AN210-3A

100	Pulley	8	AN210-4A
101	Bolt	16	AN3-4A
102	Nut, castle	10	AN310-4
103	Nut, nylon lock	16	AN364-1032A
104	Nut, nylon lock	52	AN364-428A
105	Nut, nylon lock	6	AN364-624A
106	Pin, cotter	10	AN380-2-2
107	Bolt	6	AN4-15
108	Bolt	2	AN4-20
109	Bolt	2	AN4-21
110	Bolt	52	AN4-6A
111	Bolt	6	AN6-13A
112	.09 aluminum flat stock	1	075-01090-01
113	Washer	30	AN960D10
114	Washer, thin	2	AN960D10L
115	Washer	76	AN960D416
116	Washer, thin	60	AN960D416L
117	Washer	12	AN960D616
118	Spacer	2	NAS42DD8-20
119	Spacer	2	NAS42DD8-43
120	Bushing, aft spar root	2	NAS75-7-012
121	Bushing, forward spar root	2	NAS75-8-014
122	Bushing, flap bellcrank bracket	4	NAS77-4-005


17 INBOARD LEADING EDGE SKIN
5 ROOT NOSE RIB
1 ROOT MAIN RIB
44 FORWARD SPAR
9 ROOT FLAP COVE RIB
44 FORWARD SPAR
7 NOSE RIB
7 NOSE RIB
19 CENTER LEADING EDGE SKIN
3 MAIN RIB
4
75 FLAP TRACK RIB
46 MAIN RIB
73 FLAP TRACK
47 MAIN RIB
11 FLAP COVE RIB
12
69 FORWARD STRUT BEAM ATTACH ANGLE
21 OUTBOARD LEADING EDGE SKIN
71 STRUT ATTACH ARM
68 STRUT BEAM
4 MAIN RIB
81 AILERON HINGE ARM
87 HINGE ATTACH ANGLE
70 AFT STRUT BEAM ATTACH ANGLE
83 AILERON HINGE RIB
WIDER END FORWARD
CENTER TOOLING HOLE
82 HINGE DOUBLER
52 AFT SPAR
13 AILERON COVE RIB
NOSE RIB
MAIN RIB
COVE RIB

Tool List

1. Measuring tape, 16' minimum
2. Carpenter's framing square
3. Level
4. String line, 16' minimum
5. Try square
6. Fine-point marking pen (permanent ink recommended)
7. Crosscut saw or electric circular saw (for wing jig)
8. Electric drill with screwdriver bit (for building the wing jig)
9. Plumb bob
10. Flat and round files or edge deburring tool
11. Sheet metal hand shears (offset type recommended)
12. 12" decimal/fractional rule
13. Clecos, 3/32", 1/8", 5/32" and 3/16" (approximately 200 to 250 each of the 1/8" and 3/32"; approximately 15 each of the 5/32" and 3/16"). Also needed are about a half-dozen **extended-grip** 1/8" Clecos for securing the root ribs in the spar root area.
14. Cleco side-grip clamps or small C-clamps (15 to 20)
15. Cleco pliers
16. Duck bill pliers
17. Center punch
18. Electric drill or air drill with 3/16", 1/4", 11/32", 3/8", 1/2", 9/16", D, U, #40, #30, #21 and #10 bits (#40 and #30 are used most; at least 3 to 4 each of these two sizes will be needed)
19. Right-angle drill or adapter with #40, #30 and 1/4" bits
20. Hole deburring tool
21. Dimple dies, 3/32" and 1/8"
22. Microstop countersink tool with #30 and #21 pilots
23. Riveting frame (highly recommended)
24. Rivet gun, air compressor and bucking bars
25. Flush head rivet set
26. Universal-head rivet sets, 1/8" and 3/32"
27. Rivet squeezer with flush-head set and 3/32" and 1/8" universal-head sets (highly recommended)
28. Blind rivet puller
29. Wrenches, sizes 3/8" to 3/4"

TOOL LIST (CONTINUED)

30. Straightedge, at least 4' long
31. Hole saws (for cutting aluminum) or adjustable fly cutter: 1", 1-1/4", 2-5/8", 3" and 3-5/8" diameters. Must be the type with a central pilot drill.
32. Scotch Brite wheel for a drill motor (recommended)
33. Straight reamers, .540", .5625", .600", .6255"
34. Arbor press (recommended) or bench vise
35. Band saw or hacksaw
36. Large C-clamps or spring clamps
37. Torque wrench (optional)
38. Milled, curved tooth file (optional). This file, also called a "body file" or a "panzer file," has widely spaced, curved teeth for easy chip clearance. It removes material rapidly and leaves a smooth finish. Used for trimming the leading edge skins.
39. Transit (optional)
40. Cabinetmaker's web clamps (optional)

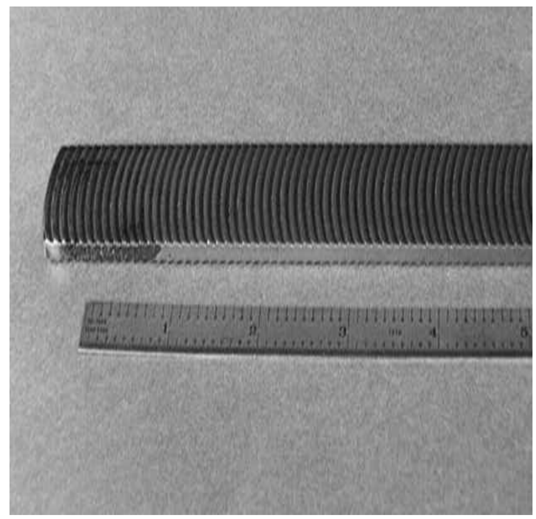


Figure 1.1: "Panzer" File

> **Note** Some of the tools, such as the arbor press, are used infrequently and need not be purchased if access to them can be obtained. Be sure to read through the entire wing section before making tool purchases.

Additional Materials

1. Lumber for wing jig table
2. Sheetrock screws or wood screws to assemble jig and mount jig brackets
3. 3/16" X 2" X 2" aluminum angle, 4' long, for jig brackets. Steel angle would also work fine. See text for details.
4. Three 1/4" X 2" lag screws (hardware store variety) for wing jig aft spar supports
5. 2 X 4 scraps to support spars while drilling lightening holes
6. Sand bags or lead shot bags to stabilize spars while drilling lightening holes
7. Corrosion-proofing materials
8. 1/2" diameter bolt (approximately 1-1/4" grip length) and 7/16" diameter bolt (approximately 3/4" grip length) for securing the spars to the wing jig brackets. Hardware-store quality is acceptable for these.
9. 1"-square pieces of 1/16" thick scrap aluminum (24-30) or wide masking tape. Used to clamp the main wing skins during drilling.
10. Loctite bearing retaining compound (either Loctite 609 low viscosity or Loctite 680 medium viscosity, high strength, or equivalent)

Workspace

The wing jig occupies a space 16' long by 2' wide. For convenient access you will need at least enough additional room to walk all around the wing jig.

PRELIMINARIES

> **Note** Minor blemishes, such as small scratches or machine tool marks, may be present on some metal wing components when you receive them, and there may be areas where the spars have been filed to remove small scratches. Such minor blemishes are acceptable; all of the parts for the Sportsman are carefully inspected, and none are shipped without meeting our rigid quality standards. If we were to ask our vendors to provide parts absolutely free of such minor blemishes, the cost of the Sportsman kit would increase dramatically. Our quality control personnel have judged any minor blemishes you might find on metal parts acceptable, so you can be confident that you can use the parts safely. If you wish to achieve a flawless exterior finish on your Sportsman, you can wet sand any blemished areas locally with 600 grit sandpaper.

The wings are built one at a time. Basic assembly procedures are identical for the left and right wings, and they can be built in either order.

> **Note** The instructions and illustrations in this section all refer to the **left** wing. The basic structure of the **right** wing is a mirror-image of the left.

The wings are built on a simple jig that holds the assembly in a vertical position with the span parallel and the chord perpendicular to the floor (leading edge up). This arrangement allows easy access to both the top and the bottom of the wing without ever requiring that the assembly be flipped over. So, the first step in building the wing is to build the jig.

The outline of the complete assembly procedure is as follows:

1. Fabricate the wing jig.
2. Mount the spars in the jig.
3. Mount the ribs and the strut beam assembly on the spars.
4. Fit-up and drill the wing skins.
5. Install the hat section stiffeners, forward spar cap strips and skin stringers.

6. Dimple the skins and countersink the forward spar flanges.

7. Assemble the aileron hinges.

8. Assemble the aileron bellcrank and mount the hinges and the bellcrank.

9. Fabricate and mount the aileron pulley brackets.

10. Assemble and mount the flap tracks.

11. Assemble and mount the flap bellcrank.

12. Fabricate and install the flap pulley brackets.

13. Rivet the ribs and the leading edge and lower skins.

The "WING ASSEMBLY" section of the *Manual* concludes before assembly of the wings is completely finished. After the basic fuselage structure has been completed ("SECTION VIII: FUSELAGE ASSEMBLY"), the partially finished wings will be mounted on the fuselage temporarily to enable installation of the flight control system. Procedures for routing the control cables and installing the fuel tanks and vent lines (as well as optional lighting and pitot systems) will be described in "SECTION IX: SYSTEMS INSTALLATION." Finally, after the flight control and other systems have been installed, the wings will be returned to the jig for riveting the upper skins and the flap and aileron cove skins ("SECTION X: FINAL ASSEMBLY").

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Fabricate the Wing Jig

The wing jig consists mainly of two vertical posts, one at either end of the wing. Support brackets are attached to these posts, and the forward and aft wing spars are in turn temporarily fastened to the support brackets. The wing is then built around the spars. Several additional supports for the aft spar are needed to keep the wing assembly from sagging.

There are many possible jig designs that would all serve equally well for the jig's main task, which is to keep the spars in one place while the wing is being assembled. The only **essential** features of a suitable jig are that the support brackets be installed precisely the proper vertical distance apart and that they be absolutely plumb (i.e., level and aligned with one another).

You'll have to live with whatever jig you build through many hours of work, however, so there are some other, non-essential considerations that are worth some thought. For example, it's very important that you build your jig at a height that's most comfortable for you—too low and you'll spend hours stooping or working on your knees; too high and you'll get a lot of practice perching on stools or paint cans. So, by all means, treat the dimensions given below as general suggestions and tailor them to your needs.

Another consideration is how best to organize the workspace under and around the wing. Our experience suggests that the most serviceable jig consists of a long, narrow work table extending between the uprights. This provides a convenient place to set your tools, as well as providing an easy way to anchor the posts and the center supports. It might also catch some of those rivets you'll drop so you won't have to search for them on the floor! Keep the work surface narrow, however, so that you don't have to lean over a large overhang to work on the wing.

Note Whatever jig design you settle on, once the spars are mounted and plumbed, it's vital that they remain that way. Therefore, the jig must be **securely** attached to the floor so that normal bumping and jostling won't move the wing assembly out of true. A good way to do this is to use a little body putty (Bondo) between the legs of the jig and the floor. Be sure, however, that you don't glue the jig to the floor until **after** you've trued it!

A suggested jig design is shown in Figure 2. The exact dimensions, materials and construction techniques can be tailored to suit, but in general it's better to build a jig that's too sturdy than one that's too flimsy. Additionally, it's important that the wood you select for the posts be as straight as possible, which probably means avoiding the cheaper grades of construction lumber and checking the pieces carefully for bows or twists. Time spent selecting good, straight posts will be repaid with the relatively easy time you'll have truing the mounting brackets.

Step 1: Fabricate the Jig Framework

Construct a framework for a base table using the suggestions in Figure 2 or an equivalent structure of your own design. Sheetrock screws work well for assembling the jig framework. Once you have assembled the base table, install the end posts as shown in **Figure** 2. Be as precise as possible in spacing the posts horizontally, and use a plumb bob to check for vertical alignment. When you're satisfied, secure the posts to the framework. To help keep the posts plumb, you can support them with diagonal braces.

Make the table top by ripping a single 4' X 8' sheet of 3/4" particle board lengthwise into two 2' X 8' pieces (most lumber yards can do this for you). Cut square holes or notches in the ends of the table top to fit around the 4 X 4 posts. Install the table top using sheetrock screws.

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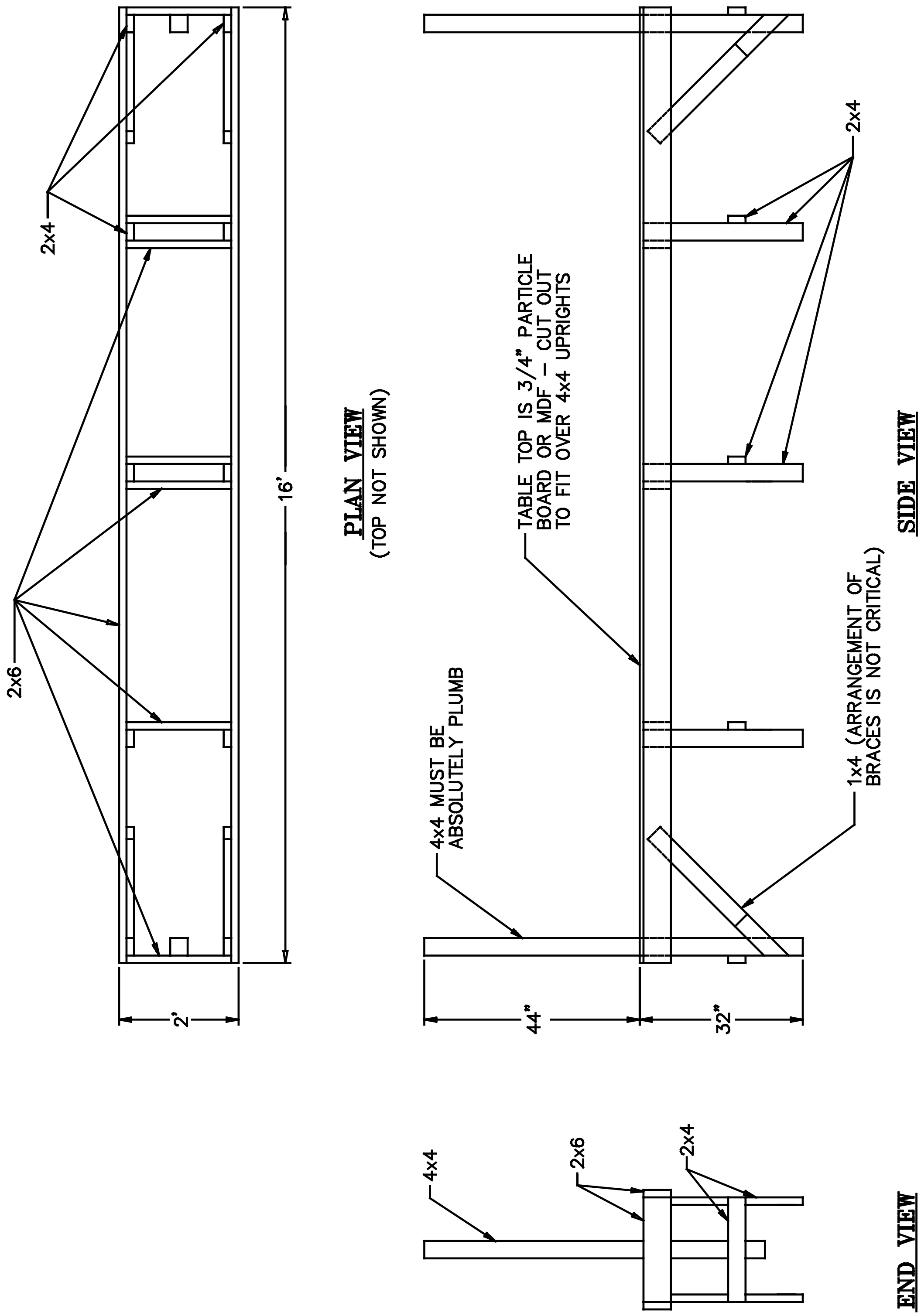

Figure 2: Suggested Wing Jig Framework

Step 2: Fabricate the Wing Jig Spar Brackets

Fabricate the **inboard forward spar bracket**, the **outboard forward spar bracket**, the **inboard aft spar bracket** and the **outboard aft spar bracket** for the wing jig, as shown in Figures 3 through 6. The recommended material (not supplied) is 2" X 2" extruded aluminum angle with a thickness of 3/16", although 1/8" thick material would probably be adequate. You will need a 4' length to make all the brackets for both wings. You may substitute any other material, such as steel angle, that is readily available, as long as it has the strength to support a complete wing panel without deforming and is large enough to provide room for laying out and drilling all the spar support holes shown in the illustrations.

The critical dimensions in the brackets are the locations of the spar attach holes and the plumb bob holes. To accurately lay out these dimensions, be careful to cut one end of each bracket square and then make all measurements from the square end. Make all measurements in the other direction from the corner of the angle, as shown, rather than from the edges of the legs.

Note The wing attach holes in the front and rear spars are not on the same axis. The rear spar attach hole is centered 1/2" inboard and .057" above the forward spar attach hole (when the airplane is level longitudinally and laterally). **Front Spar BL 22.5; Rear Spar BL 22.0**

The sizes and locations of the holes for fastening the brackets to the jig posts are not critical; these can be adjusted, if necessary, to suit your particular circumstances.

Note Figures 3–6 show the jig brackets for the **left** wing. The **right**-wing brackets are mirror images. The “OUTBRD” and “UPPER” arrows apply only to the **top view** of each bracket (i.e., the view in the upper right corner of each figure).

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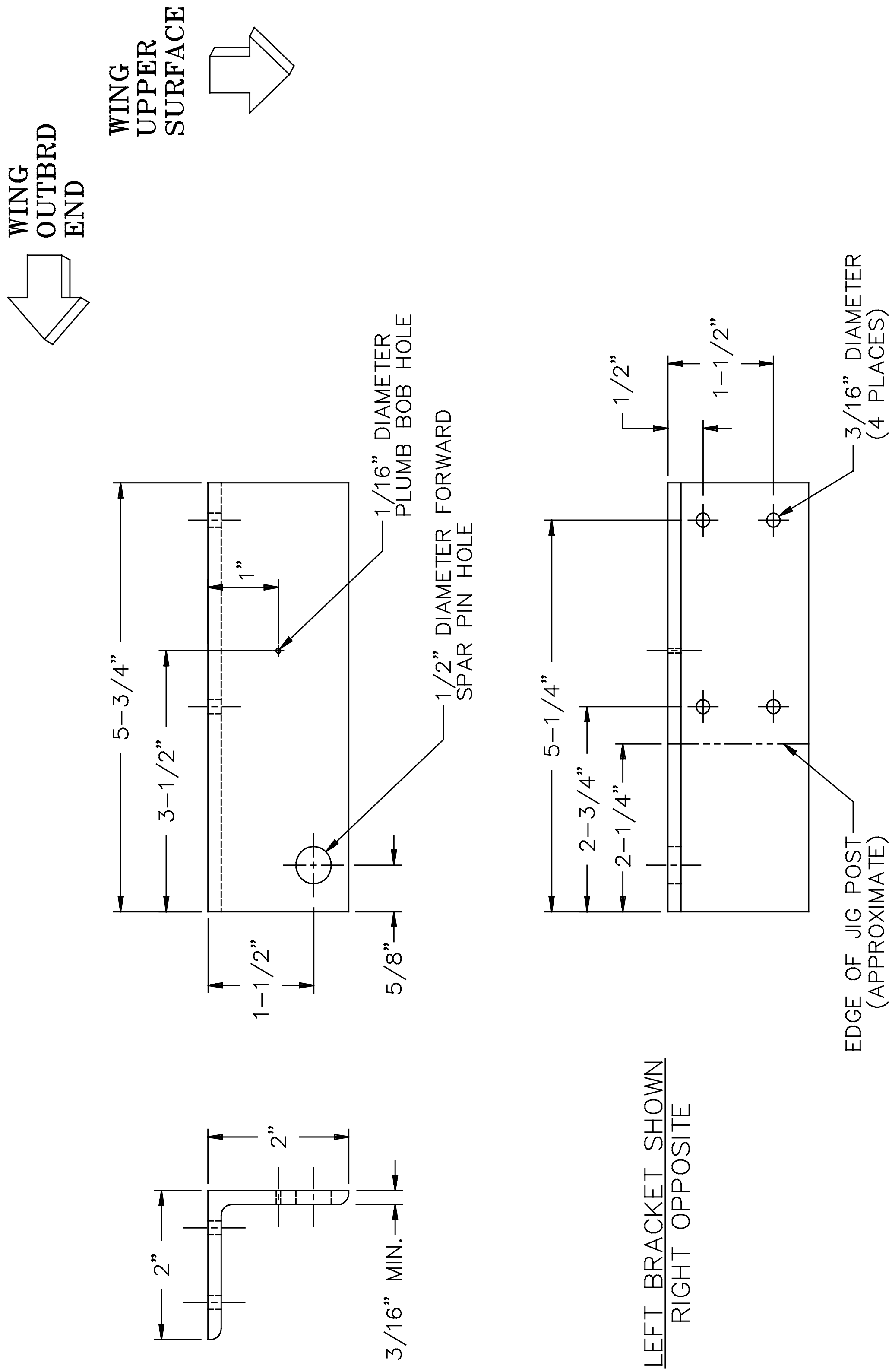

Figure 3: Inboard Forward Spar Bracket

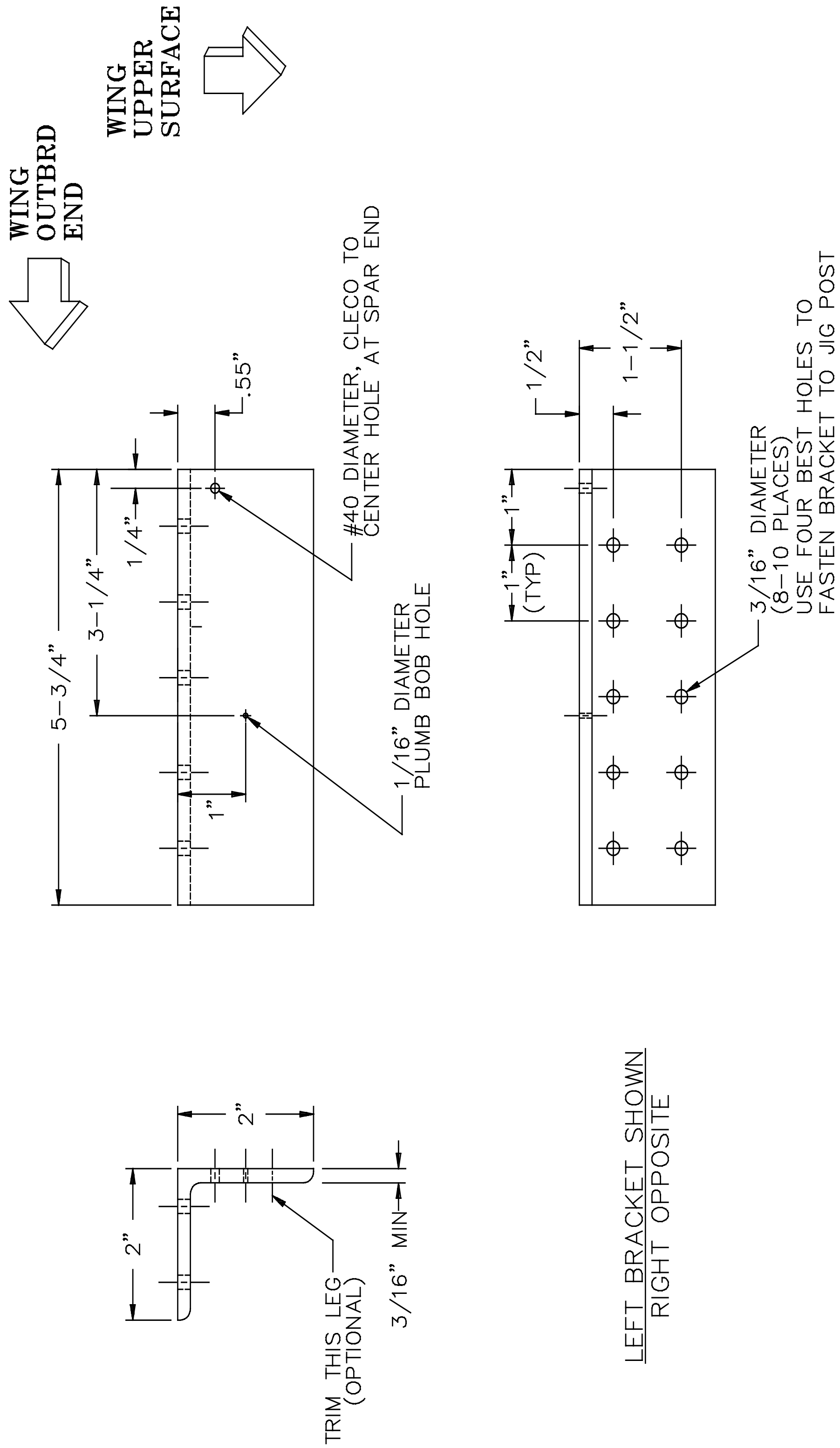

Figure 4: Outboard Forward Spar Bracket

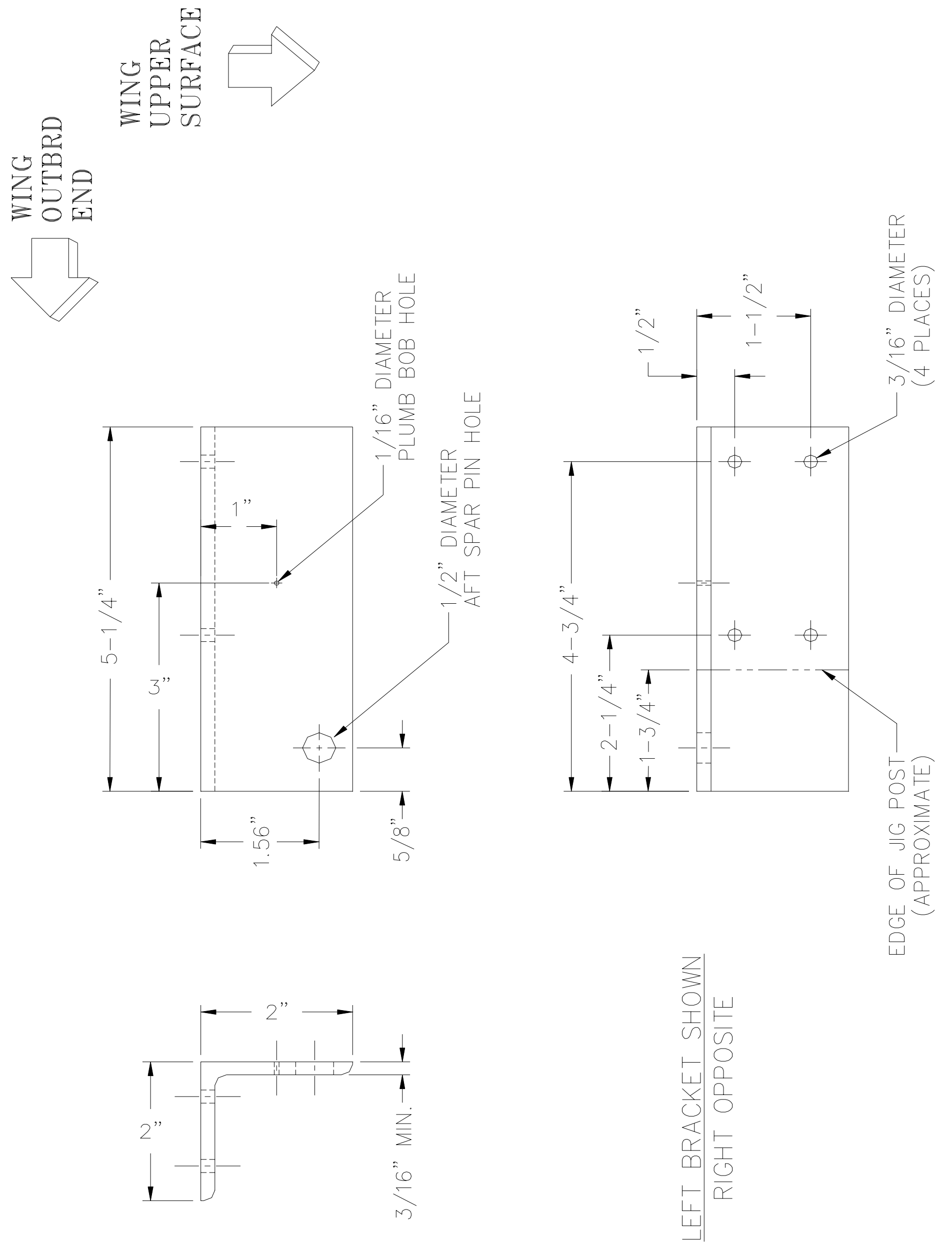

Figure 5: Inboard Aft Spar Bracket

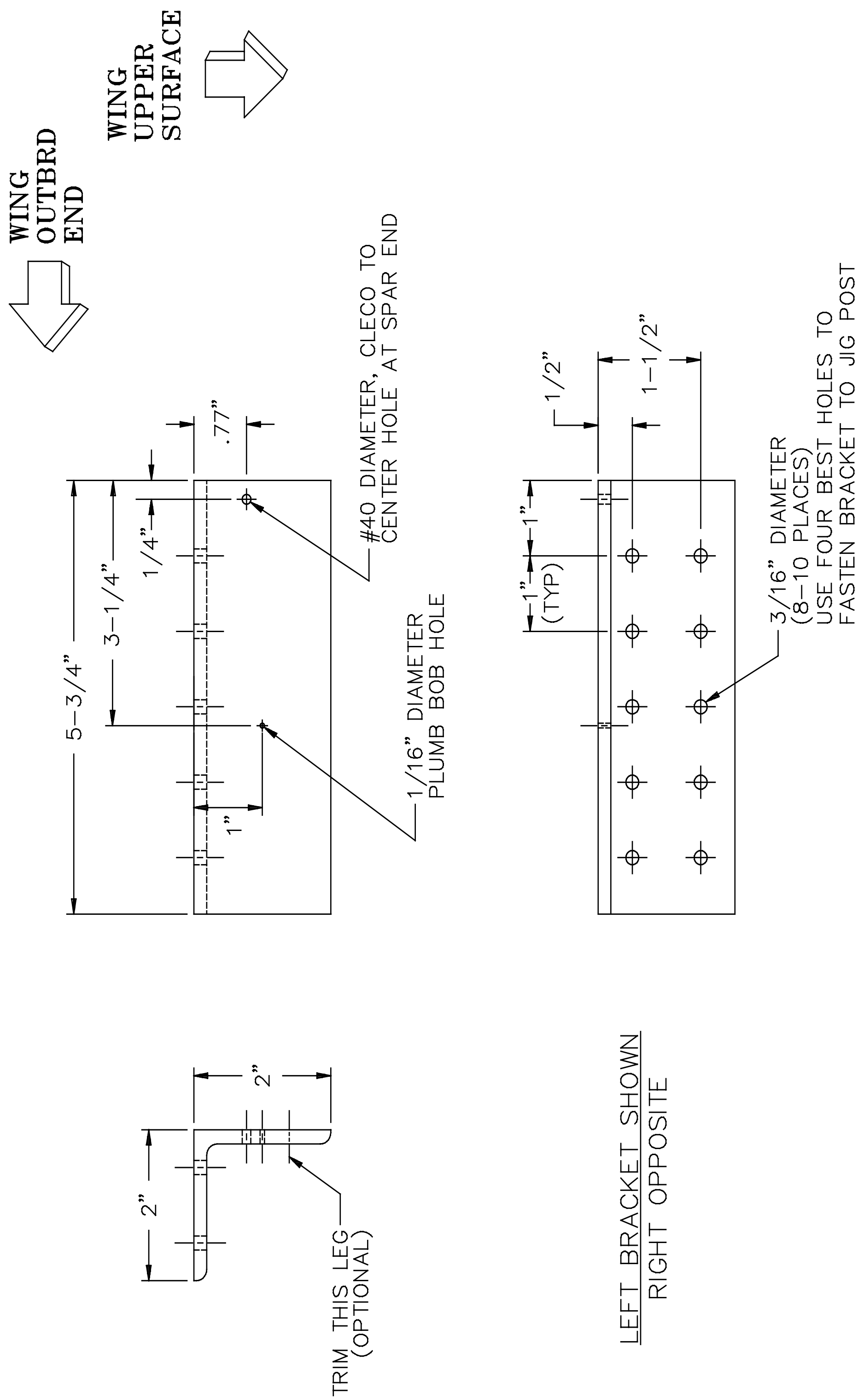

Figure 6: Outboard Aft Spar Bracket

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Step 3: Install the Inboard Spar Brackets

After the jig posts are erected and secured, use four sheetrock screws to mount the **inboard forward spar wing jig bracket** fabricated in the previous step on one of the posts **40.95"** above the jig table, as shown in Figure 7. (Mount the inboard bracket for the **left** wing on the **right** post, when facing either side of the jig. Mount the inboard bracket for the **right** wing on the **left** post.) Use a small carpenter's level to make sure that the top of the bracket is level. (If you carefully plumbed the posts, the top of the bracket should be perpendicular to the edge of the post.)

Note Refer to Figure 28.1 for another view of the inboard wing jig brackets. Do not mount the outboard brackets yet. This will be done in a subsequent step.

Measuring down the post **21.95"** from the top of the newly-installed forward spar bracket, mark the location of the upper edge of the **inboard aft spar wing jig bracket**, as shown in Figure 7.

Hang a plumb bob from the plumb bob hole in the forward spar bracket. While holding the upper edge of the aft spar bracket on its marked height line, align the plumb bob hole in the **aft bracket** with the point of the plumb bob to position the aft bracket in the spanwise direction. (If the post is truly plumb, the aft bracket will be positioned correctly in the other direction when it is secured to the post.) Use four sheetrock screws to secure the aft spar bracket to the post, again using a level or a square to make sure that the bracket is level.

Note It's a good idea to check your jig for plumb and true periodically, especially before any major drilling operation. The lumber in the jig can shrink or warp as it ages, and the jig can get jostled enough, while working, to knock it out of alignment. Leave the plumb bob in place so that you can easily check and adjust the jig's alignment.

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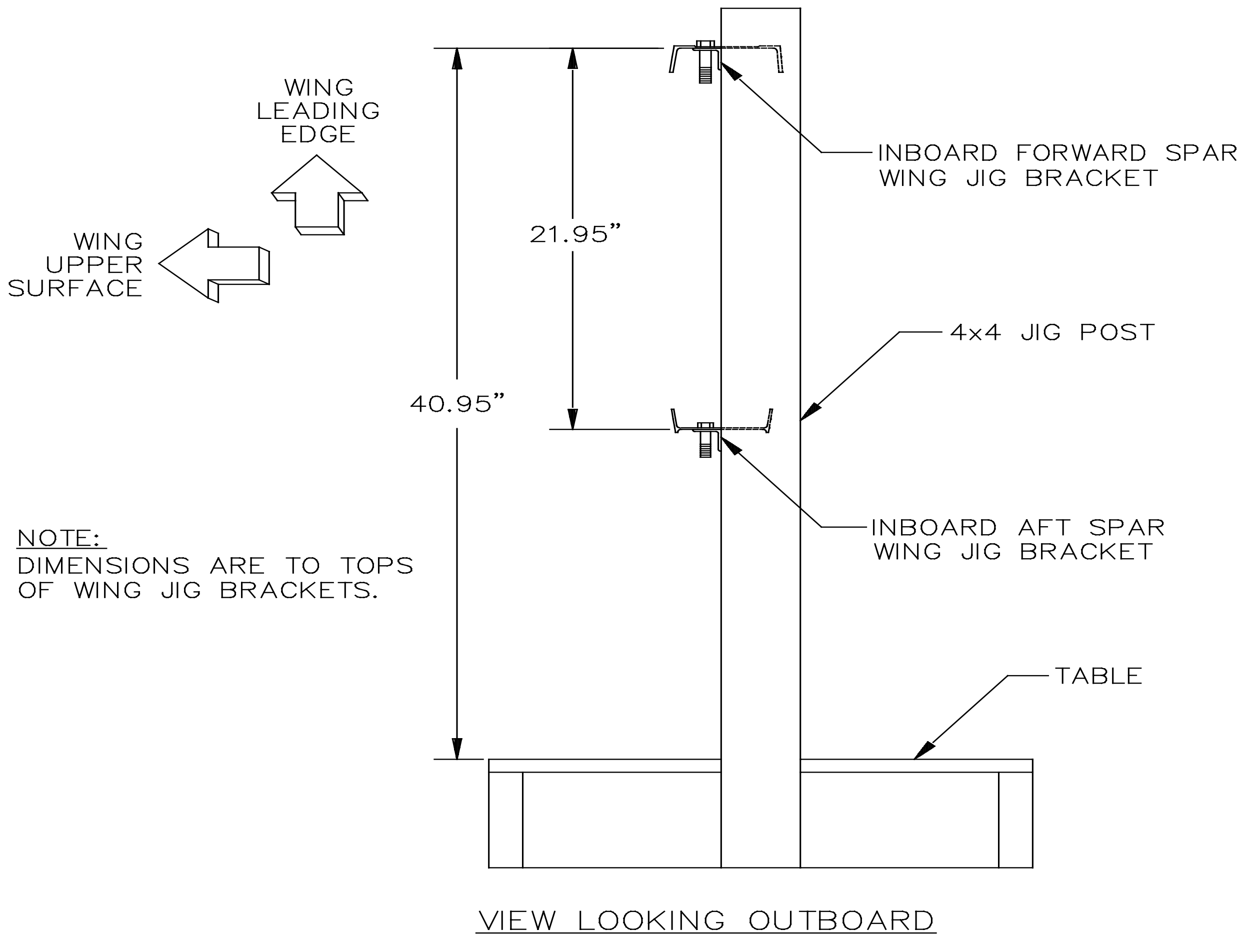

Figure 7: Mounting the Inboard Wing Jig Brackets

WING REFERENCE INFORMATION

The following pages will give you some reference information regarding the spars, rib layout in the wing etc. You will find this information handy, so tag the pages for easy reference later.

Note The locations of the lightening holes are given in "butt line" (BL) dimensions, which are measured in inches from the **longitudinal centerline of the airplane, not** from the end of the spar. Notice that the wing attach hole in the **forward spar** is centered at **BL 22.5**; the wing attach hole in the **aft spar** is centered at **BL 22.0**. Some early run Sportsman spars have been assembled from GlaStar spars. You can identify these by finding the lightning holes that have been filled in with a reinforcement cap. Not to worry, the spar extrusion itself is identical for the two airplanes, only the reinforcement schedule is different.

Caution It is important to avoid scarring the spar when working and moving the wing spars. Scars or scratches in the spar provide places where stresses concentrate, which can reduce the strength and fatigue-resistance of the spar. A spar with a scratch deeper than 10% of the material thickness generally cannot be used or must be repaired.

Note Minor blemishes may be present on the spars when you receive them, or there may be areas where the spars have been filed or sanded to remove small scratches. Such minor blemishes are acceptable; each spar is thoroughly inspected, and is not shipped unless it meets our rigid quality standards. If you find minor blemishes or repaired areas on your spars, we recommend wet sanding the area locally to a 600 grit surface finish.

FORWARD SPAR LIGHTENING HOLES		AFT SPAR LIGHTENING HOLES	
LOCATION:	DIAMETER:	LOCATION:	DIAMETER:
BL 35.48	2-5/8"	BL 35.75	3"
BL 39.98	2-5/8"	BL 40.75	3"
BL 44.45	2-5/8"	BL 52.25	3"
BL 48.95	2-5/8"	BL 57.00	3"
BL 53.38	2-5/8"	BL 61.63	3"
BL 57.90	2-5/8"		
BL 62.38	2-5/8"	BL 88.50	3"
BL 66.88	2-5/8"	BL 152.50	3"
BL 71.30	2-5/8"		
BL 147.86	2-5/8"	BL 162.31	3"
BL 152.08	2-5/8"	BL 166.75	3"
		BL 174.00	3"
BL 161.66	2-5/8"	BL 180.73	3"
BL 165.43	2-5/8"	BL 185.25	3"
BL 169.23	2-5/8"	BL 195.25	3"
BL 176.14	3-5/8"	BL 199.75	3"
BL 180.71	3-5/8"		
BL 185.28	3-5/8"		
BL 189.88	3-5/8"		
BL 194.46	3-5/8"		
BL 199.03	3-5/8"		

Table 1: Lightening Hole Locations

MAIN RIBS		
RIB:	**LOCATION:**	**FLANGE:**
Root Rib	BL 24.25	Inboard
Double Rib	BL 69.00	In/Outboard
Main Rib 3	BL 84.0	Inboard
Main Rib 4	BL 98.25	Outboard
Main Rib 5	BL 112.53	Outboard
Main Rib 6	BL 126.0	Inboard
Main Rib 7	BL 141.75	Outboard
Main Rib 8	BL 156.75	Inboard
Main Rib 9	BL 171.75	Outboard
Tip Rib	BL 201.75	Outboard

Table 2: Main Rib Locations and Orientations, LH

NOSE RIBS		
RIB:	**LOCATION:**	**FLANGE:**
Nose Rib 1	BL 24.25	Inboard
Nose Rib 2	BL 33.20	Outboard
Nose Rib 3	BL 42.15	Outboard
Nose Rib 4	BL 51.10	Outboard
Nose Rib 5	BL 60.05	Outboard
Nose Rib 6	BL 69.00	Outboard
Nose Rib 7	BL 79.29	Outboard
Nose Rib 8	BL 89.17	Outboard
Nose Rib 9	BL 99.89	Outboard
Nose Rib 10	BL 110.60	Outboard
Nose Rib 11	BL 120.48	Outboard
Nose Rib 12	BL 130.75	Outboard
Nose Rib 13	BL 144.95	Outboard
Nose Rib 14	BL 159.15	Outboard
Nose Rib 15	BL 173.35	Outboard
Nose Rib 16	BL 187.55	Outboard
Nose Rib 17	BL 201.75	Outboard

Table 3: Nose Rib Locations and Orientations

FLAP COVE RIBS		
RIB:	LOCATION:	FLANGE:
Root Cove Rib 1	BL 24.25	Inboard
Flap Cove Rib 2	BL 33.64	Outboard
Flap Cove Rib 3	BL 43.03	Inboard
Flap Cove Rib 4	BL 49.97	Outboard
Flap Cove Rib 5	BL 59.36	Outboard
Flap Cove Rib 6	BL 69.00	Outboard
Flap Cove Rib 7	BL 76.94	Inboard
Flap Cove Rib 8	BL 81.56	Outboard
Flap Cove Rib 9	BL 91.37	Outboard
Flap Cove Rib 10	BL 101.17	Outboard
Flap Cove Rib 11	BL 109.75	Inboard
Flap Cove Rib 12	BL 114.25	Outboard
Flap Cove Rib 13	BL 123.64	Outboard
Flap Cove Rib 14	BL 134.25	Inboard

Table 4: Flap Cove Rib Locations and Orientations

AILERON COVE RIBS		
RIB:	LOCATION:	FLANGE:
Aileron Cove Rib 1	BL 134.88	Outboard
Aileron Cove Rib 2	BL 141.75	Outboard
Aileron Cove Rib 3	BL 149.95	Outboard
Aileron Cove Rib 4	BL 159.15	Outboard
Aileron Cove Rib 5	BL 168.95	Outboard
Aileron Cove Rib 6	BL 178.45	Outboard
Aileron Cove Rib 7	BL 187.55	Inboard
Aileron Cove Rib 8	BL 193.08	Outboard
Aileron Cove Rib 9	BL 201.75	Outboard

Table 5: Aileron Cove Rib Locations and Orientations

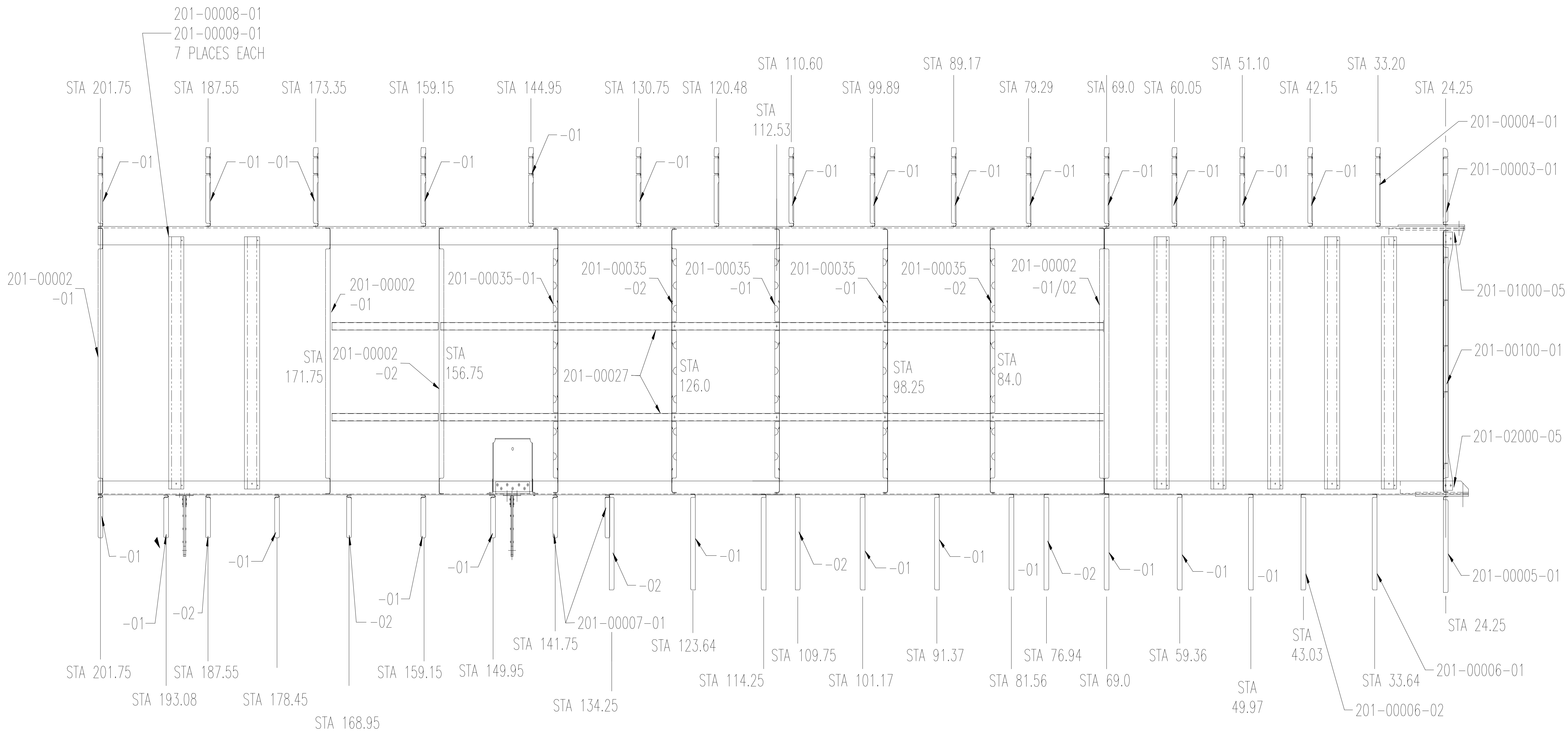

Figure 7.1 Wing Plan View

Steps 4-6 have been removed because the spars now come pre-assembled

This deletes figures 8, 9, and 10

Step 7: Mark Rivet Lines on Forward Spar Flanges

Rivet lines need to be drawn on the forward spar flanges, and these are easier to make when the spars are lying flat on the bench than when they are installed in the jig. The first rivet line is **5/16"** - **3/8"** forward of the aft edge of the spar flange; the second rivet line is **1-1/16" - 1-1/8"** forward of the aft edge of the spar flange, as shown in Figure 11.

As on the stabilizer and elevator spars, the wing spars may be slightly bowed. Keep the rivet lines parallel to the spar flange edges, not necessarily straight. You will straighten the spars in the fore-and-aft direction when they're placed in the jig.

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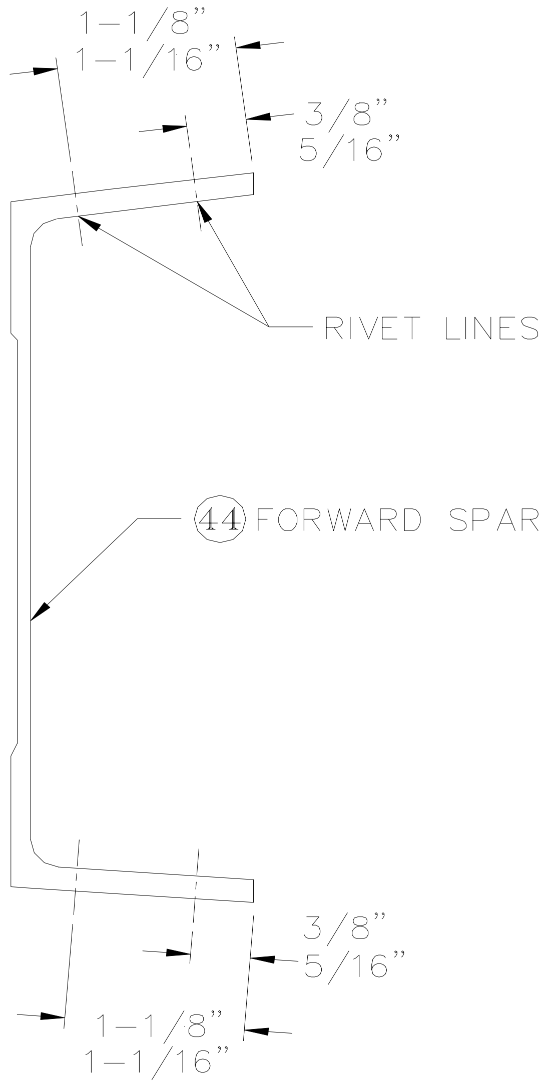

Figure 11: Forward Spar Rivet Line Dimensions

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MOUNT THE SPARS IN THE JIG

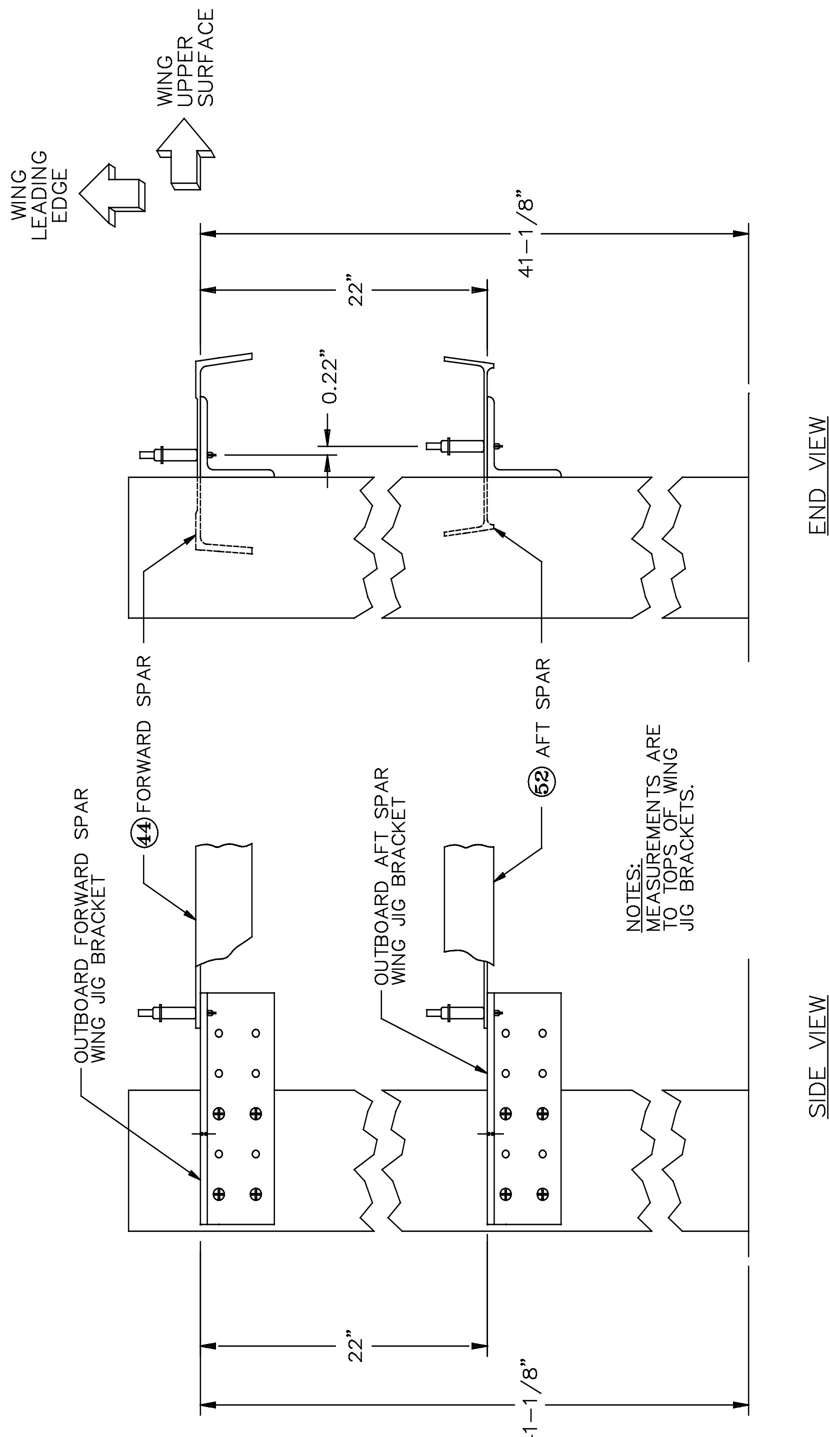

Figure 12: Mounting the Outboard Spar Brackets

Step 8: Fasten the Spars to the Jig Brackets

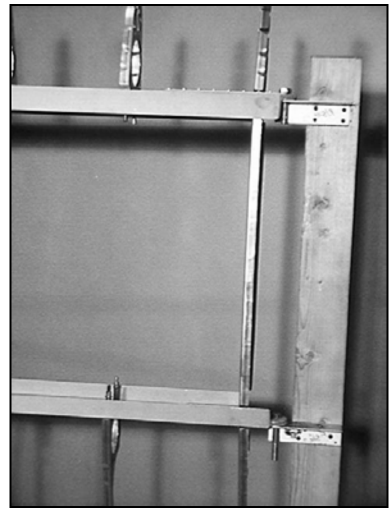

Figure 13: Inboard End of the Wing Jig

Using one Cleco inserted through the **center** rivet hole at the outboard end of the forward spar, mount the **outboard forward spar wing jig bracket** to the spar, as shown in Figure 13. Mount the forward spar on the **inboard forward spar jig bracket**, which was attached to the jig post in Step 3, by resting the spar on the bracket and inserting a 1/2" bolt through the wing-attach hole.

> **Note** You don't need a special bolt for this purpose; any 1/2" hardware-store bolt with a grip length of about 1-1/4" will do.

> **Note** As mentioned previously, the forward spar flanges point aft (down, when the wing is in the jig) and the upper flange of the spar is oriented away from the jig post (toward you when you are facing the jig).

Hold the outboard forward spar wing jig bracket against the outboard jig post and level the spar in the spanwise direction. When you're satisfied that the spar is level from root to tip, fasten the outboard jig bracket to the post with sheetrock screws.

> **Note** To level the spar, use a water level or a transit or, if you're sure the jig table is level from end to end, simply measure up from the table **41-1/8"** as shown in Figure 12. (A water level is simply a length of clear, flexible tubing partially filled with water. It has to be long enough to run down from the top of one jig post, across the floor and up to the top of the other jig post. As long as the ends of the tube are open to the air, the level of the water will be the same at both ends when the ends are held up along the jig posts. So, you can measure up or down at each end to equalize the distance from the spar to the water.) Since the spars sag from their own weight when in the jig, you won't be able to use a carpenter's level. Supports to keep the spars from sagging are described in the next step.

Measure down **22"** from the top of the **outboard forward spar wing jig bracket** and mark a line on the jig post for the top edge of the **outboard aft spar jig bracket**, as shown in Figure 28. Use a Cleco to fasten the outboard aft spar jig bracket to the center rivet hole at the outboard end of the aft spar. Rest the root end of the aft spar on the inboard aft spar jig bracket and insert a 1/2" bolt (hardware-store quality is okay; grip length about 3/4") through the wing attach hole. Hold the top edge of the outboard aft spar jig bracket on the line just marked and secure the bracket to the jig post with sheetrock screws.

Note It's possible that, if either of your jig posts is **twisted**, the forward spar will not be held in the correct relationship to the aft spar, even when the plumb bob holes in the jig brackets are properly aligned. This could induce an unwanted twist in the wing. **The Sportsman wings are intended to be straight with no twist (wash-in or wash-out).** To double-check that the wing is not twisted in the jig, have one helper hold a straightedge from the upper forward spar flange to the upper aft spar flange at the wing root. Have another helper do the same at the wing tip. When viewed from either end of the wing, the two straightedges should be parallel. (Alternatively, measure with a digital level across the upper spar flanges at the root and the tip to verify an untwisted condition.) Another situation that will result in a twisted wing is inadvertently swapping the positions of the two outboard jig brackets. We recommend checking for twist and making any necessary jig adjustments before each major skin drilling or riveting operation.

Note It may be helpful from now on to remember that, as long as the wing assembly is in the jig, "forward" is up, and "aft" is down. In general, remember that all directional references in the text are keyed to the completed aircraft in a level-flight attitude, irrespective of what position the parts are in when jigged.

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Step 9: Fabricate the Aft Spar Center Supports

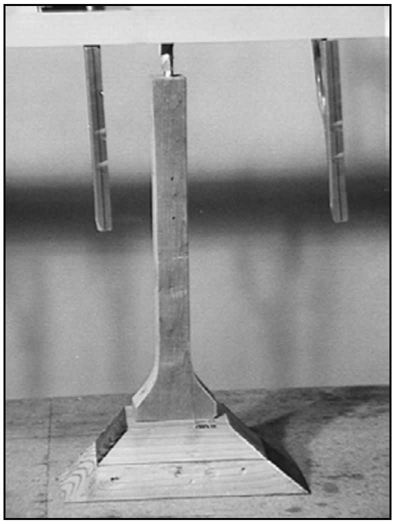

Figure 14: Aft Spar Support

Until the wing skins are riveted in place, it's necessary to support the center of the wing assembly to prevent the spars from sagging. To accomplish this, build **three** adjustable supports and install them between the wing jig table and the aft spar. A suggested design is shown in Figure 15.

Place the supports, spaced equidistantly, under the aft spar and adjust them until the bow in the spar disappears. To check this, simply sight along one of the corners of the aft spar or stretch a string tautly from one end of the spar to the other. When the string contacts the spar along its entire length, the spar is straight. A transit could also be used if you have access to one, but it's really not necessary since either of the "low-tech" methods mentioned above works just fine. When you're satisfied that the spar is straight, secure the supports to the jig and lock the height adjustment in place. If you've used something similar to the design suggested in Figure 29, then we suggest using sheetrock screws to secure the support to the jig table and hot-melt glue to lock in the bolt.

Note Do not place the supports in areas where they will interfere with installing wing ribs or other components. Such locations are marked by pilot holes in the spar. If you place them near main ribs, however, they will offer support to both the forward and the aft spars.

Note In addition to checking your jig for plumb and true periodically, also check the straightness of the spars and adjust as necessary.

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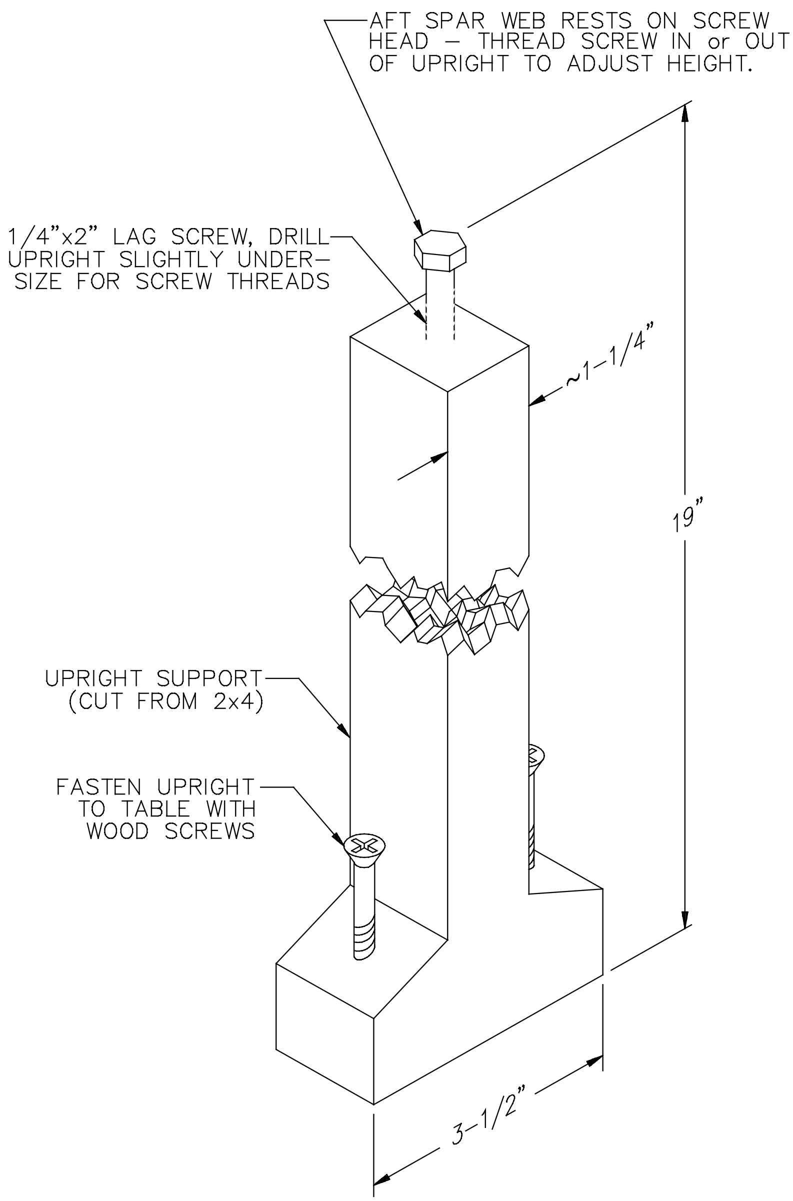


Figure 15: Suggested Aft Spar Center Support Design

MOUNT THE RIBS AND STRUT BEAM ASSEMBLY TO THE SPARS

Step 10: Square the Rib Flanges and Mark the Rivet Lines

Using a try square, check that all the nose rib, main rib, flap cove rib and aileron cove rib flanges are perpendicular to the rib faces. If necessary, square the flanges up with duck bill pliers.

Use a fine point felt-tip marking pen to mark centerlines (rivet lines) on all the rib flanges.

Completed: Left [ ] Right [ ]

Step 11: Reinforce the Root Main Rib

The **root main rib** [1] must be reinforced with the **upper root rib doubler** [39], the **lower root rib doubler** [41], the **root rib reinforcement angle** [43} and the **root rib web doubler angles** (cut from the **.063 X 1/2 X 1/2 angle** [95]), as shown in Figure 16.

Fit the upper and lower doublers to the outboard side of the root rib, as shown, trimming the corners of the ribs, as necessary, to allow the doublers to fit tightly against them. Only trim as much as necessary.

Cleco the root rib into place between the spars. Make sure the rib fits squarely between the spars and the spars are square and true to the jig brackets. Slide the upper and lower rib doublers into place from the outboard side of the rib, nesting them against the rib. Trim the ends of the rib doublers the **minimum** amount necessary to allow them to fit into place under the spar flanges. **Be careful not to trim too much**; you will need room to install rivets through the doubler flanges later. You also may have to trim the corners of the ribs additionally to allow the doublers to fit relative to the spars. When the rib/doubler assembly is fitting satisfactorily between the forward and aft spars, mark trim lines onto the upper and lower **flanges** of the root rib doublers, as shown in Figure 16. Notice that the trim lines are referenced to the edges of the spar flanges and that, for most of their length, the doubler flanges are trimmed even with the inboard edges of the rib flanges. The trim lines are the same for both the upper and the lower doubler flanges. Use a band saw or a hack saw to trim the doublers, and then finish the cuts with files and sandpaper. When finished, clamp the doublers to the rib once again.

Mark the positions of the root rib web doublers onto the root rib. Cut the **root rib reinforcement angles** from the supplied **.032" x .63" x 3.3" x 18"** long [43] stock. The reinforcement angles nest inside the flanges on the forward and aft side of the root rib and extend to the nearest web doubler angle as shown in Figure 16 by the two shaded regions. The two forward spar reinforcements are 4.7" long and the two aft spar reinforcements are 4.2 long. You do not have a lot of excess so measure twice cut once! Trim the flange to fit.

Cut the **root rib web doubler angles** from the **.063" X 1/2" X 1/2" angle** [95] as shown in Figure 16. Make the angles just long enough to fit inside the rib flange bend radii at both ends (about **1/8"–3/16"** from the rib flange itself on each end). Lay out and/or center punch the rivet patterns shown onto the assembly. Clamp the web doubler angles and reinforcement angles into position against the rib/doubler assembly. Drill the holes through all parts with a **#40** bit. Don't place rivets in the area of the fuel tank fitting at the lower, aft edge of the rib, as shown in Figure 16.

With the rib assembly held securely in place, pass drill the three holes on both the forward and aft spar to a 3/16" diameter for AN3 hardware. Both the nose and flap cove rib will have to be pass drilled as well.

Disassemble the root rib , deburr the rivet holes and corrosion-proof the parts.

It is recommended that the following assembly be riveted while in the wing jig nested between the spars.

Cleco and then rivet the root rib/doubler/web doubler angle assembly together. Use 3/32" AN470AD3 universal-head rivets for all the rivet holes in the assembly.

Completed: Left [ ] Right [ ]

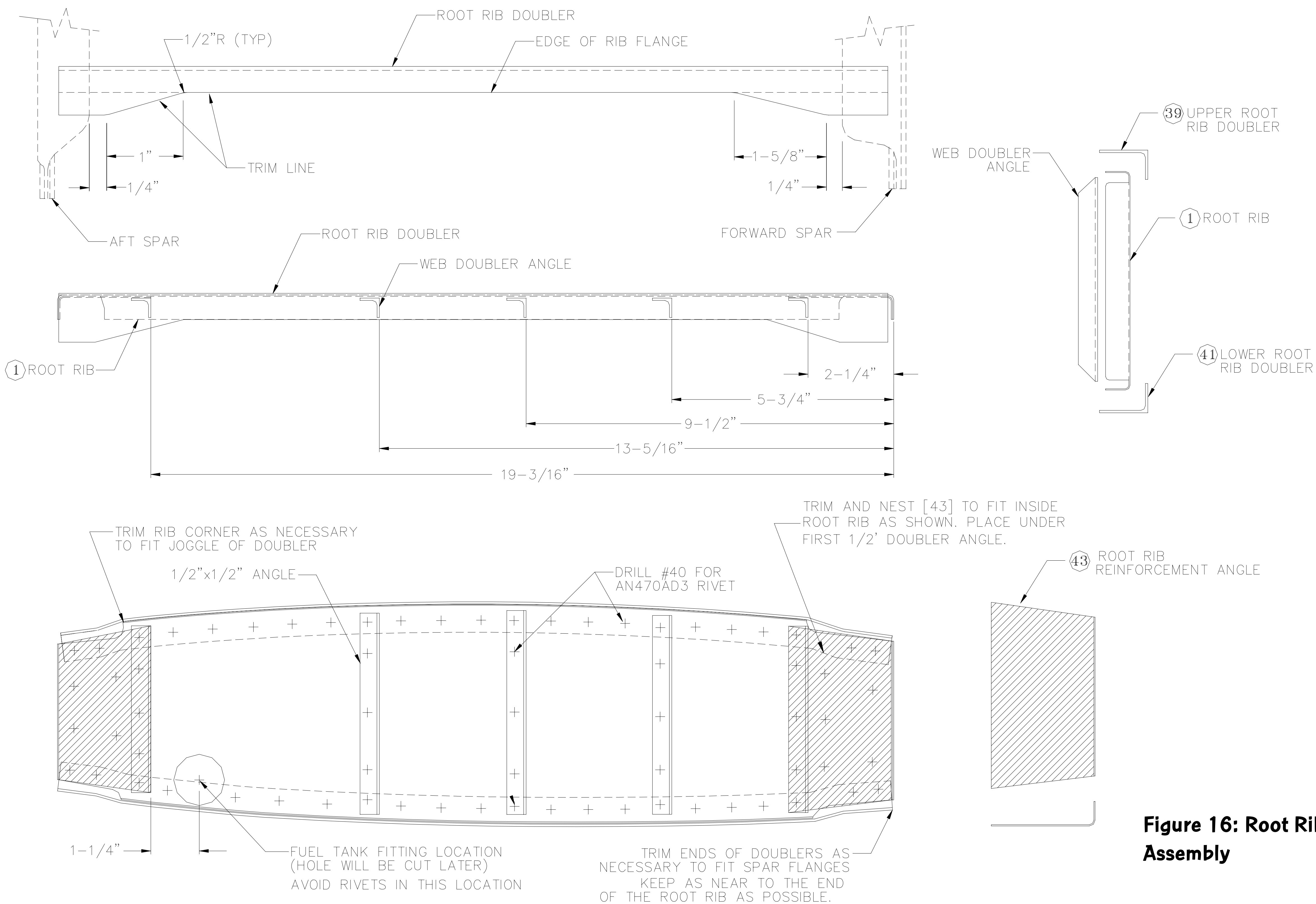


Figure 16: Root Rib Assembly

Step 12: Mount the Ribs to the Spars

Cleco the **root nose rib** [5], the reinforced **root main rib** [1] and the **root flap cove rib** [9] to the spars.

> **Note** You will need extended-grip Clecos for the root ribs. These three holes will eventually get drilled up to 3/16" diameter for three AN3 bolts through both the forward and aft spar.

The flanges of these three ribs point inboard. Use two Clecos through the forward spar to secure the nose rib and the forward end of the main rib; use two Clecos through the aft spar to secure the flap cove rib and the aft end of the main rib.

> **Note** To orient the main ribs, position the wider ends of the ribs forward and position the center tooling holes in the ribs toward the upper surface of the wing, as shown in Figure 17. The root main and root nose ribs can be distinguished from the outboard ribs by the absence of the flanged lightening holes in the root ribs. The root flap cove rib is slightly shorter than the other flap cove ribs to accommodate the rear-side aft spar root doubler.

Three #30 pilot holes for mounting the ribs are drilled through the spar assemblies, but only two holes exist in the end flanges of the ribs. Drill the additional holes through the rib flanges at this time. First, remove the root nose rib and root flap cove rib, and use the three holes in each spar to drill **#30** holes through the end flanges of the root main rib. Then, remove the main rib, reinstall the nose and flap cove ribs and use the three extra holes in the spar to drill holes through the nose and cove rib flanges. Reinstall the main rib.

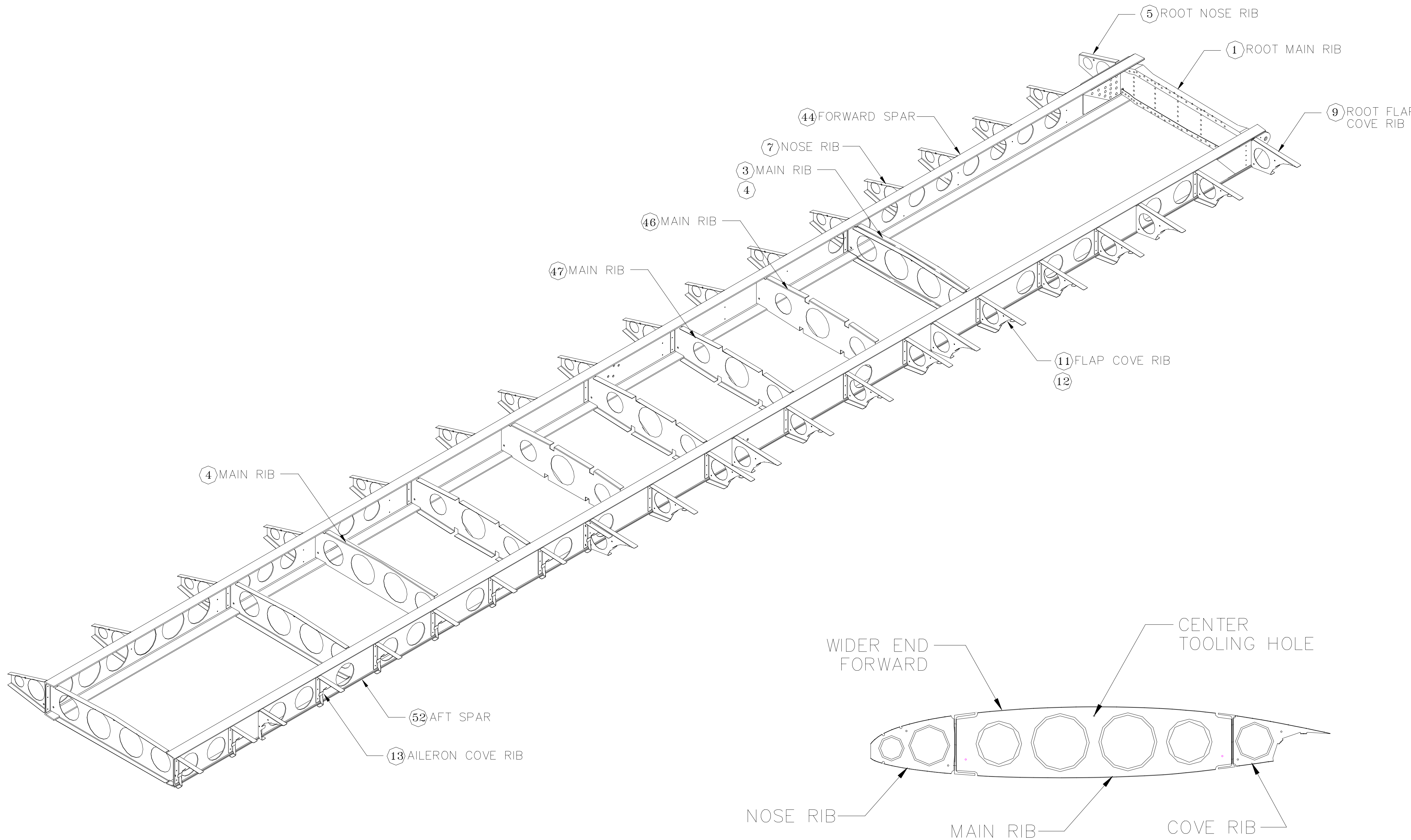


Figure 17: Rib Installation

> **Note** We will use numbers to refer to specific ribs throughout this section of the manual, with the **furthest inboard** rib of any particular type called "Rib 1" and the other ribs of that type numbered sequentially outboard from Rib 1. For example, when we refer to "Flap Cove Rib 3," we mean the third flap cove rib from the root, counting the root flap cove rib as number one. We might also refer to the wing station for the rib, such as the rib at station 69.0.

Cleco the sixteen **outboard nose ribs** [7], and the ten **outboard main ribs** [3, 4, 46 and 47] to the spars, paying careful attention to the orientation of the flanges (see Figure 1 and Tables 2 and 3). Note the ribs at station 69.0 are two ribs [3 and 4] placed back to back with the inboard most rib at station 69.0. Fasten the main ribs in place with two Clecos at each end using the pre-drilled holes in the spars. Fasten each of the nose ribs with two Clecos, also.

> **Note** The extra thickness of the spar cap legs makes for a shorter rib span. For this reason, the [46 and 47] ribs are used. The space between th upper and lower spar cap should be filled in with shim stock or any scrap material at each rib location. It only acts as a fille for the rivets. The ribs at station 84.0 and 141.75 will requir a full shim on the rear spar since the rear spar caps stop before that rib station. The spar caps are made from .09 thick material Use the provided shim material [112] to shim as required.

Cleco the flap cove ribs [11 and 12] and the aileron cove ribs [13 and 14] to the aft spar, with the flange orientations shown in Figures 1 & 17 and Tables 4 and 5. Counting outboard with the root flap cove rib number one, the flanges of Flap Cove Ribs 1, 3, 7, 11 and 14 are oriented inboard; the flanges of the remaining flap cove ribs are oriented outboard. Counting from the furthest inboard location, the flange of Aileron Cove Rib 7 is oriented inboard; all other aileron cove rib flanges are oriented outboard.

Holes are not pre-drilled in the aft spar for Aileron Cove Rib 1. To mount Aileron Cove Rib 1, butt its inboard side against the outboard side of Flap Cove Rib 14 (the flanges of the two ribs are oriented in opposite directions. Clamp the aileron cove rib to the aft spar and use the holes in its forward flange to drill #40 holes through the spar. When using the tables for the rib locations remember that the wing attach hole in the forward spar is located at BL 22.5 and the wing attach hole in the aft spar is located at BL 22.0.

Note The outboard wing jig brackets interfere with installing the tip ribs. Relieve the ends of the jig brackets, if necessary, to clear the rib webs. Fit the forward end of Main Tip Rib between the forward spar wing jig bracket and the forward spar; fit the forward end of Aileron Cove Rib 9 between the aft spar wing jig bracket and the aft spar. This raises both spars by the thickness of the rib material, which is acceptable.

When all of the ribs have been mounted to the spars, check that the rib is centered vertically on the spar so the flange of the rib mates nicely to the flange on the spar. The rib can be adjusted up or down slightly and clamped with C-clamps while re-drilling to optimize the skin match-up between the rib flanges and the spar. Use a **#30** bit to drill up all the rib-to-spar web rivet holes to final diameter for 1/8" rivets.

All the leading edge and main ribs between Station 33.2 and 144.95 will need 5 #30 holes. The rest require only three each. The double main rib at Station 69.0 only require 3 per rib on the aft spar and 5 at 69.0 common to the front spar. Since there are two ribs, there will be a total of 6 rivets on the rear spar. Drill the holes per Figure 18 to secure the two main ribs at 69.0 to each other. Refer to Figures 18-21 for drilling and rivet information for the nose and main ribs between Stations 69.0 and 171.75.

Note **Do not** drill all five holes where Main Rib 5 (Station 112.53) attaches to the aft spar. These holes share rivets with the flap track ribs and will be drilled when the flap tracks are installed. Also, **do not** drill the **middle** rivet holes for Flap Cove Rib 14 and Aileron Cove Rib 1; rivets installed in these holes would interfere with the aileron pulley brackets (see Step 51 in this WING ASSEMBLY section). To drill the center holes through the tip ribs, clamp the spar/rib assemblies to the jig brackets and remove the 3/32" Clecos. Drill up to **#30** size through the ribs, spar webs and jig brackets, and then use 1/8" Clecos to secure the spar/rib assemblies to the jig brackets.

Completed: Left [ ] Right [ ]

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: [redacted].

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

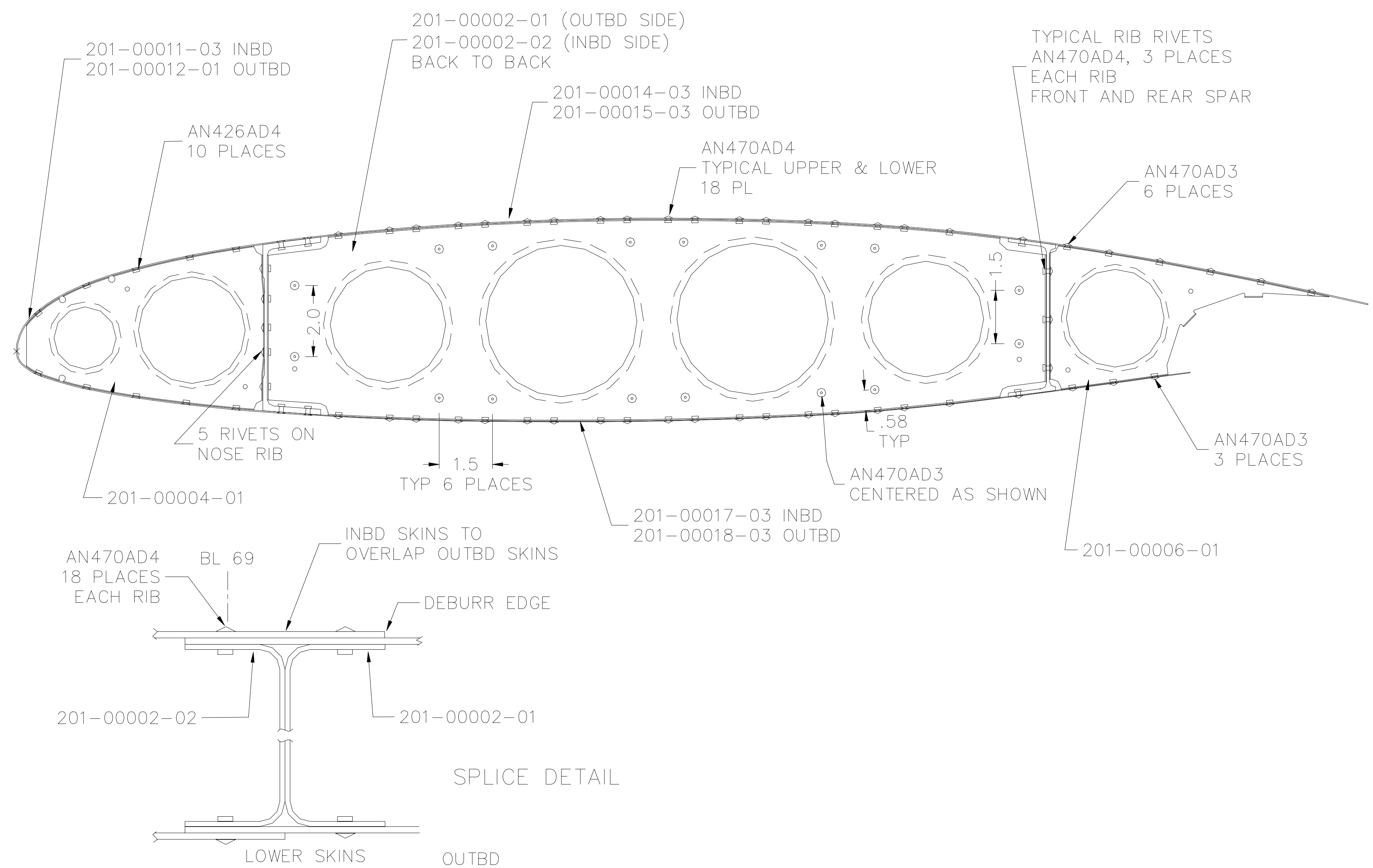


Figure 18: Wing Station 69.0 Details

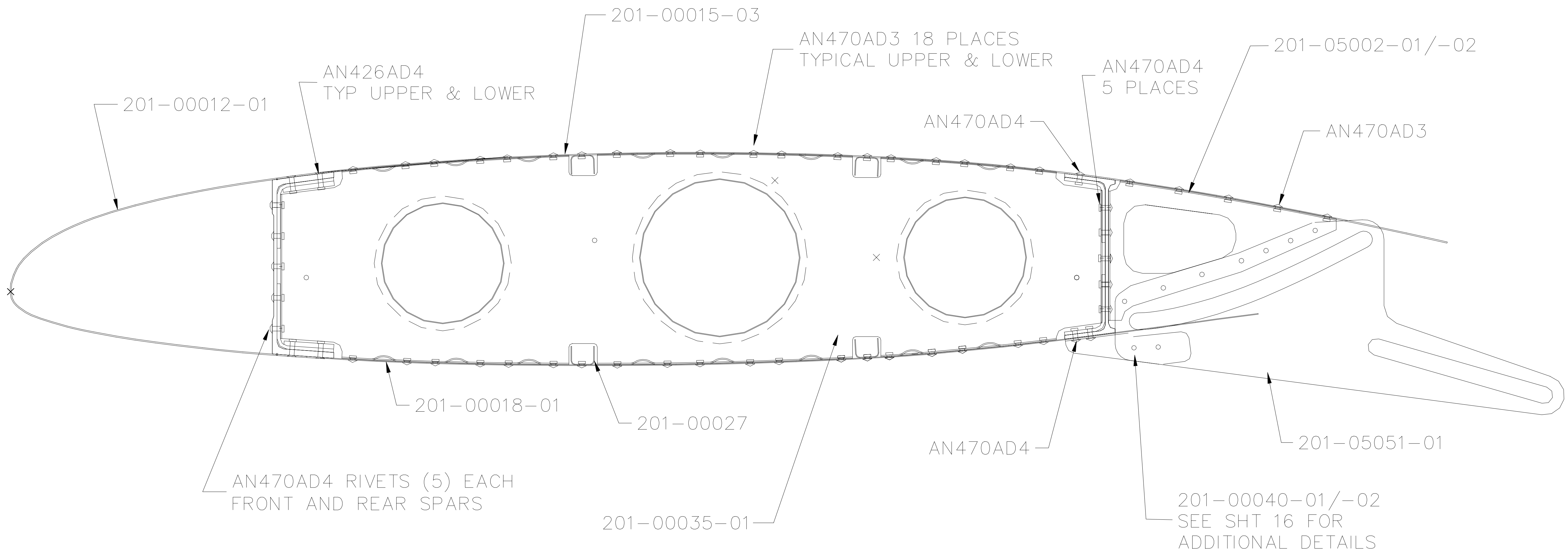
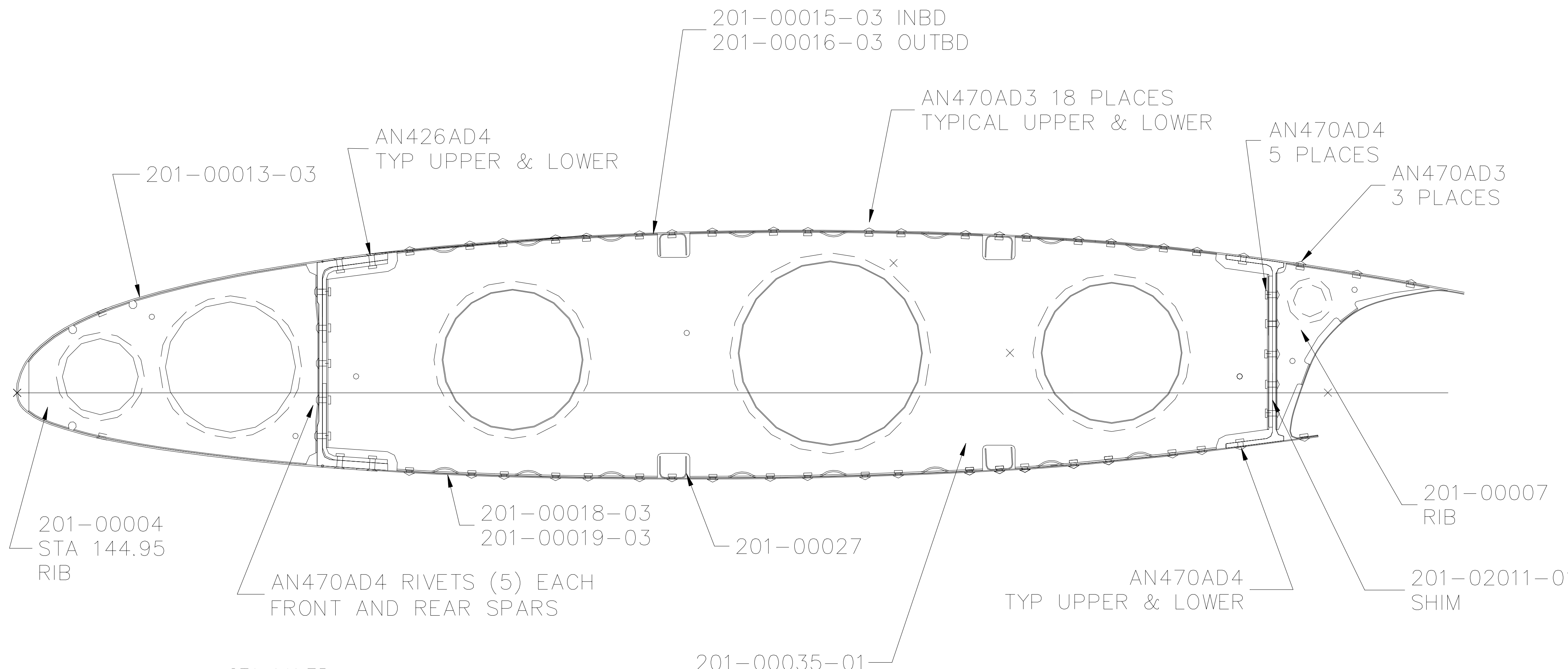


Figure 19: Wing Station 112.53 Details



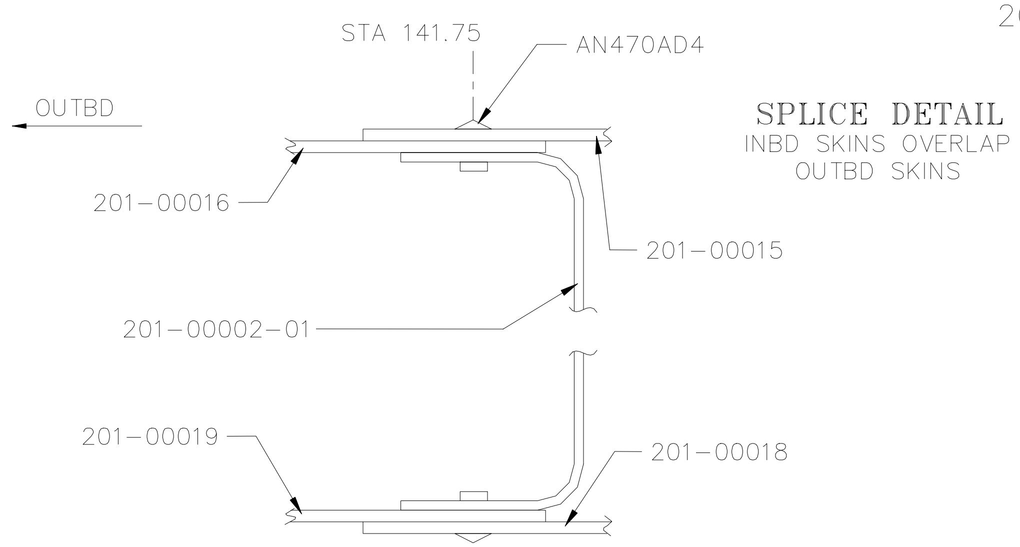


Figure 20: Wing Station 141.75 Details

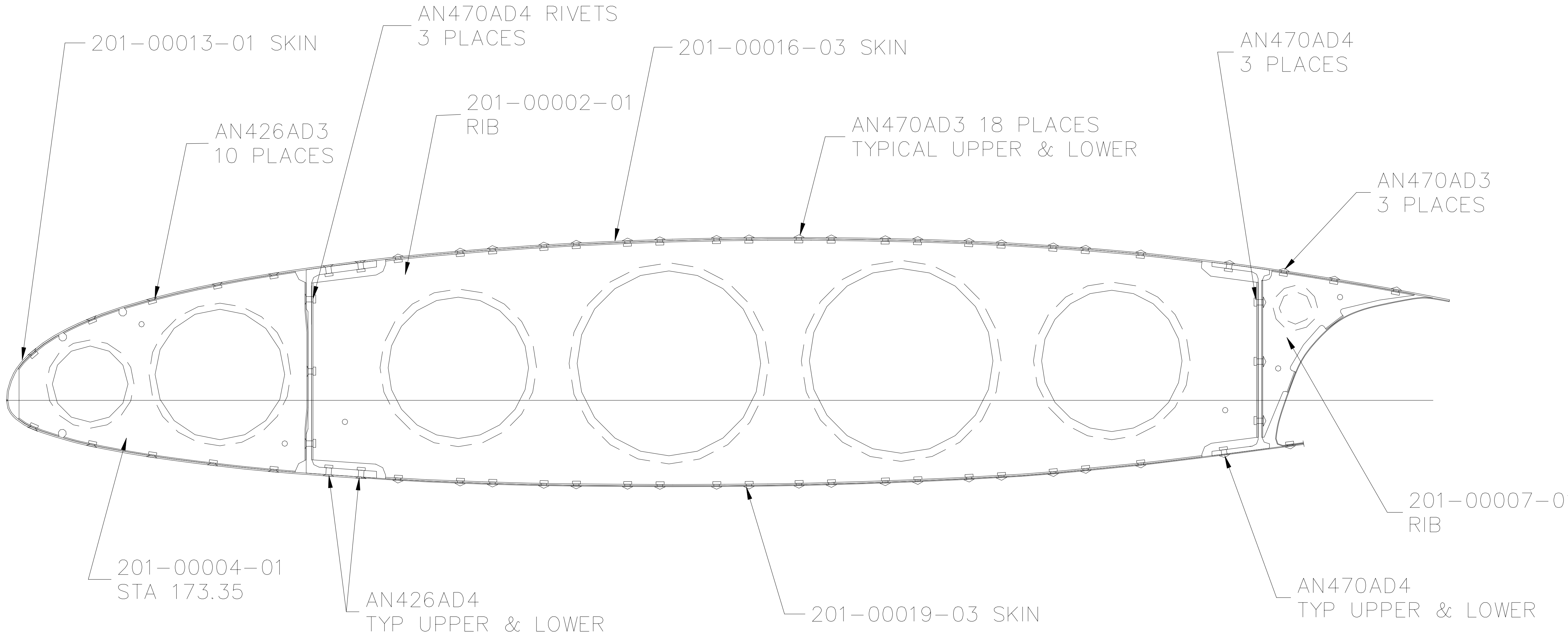


Figure 21: Wing Station 171.75

Step 13: Mark the Ribs

Choosing a standard notation (for example, "LM1" through "LM6" for the left main ribs, "LN1" through "LN17" for the left nose ribs, and so on), mark each rib, noting its order relative to the other ribs. Also mark the spar with the same notation at each rib location. The spar/rib assembly will be disassembled and reassembled multiple times, and **it's vital that each rib be returned to its original position** at each reassembly. Mark a rivet centerline on all the ribs as well.

> **Hint** Use a grease pencil or a marking pen with permanent ink to mark the ribs, or attach a tag to each part. Don't use a lead pencil as this can lead to dissimilar metal corrosion.

Completed: Left [ ] Right [ ]

Step 14: Assemble the Strut Beam

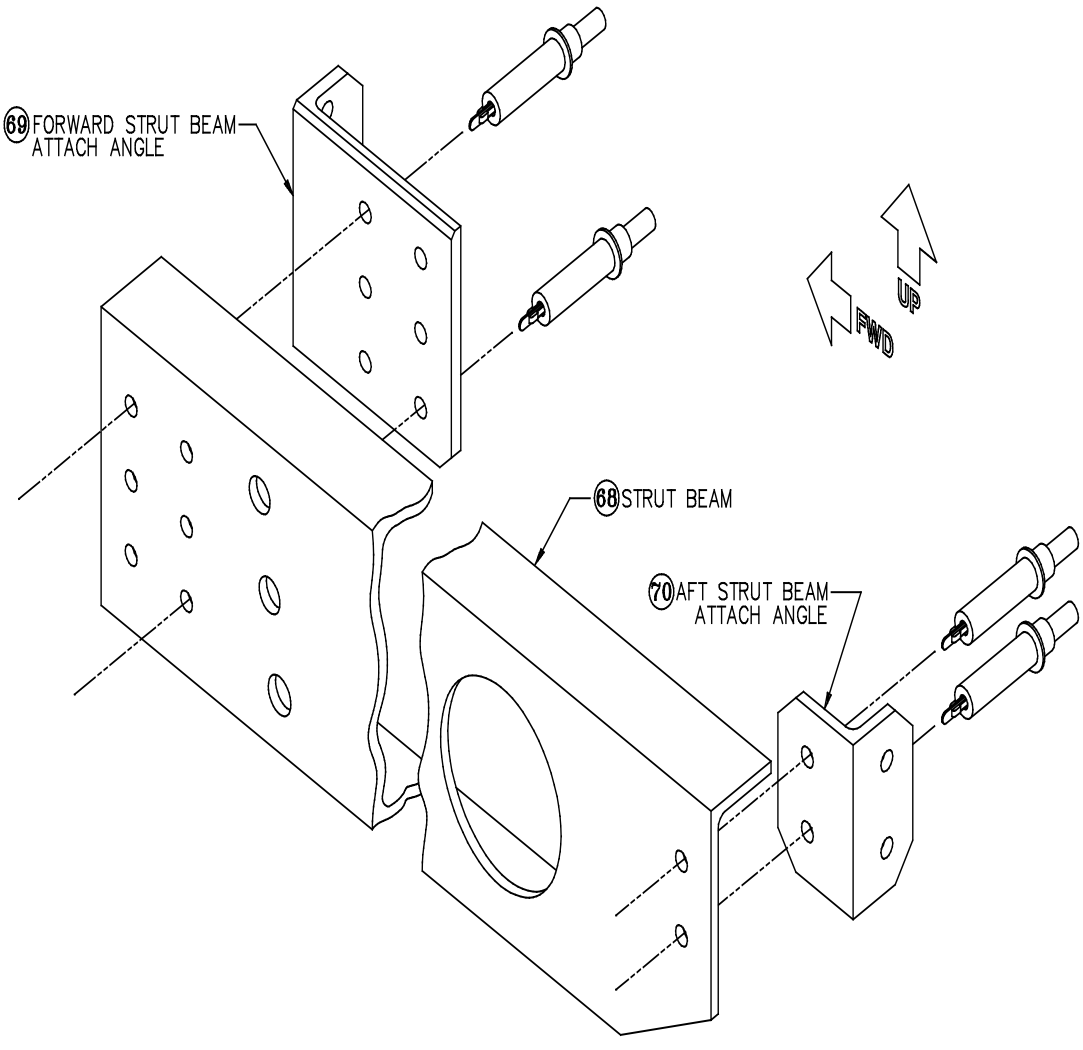


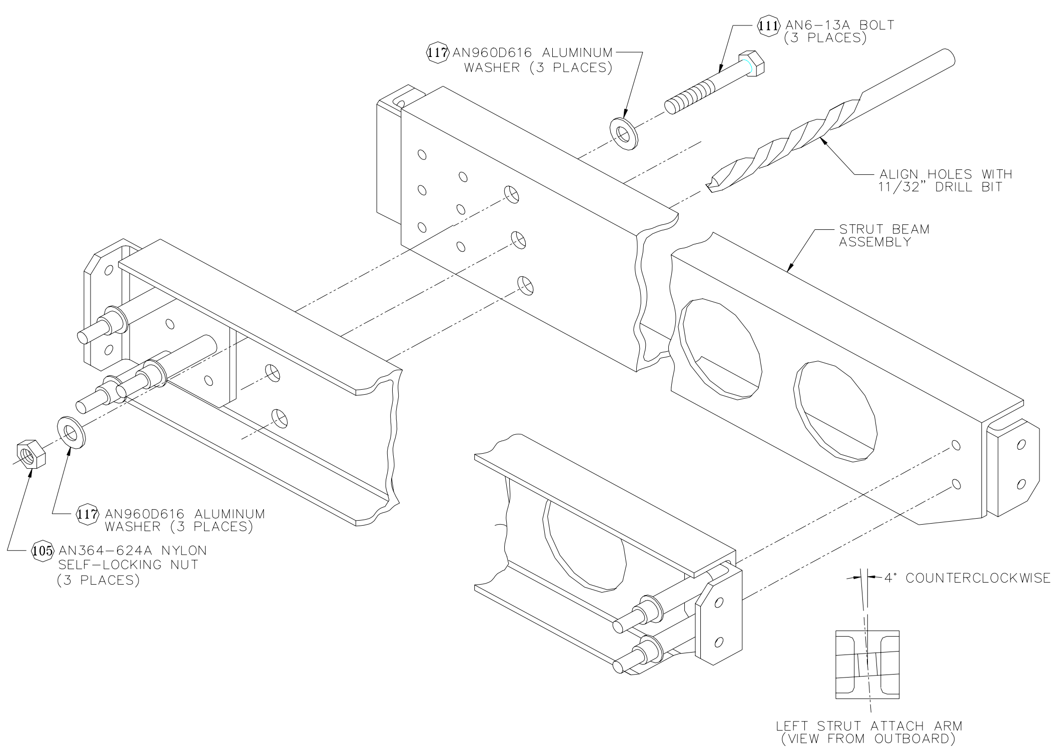
Figure 22: Fastening the Attach Angles to the Strut Beams

Your strut beam assembly will be one of two versions. The early Sportsman kits will have the type shown in Figure 22 with two holes at the Aft Strut Beam Attach Angle (the ones used by the clecos above). The later kits will have only one 3/8" hole common to the Aft Strut Beam Attach Angle and the Strut Beam.

Use 3/16" Clecos or temporary AN3 bolts to fasten a **forward strut beam attach angle** [69] and an AN6-15A bolt (or 3/16" Clecos) to fasten an **aft strut beam attach angle** [70] to both the **left-flange strut beam** [67] and the **right- flange strut beam** [68], as shown in Figure 23. (The longer leg of the aft strut beam attach angle fastens to the strut beam.) To distinguish between the **left** and **right strut attach arms** [71 and 72], refer to Figure 23. Notice that, for the **left** arm, the **outboard** end (the thin end that fastens between the strut beams) is rotated about **4° counterclockwise** relative to the inboard end when viewed from the outboard end. For the **right** arm, the **outboard** end is rotated about **4° clockwise** relative to the inboard end when viewed from the outboard end.

Pass drill with a 1/4 " bit or reamer all the holes common to the forward angles [67, 68 & 69] making sure the other holes for the strut attach arms and aft strut attach angle are aligned with each other. As shown in Figure 24, the overall dimension across the forward and aft angles should be 21.740 / 21.710. Make sure all the angles are parallel to each other.

Figure 23: Pass Drilling the Strut Beam



Next, insert the clamp up spacers [57 & 58] in the respective space between the two strut beams and install the left strut attach arm [71]. Use a 3/8" AN6-13A bolt [111] to pin the **strut attach arm** [71] between the two strut beams through the one 3/8" diameter hole in all three parts. Pin the attach arm to the beam assembly with an 11/32" drill bit through one of the other two holes. Finally, ream the other two holes common to the strut beams and the arm up to a final .375" diameter.

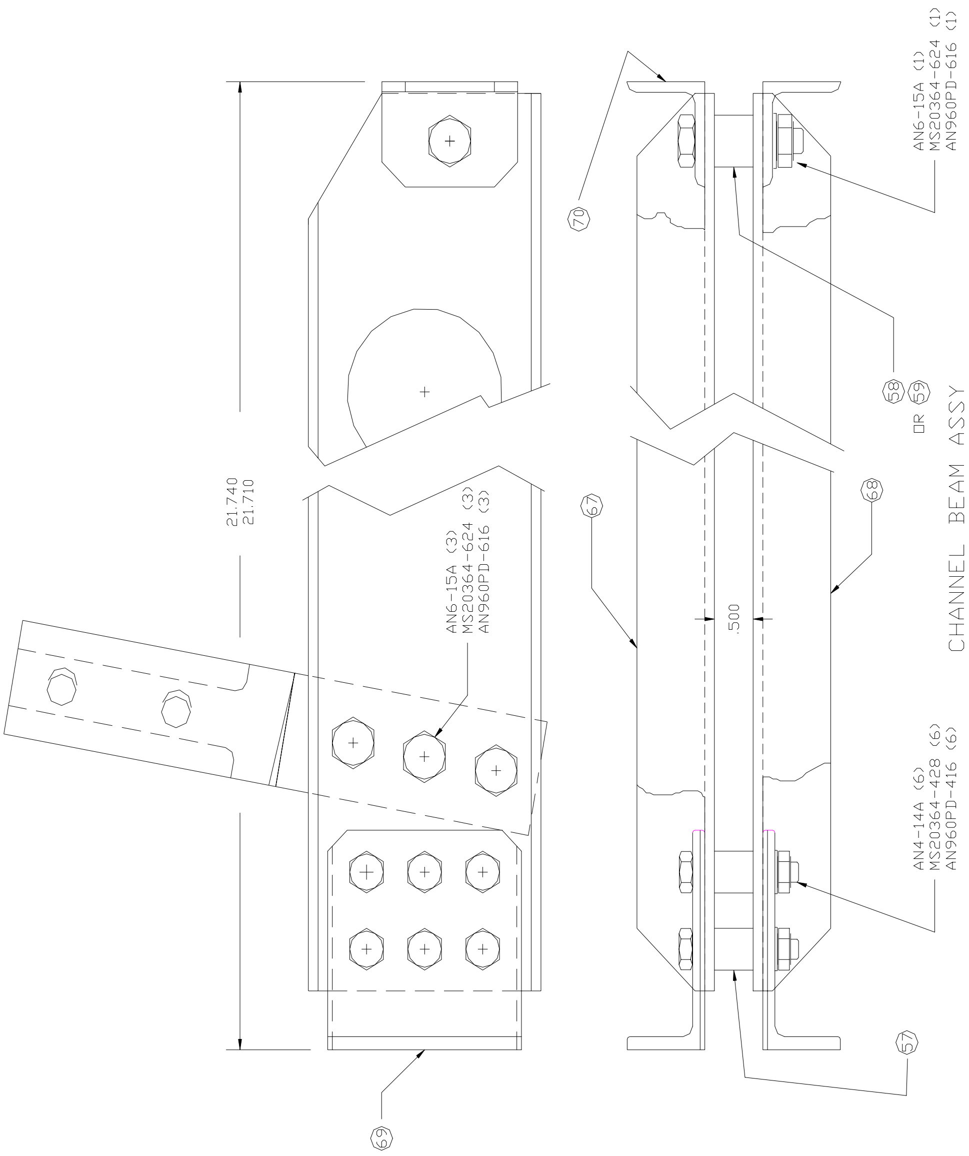


Figure 24: The Strut Beam Assembly

You can clean, deburr and corrosion proof all the strut beam assembly parts at this time. Finally, assemble the hardware as shown in Figure 24. Use 3 AN6-13A bolts [111], 3 AN960D616 washers [117] and 3 AN364-624A locknuts [105] to secure the strut attach arm [71] to the two strut beams. Make sure the bolt heads point up for the assembly.

Use 6 AN4-14A bolts, six of the 1/4 " diameter clamp-up spacers [57], six AN960PD-416 aluminum washers and six MS20364-428 (AN364-428A) locknuts to secure the angles on the forward end.

Use 1 AN6-15A bolt, the 3/8" diameter clamp-up spacer [58] and one AN960PD616 washer and MS20364-624 (AN364-624A) locknut. **[If you have the earlier version of the strut beam assembly, then replace the hardware on the aft attach angle with (2) AN4-14A bolts, washers, and nuts.]**

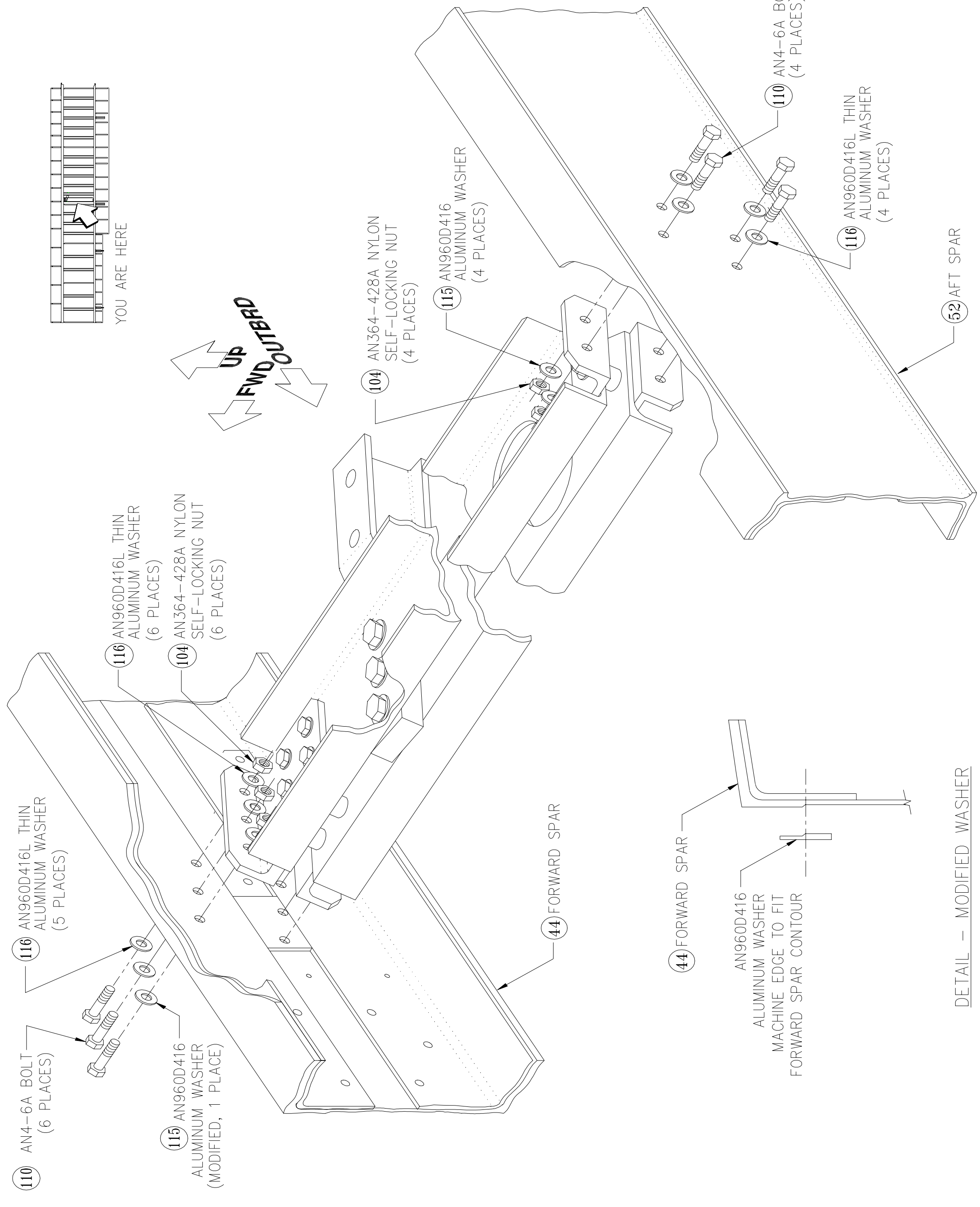
Completed: Left [ ] Right [ ]

Step 15: Mount the Strut Beam Assembly

Install the strut beam assembly between the spars, and fasten it to the forward spar using six AN4-6A bolts and AN364-428A nylon self-locking nuts, as shown in Figure 25. The washer for the **upper, outboard** bolt head must be ground to fit the contour of the spar; use a file or a bench grinder to modify an AN960D416 aluminum washer to fit, as shown in the detail in Figure 25. The other five bolts use an AN960D416L thin aluminum washer on the forward side under the bolt head. All six bolts use AN960D416L thin aluminum washers under the nut.

Fasten the strut beam assembly to the aft spar with four AN4-6A bolts and AN364-428A nylon self-locking nuts. Use AN960D416L thin aluminum washers under the bolt heads and standard AN960D416 aluminum washers under the nuts. Space any gaps under the attach angles between the upper and lower spar flange caps with material of the appropriate thickness.

Completed: Left [ ] Right [ ]



Wing Figure 25: Strut Beam Assembly Installation

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Fit-Up and Drill the Wing Skins

Step 16: Position, Clamp and Index Drill the Outboard Leading Edge Skin

Note The **inboard** leading edge skin is **45-7/16"** long, the **center** leading edge skin is **62-1/2"** long and the **outboard** leading edge skin is **71-3/4"** long. The **inboard** skin has pilot holes for drilling rivet holes through the nose ribs at **both** ends (in addition to the holes for the intermediate ribs, of course); the other two skins **do not** have nose rib pilot holes at the **inboard** ends. (The outboard end of each skin overlaps the inboard end of the adjacent skin. If any of the skins, other than an inboard skin, has pilot holes for a rib at the inboard end, **something is wrong**! Make sure that you have selected the correct skin for the location.) It is very difficult to distinguish between the upper and lower surfaces of the leading edge skins visually. When you wrap the skin around the nose ribs, however, it will very obviously fit if it is right side up and equally obviously not fit if it is upside down. Refer to Figure 26 for help identifying and orienting the leading edge skins.

Note Before beginning to fit your wing skins (as before any major fitting and drilling operation) check that your wing jig posts are still plumb and true and that the spars are still straight. Make any necessary adjustments. Any twist or misalignment will be locked permanently into the structure once the wing skins are drilled.

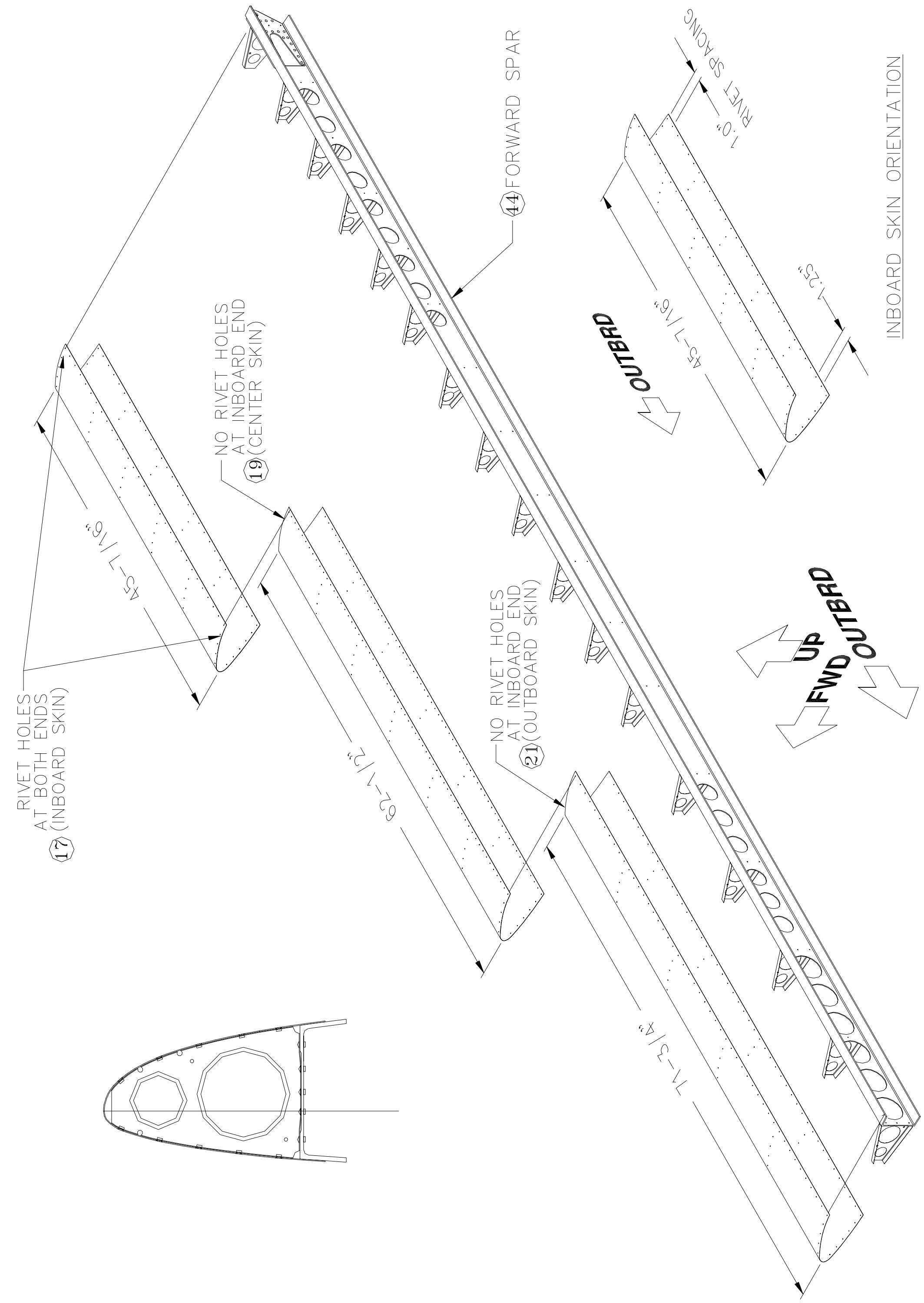

Figure 26: Leading Edge Skins

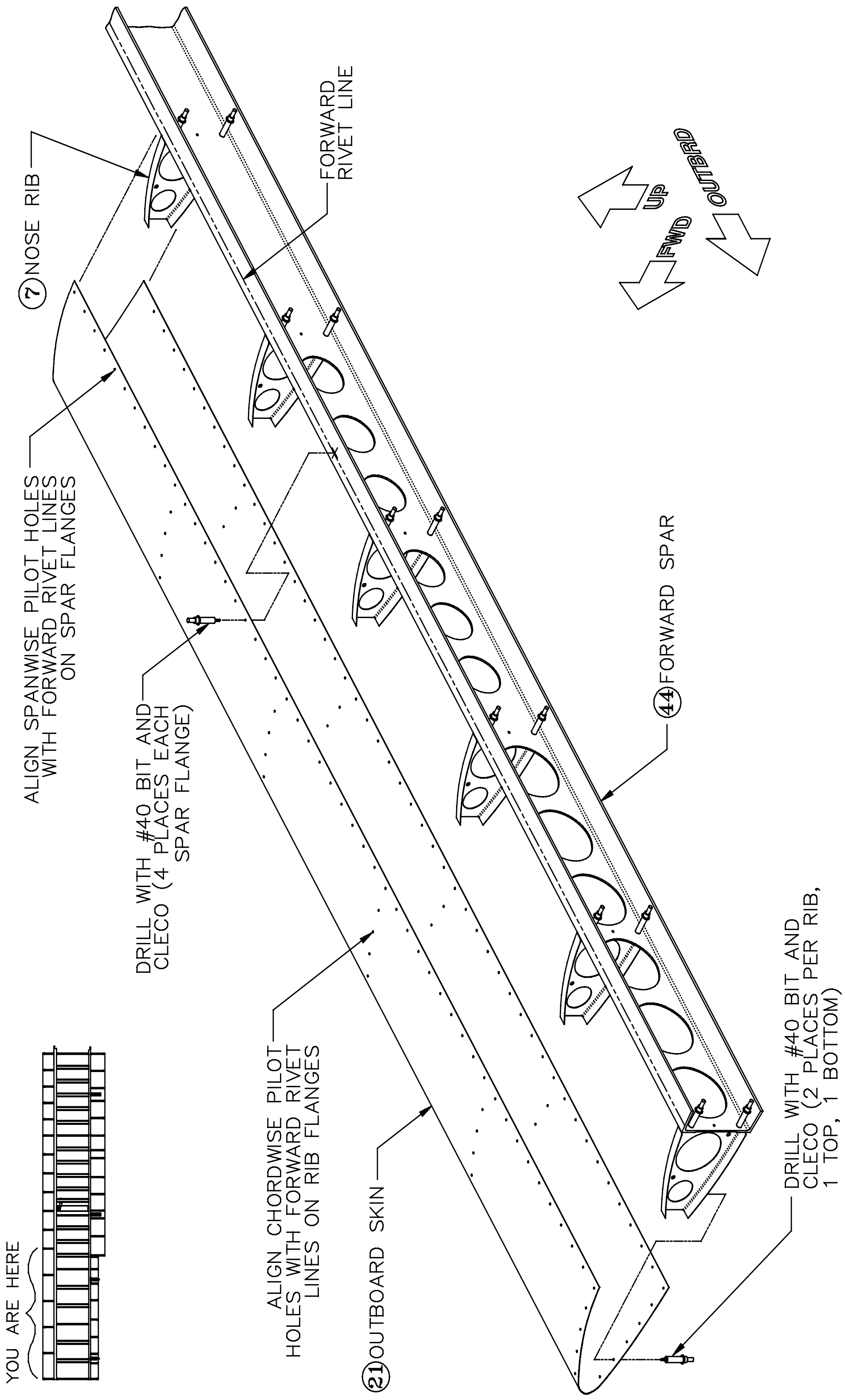

Figure 27: Leading Edge Skin Installation

Note We recommend transferring the rivet lines marked on the nose rib flanges to the forward spar flanges. This will help you to position the leading edge skins correctly in the spanwise direction.

Slide the **outboard leading edge skin** [21] over the nose ribs and forward spar, as shown in Figure 27, aligning the chordwise row of pilot holes in the skin with the centerline marked on the outermost nose rib. When the rib is held perpendicular to the spar and the marked line is aligned under the pilot holes, the outboard edge of the skin will extend **just slightly** (approximately 1/16") beyond the outboard end of the spar and the outboard edge of the rib flanges. Hold the skin tightly against the nose ribs and spar and shift its position forward and aft around the leading edge, as necessary, until the **forward** rivet lines you drew on the spar flanges in Step 7 appear centered or nearly centered in the pre-punched pilot holes in the skin on **both the top and the bottom**.

Hint If you don't have a helper available for this procedure, you can use cabinetmaker's web clamps to pull the leading edge skin into position. Place wooden blocks against the spar web at each clamp position so that the clamps don't deform the spar flanges when tightened. Also, position the straps over nose ribs to avoid deforming the skins. Be careful not to pull the straps too tight.

Hint Sometimes it can be a challenge to keep the ribs in position when moving the skins around. Try hot gluing triangular wooden gussets between the spar and the rib in order to fix the rib in a perpendicular position relative to the spar.

It will be easier to fit the skin into position if you make sure the nose ribs are all straight so that the rivet lines you marked on the rib flanges appear in the pilot holes in the skin. To align the ribs you can use a sharp scribe or an awl inserted through the skin pilot holes to lever the ribs into position or use the rib alignment probe described in "ALUMINUM SHEET METAL WORK, *Clamping Parts Together*" in "SECTION II: TOOLS AND TECHNIQUES."

Once you have the skin positioned satisfactorily, use Cleco side-grip clamps or C-clamps to secure it to the spar flange and to the outboard rib flange.

With the outboard leading edge skin clamped in position, use the pilot holes in the skin as a guide to drill one **#40** index hole through the skin and the spar flange near each end of each spar flange rivet line. Insert a Cleco into each hole to hold the skin in place. Drill and Cleco a few more **#40** holes along the spar flange between the ends on both the top and the bottom.

Note For the holes near the ends of the skin, use holes a few inches inboard or outboard of the ends. This way, if a skin's position has to be shifted slightly, it won't affect a hole common to another skin. Don't drill all the rivet holes until the other leading edge skins have been positioned, aligned and index drilled.

Adjust the nose rib alignment, if necessary, and then use the pilot holes in the skin as a guide to drill two **#40** holes (one on the upper surface and one on the lower surface) through each nose rib **except for the rib under the inboard end of the skin** (Nose Rib 12). The outboard skin does not have pilot holes for drilling Nose Rib 12; these holes will be drilled after the center skin, which overlaps the outboard skin, has been positioned.

Since the inboard end of the outboard skin hides the rivet line marked on the flange of Nose Rib 12, the rivet line must be transferred to the outside surface of the skin so that it will be visible through the pilot holes punched at the outboard end of the center skin. Use a fine-point marking pen to mark rivet lines onto the outboard skin parallel to and **3/8"** from the inboard end of the skin, as shown in Figure 28.

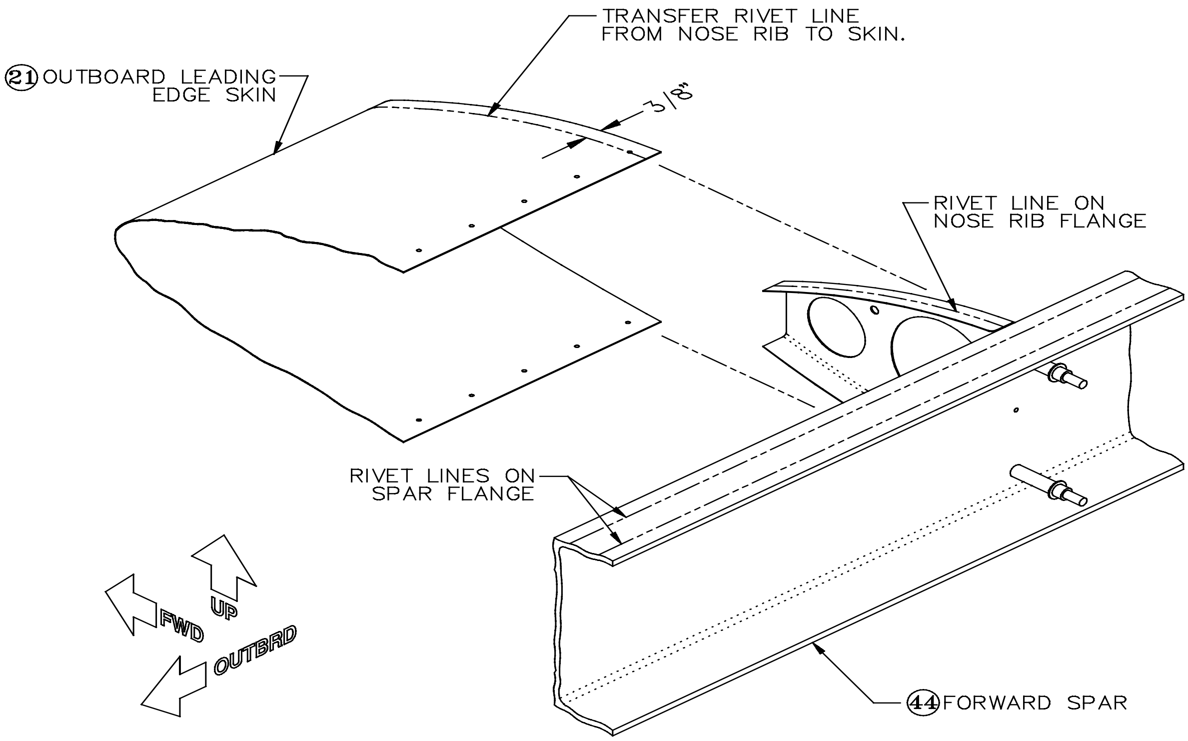

Figure 28: Transfer Nose Rib Rivet Line to Skin

Note Since there are no pilot holes in the outboard skin, you can't tell if Nose Rib 12 is properly aligned when drilling. We recommend removing Nose Rib 12 until a couple of holes have been drilled in the overlap between the center and outboard skins. Then you can reinstall Nose Rib 12 and see the rivet line on its flange to align it for drilling. Use the same procedure for Nose Rib 6, which lies under the overlap for the center and inboard skins.

Completed: Left [ ] Right [ ]

Step 17: Position, Clamp and Index Drill the Center and Inboard Leading Edge Skins

Caution Since the **inboard** leading edge skins are nearly symmetrical, it is very easy to install them on the wrong side (right skin on left wing and vice versa). To distinguish between the left and right skins, notice that the rivet centerline distance on the upper and lower surface of the spar is 1.0" on the inboard end and 1.25" on the outboard end as shown in Figure 26. As a general rule for **all** of the wing skins, take your time and be **absolutely certain** that you have chosen the correct skin for each location before drilling any holes. After you have drilled rivet holes, mark each skin with its location and orientation.

Repeat the process described in the previous step for the **center** [19] and the **inboard leading edge skins** [17], in that order. Refer to Figures 26 thru 29. The outboard end of each skin overlaps the inboard end of the adjacent skin. Position the **center** leading edge skin in the spanwise direction so that the pilot holes for the nose rib rivets are best centered over the rivet lines marked on Nose Ribs 7 through 12. (The Nose Rib 12 rivet line is actually marked on the outside of the outboard skin.)

Since the outboard end of each skin overlaps the previous skin, the spanwise rows of pilot holes for the rivets into the spar flanges will be pulled forward slightly, away from the rivet lines marked on the spar flanges, as shown in Figure 29. This means that the lines of rivet holes will not be perfectly parallel to the marked rivet lines, which is acceptable. Adjust the skins so that the pilot holes on the upper and lower surfaces are offset an equal distance from the rivet lines at their outboard ends. In other words, try to distribute the misalignment caused by the overlap of the skins equally between the upper and the lower surface.

Note Peel off the protective plastic coating from the underlying skin at the overlap. This will reduce the misalignment and result in a tighter fitting skin when finished.

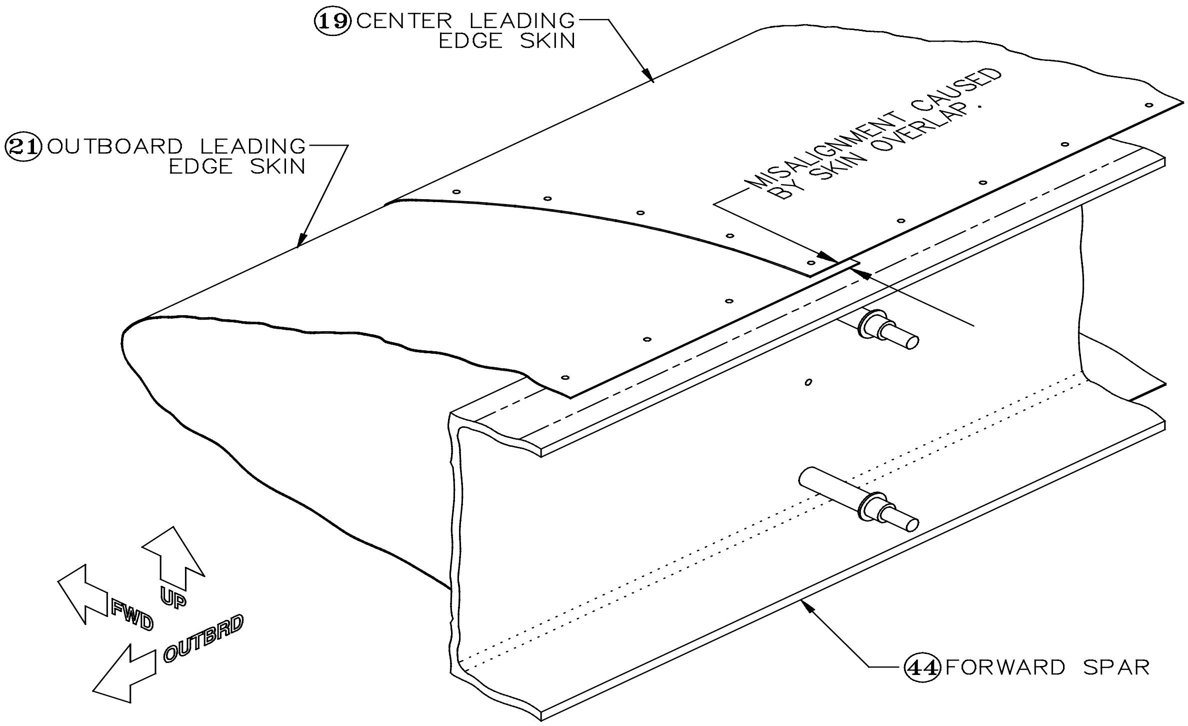

Figure 29: Rivet Line Misalignment Caused by Skin Overlap

Use two tightly stretched strings along the leading edge of the wing (one about 2" back from the nose on the upper surface, the other the same distance back on the lower surface) or a long straightedge to monitor alignment of the leading edge (or simply sight down the leading edge). Adjust the positions of the skins, by shifting their upper and lower trailing edges in opposite directions (fore and aft) relative to the forward spar flange, until the entire wing leading edge is a straight line from root to tip, without dips or jogs (other than those resulting from the skin overlaps) where the skin sections meet. You'll find that small corrections in the skins' positions at the spar result in relatively large changes in the alignment of the leading edge. (To accomplish a straight leading edge, it may be necessary also to adjust the position of the outboard leading edge skin. This is acceptable since only a few holes have been drilled at this time and the holes through the spar flange are undersized to accommodate adjustment.)

When the positions of the center and inboard leading edge skins have been set, drill and Cleco several index holes, first through the spar flanges and then through the nose ribs for each skin in turn, as was done with the outboard skin.

Completed: Left [ ] Right [ ]

Step 18: Install the Forward Spar Caps

By positioning the **Forward Spar Cap [36]** at this time, you can eliminate some deburring and extra steps later. The spar caps are centered about the strut beam on both the upper and lower flanges of the forward spar. They are positioned between wing stations 92 and 128" as shown in Figure 30. The caps will be common to both the leading edge and main skin rivet lines. Using any of the previously drilled index holes pass drill several holes into the spar cap making sure there is adequate edge margin in the corners. If necessary radius the corner of the cap and position it as far forward as possible.

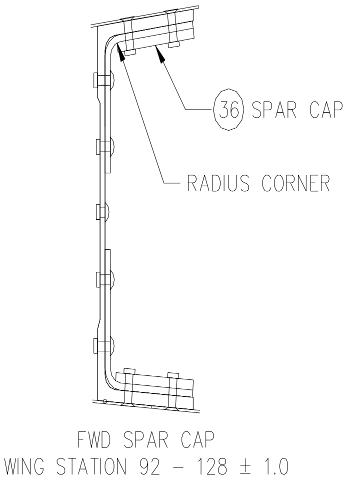

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Figure 30: Positioning of Forward Spar Cap

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Step 19: Finish Drilling the Leading Edge Skins

With all three leading edge skins satisfactorily positioned, you are ready to finish drilling all of the rivet holes. Before doing so, however, mark each skin for its location and orientation, remove the skins, brush off all chips resulting from the index drilling and reassemble. Removing drill chips will help prevent gaps between the skins and the structural framework while drilling.

Note Once again, before beginning to drill, check your jig for plumb and true and check that the spars are straight. This is also your last chance to check that the pilot holes in the skins are well aligned with the rivet lines marked on the rib and spar flanges and to make any minor adjustments.

Except for the rivet holes through the <u>lower</u> spar flange for the <u>inboard</u> leading edge skin, first drill **#40** holes through the spar flanges, using the pilot holes in the skins as guides. Drill every hole, inserting a Cleco into every second or third hole to maintain alignment and to keep the skins clamped tightly to underlying structure while drilling.

Note The **inboard skin lower spar flange** rivet holes (except for the few #40 alignment holes drilled during initial skin fit-up) will be drilled when the lower inboard skin is installed in a subsequent step.

When you have finished drilling all the holes through the spar flange on one side (either upper or lower first is fine), repeat the process on the other side. Then, use the pilot holes in the skins as guides to drill **#40** holes through all the nose ribs. Again, pin every second or third hole as you go.

Hint When drilling the skins, make sure they're clamped securely along their edges. 2"-wide masking tape works well in addition to Clecos. Rather than starting at one end of a line of holes and drilling to the other end, drill holes at the ends and then in the middle of the line; then drill halfway between the holes already drilled, continuing in this fashion until all the holes are finished.

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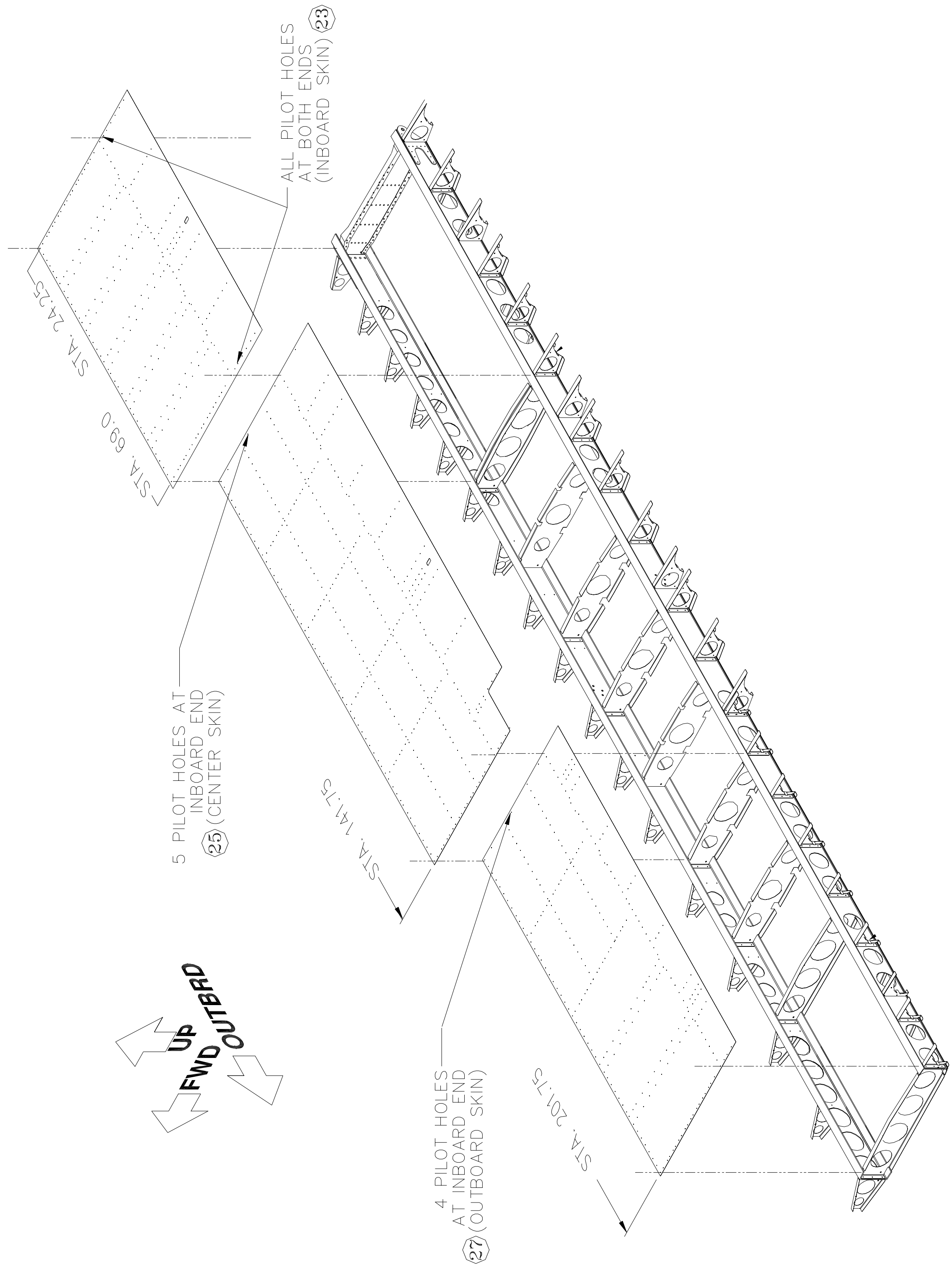

Figure 31: Upper Main Skins

Step 20: Position and Drill the Upper Main Skins

Begin with the **upper outboard skin** [27]. As shown in Figure 31, align the outboard end of the skin with the outboard edge of the outboard main rib flange; align the forward spanwise line of pilot holes in the skin with the aft rivet line on the forward spar flange.

Note Although our Quality Assurance Department makes every effort to be accurate in stamping part numbers on the parts, you should not rely **solely** on the stamped part numbers to identify the wing skins. If you have any questions at all about whether you have chosen the proper skin for a particular location, refer back to the distinguishing features and dimensions discussed above **before** drilling any holes! Once again, check your wing jig for plumb and true and check your spars for straightness before beginning the procedures described in this step

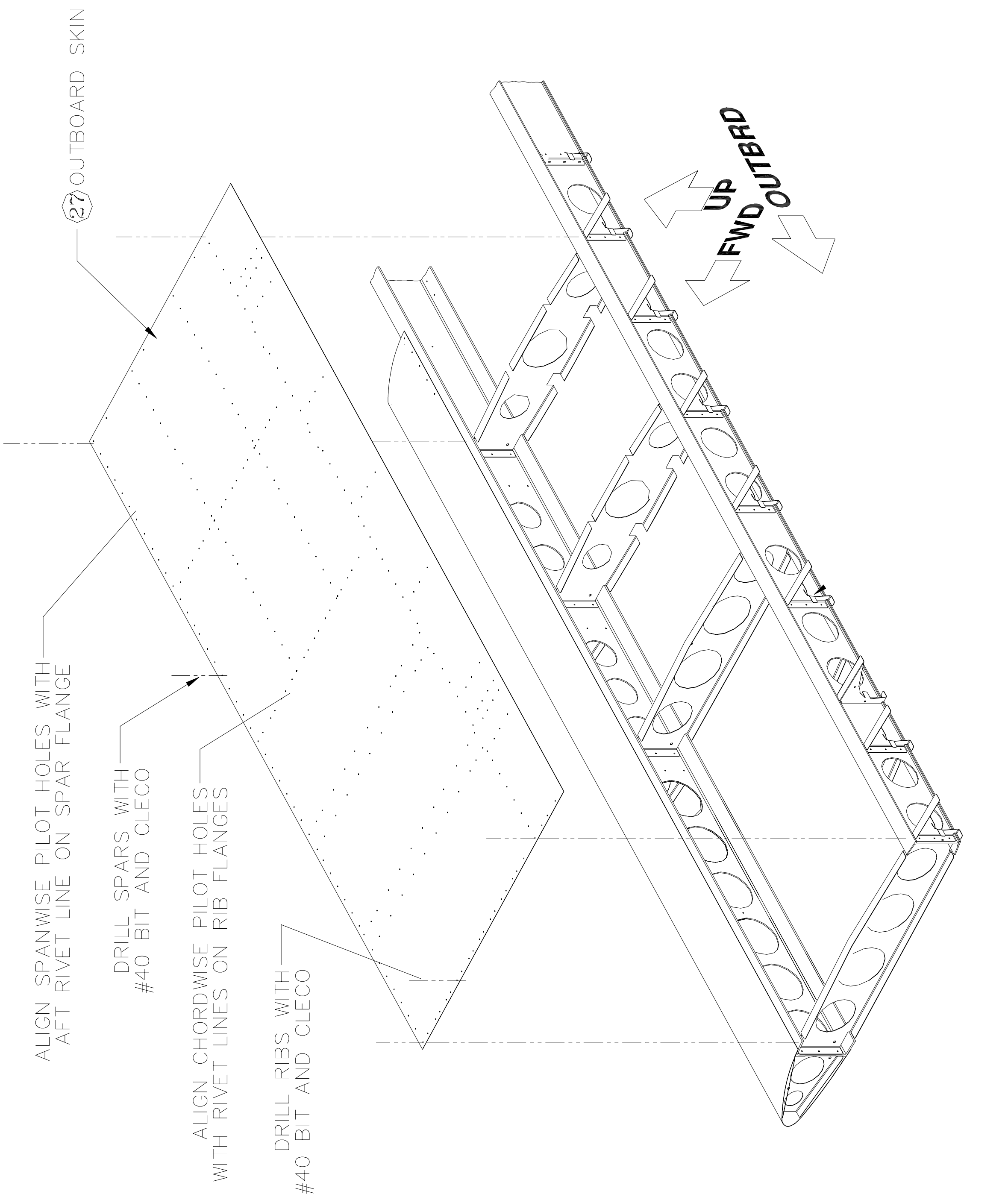

Figure 32: Upper Outboard Skin Installation

Note The forward edge of the upper outboard main skin overlaps the aft edge of the leading edge skin, as shown in Figure 33. This is acceptable for now. The skins will be trimmed in a later step to eliminate the overlap.

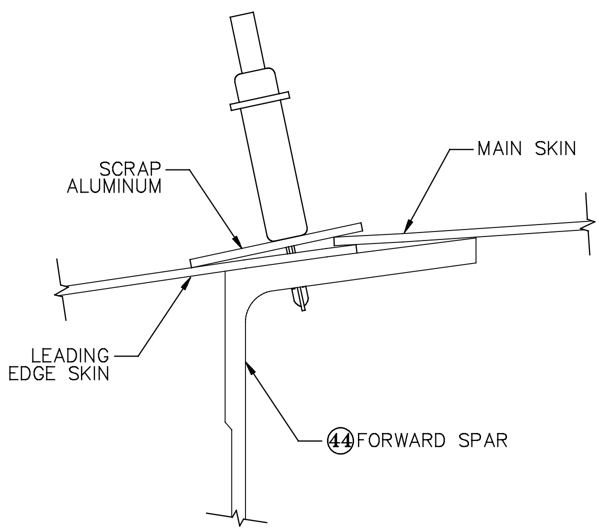

Figure 33: Clamping Method for Main Skins

Use Cleco side-grip clamps or C-clamps to clamp the upper outboard skin to the Main Rib flanges. Use the method shown in Figure 33 to clamp the skin along its leading edge. To use this method, drill #30 holes in some small, square pieces of 1/16" scrap aluminum sheet, and Cleco these pieces to the wing assembly using the same Clecos securing the leading edge skins. The Clecos exert pressure against the aluminum scraps, which in turn clamp the main skin against the spar flange.

Hint 2" wide masking tape also works well to hold the edges of the main skins until you have a few clecos to support the skin.

When the skin is fitted satisfactorily (pilot holes aligned over the rivet lines on the spar and rib flanges), use the pilot holes in the skin as guides to drill three or four **#40** holes through the forward spar, and Cleco the skin in place. Also, using a **#40** bit, drill and Cleco the skin to the main ribs in one or two places per rib, to the aft spar in three or four places and to the aileron cove ribs in one place per rib, in that order.

Repeat this process first for the **upper center skin** [25] and then for the **upper inboard skin** [23]. As with the leading edge skins, lap the outboard ends of the center and inboard skins over the inboard ends of the adjacent skins.

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Note: Step 21 has been omitted

Step 22: Mark and Trim the Leading Edge Skins

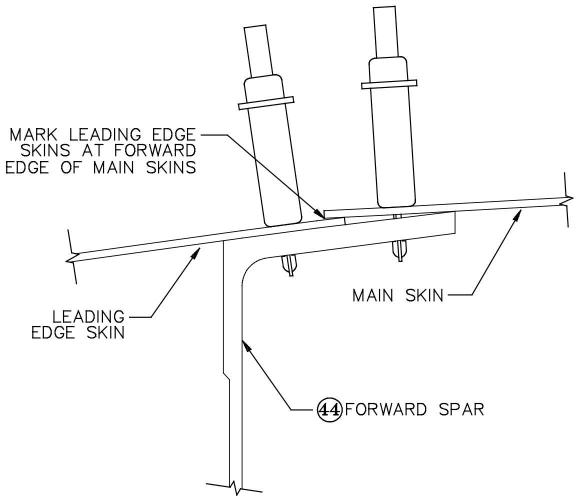

Figure 34: Marking the Leading Edge Skins for Trimming

With all three upper main skins drilled in several places and secured with Clecos as described in the previous step, use a fine point pen to mark along the forward edges of the main skins onto the leading edge skins, as shown in Figure 34.

Remove all the skins and trim the leading edge skins to the marked lines. To do this, first use a pair of offset shears to trim just aft of the line and then file forward to the line.

Note There is no absolute requirement that **only** the leading edge skins be trimmed. You could just as well trim half the necessary width off both the leading edge skins and the main skins. You might want to do this, for example, if the main skins have become nicked along their forward edges or if trimming just the leading edge skins would reduce the edge distance to the centers of the leading edge skin rivet holes to less than the required minimum dimension (5/16" or 2-1/2 times the rivet diameter for countersunk rivets). Since the edges of the skins tend to spread out slightly when riveting, you might want to leave just the slightest gap (.010" or so) between the skins when you have finished trimming them to avoid buckling when riveting.

Hint To simplify trimming the leading edge skins, use a **milled curved-tooth file**. This file, also called a "body file" or a "panzer file," has widely spaced, curved teeth for easy chip clearance. It removes material rapidly and leaves a smooth finish.

Deburr the edges of the leading edge skins when you have finished trimming them.

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Step 23: Finish Drilling the Upper Main Skins

Brush off all chips and shavings and reinstall the leading edge and main skins to the wing structure. Make sure that the main skins no longer overlap the leading edge skins anywhere; trim the leading edge skins further, if necessary.

When the skins are fitted satisfactorily, use the pilot holes in the main skins as guides to drill all the rivet holes through the spars and the ribs. First drill **#40** holes through the forward spar flanges, and insert a Cleco into every second or third hole. Then drill and Cleco **#40** holes through the main ribs. Next, drill and Cleco **#40** holes through the aft spar. Finally, drill and Cleco **#40** holes through the flap and aileron cove ribs.

> **Note** The rivet holes through the spars will be enlarged to #30 diameter as a final step after all of the skins, the forward spar cap strips and the hat section stiffeners have been installed.

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Step 24: Position and Drill the Lower Outboard and Center Main Skins

Use the same procedures described for the **upper** skins in Steps 27 through 29 to position and drill the **lower outboard skin** [33] and the **lower center skin** [31], in that order.

> **Note** The procedure for installing the **lower inboard skin** [29] is different, and will be described below in Step 25.

> **Caution** As described for the other wing skins in previous steps, make sure that you have chosen the correct skin for each location before drilling any holes. Reference Figure 35 for proper orientation. At station 69.0, the inboard skin will have a wide edge margin to allow for the double rib.

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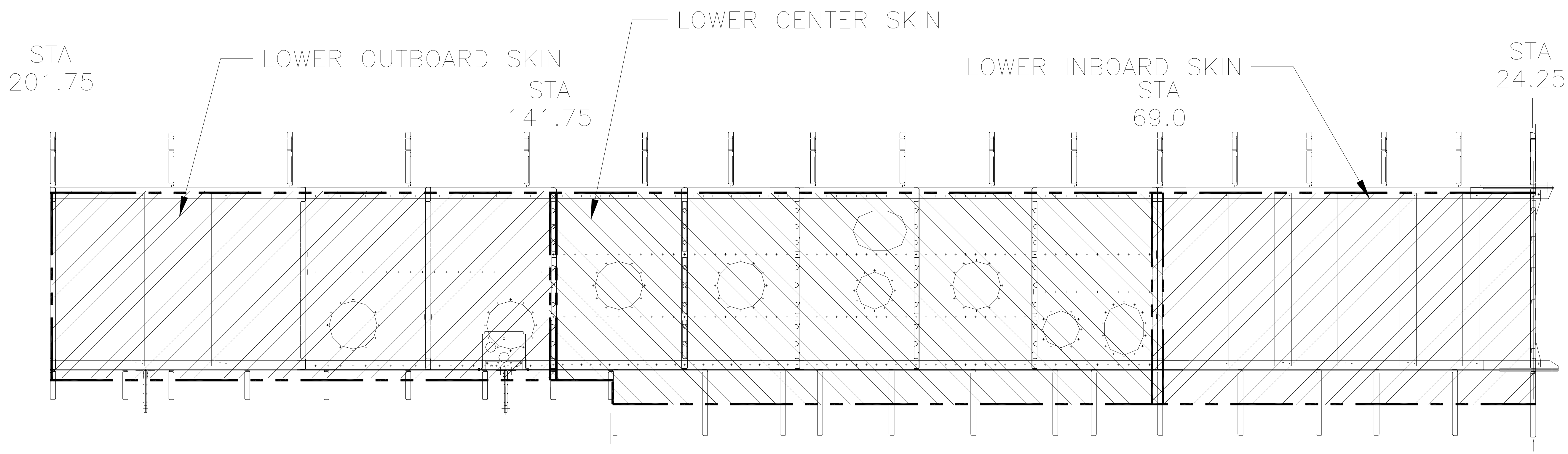

Figure 35: Layout of Lower Skins

Step 25: Position and Drill the Lower Inboard Main Skin

The **lower inboard main skin** [29], unlike the other main skins, is overlapped by the leading edge skin and is secured by a double row of rivets to the lower forward spar flange and a single row of rivets at Station 69.0. The lower inboard skin comes pre-drilled with one row of pilot holes for the forward spar flange rivets; these pilot holes are positioned over the **aft** rivet line marked on the forward spar flange. (See Figure 36.) The second row of rivets is the same one that secures the leading edge skin.

Caution Make sure the lower inboard skin has the wide edge margin at station 69.0 and not at 24.25.

Remove the inboard leading edge skin along its lower edge. Position the lower inboard main skin on the wing structure with its outboard end overlapping the inboard ends of both the center leading edge skin and the lower center main skin, as shown in Figure 37. Align the forward, spanwise line of pre-drilled pilot holes in the lower inboard main skin with the **aft** rivet line marked on the lower forward spar flange, as shown in Figure 36. Align the chordwise lines of pilot holes in the skin with the rivet lines marked on the rib flanges. Use the pilot holes in the lower inboard skin as guides to drill several **#40** rivet holes through the forward spar, the main ribs, the aft spar and the flap cove ribs, in that order. Cleco as you go.

Transfer the **forward** rivet line on the lower spar flange to the outside surface of the inboard lower main skin. Reinstall the inboard leading edge skin with its lower aft edge overlapping the forward edge of the inboard lower main skin, as shown in the detail in Figure 36. Cleco the leading edge skin to the **upper** spar flange and to the nose ribs through the holes drilled earlier. Position the pilot holes in the lower aft edge of the leading edge skin over the rivet line marked on the lower inboard main skin.

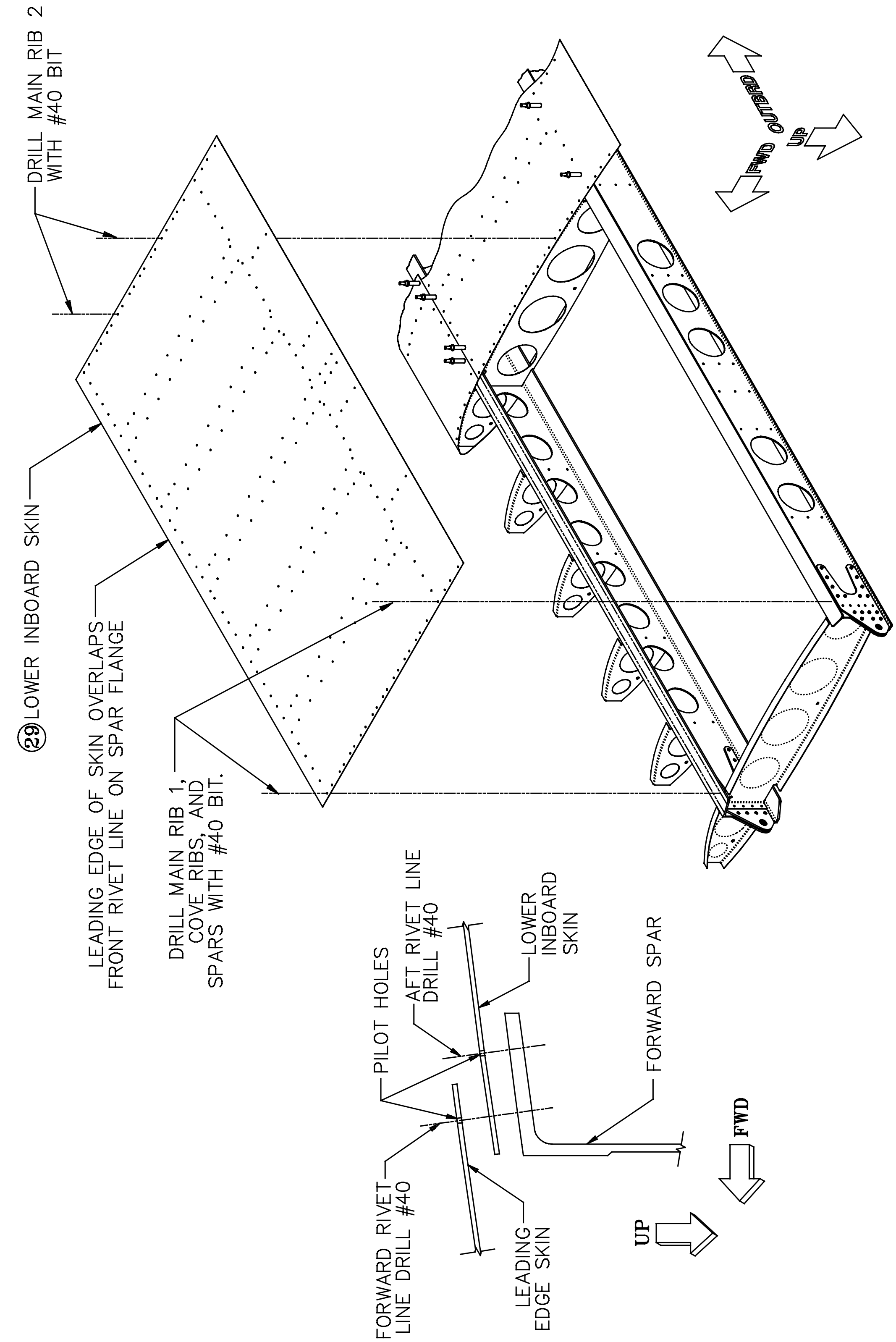

Figure 36: Lower Inboard Main Skin Installation

Use the pilot holes in the lower aft edge of the **leading edge skin** as guides to drill the **forward** line of **#40** rivet holes through the lower inboard main skin and the lower forward spar flange, as shown in Figure 48. Cleco as you go. Use the forward, spanwise row of pre-drilled pilot holes in the **lower inboard main skin** to drill the **aft** line of **#40** rivet holes through the forward spar flange, as shown in Figure 36. (These #40 holes will be enlarged to #30 diameter as a final step after the forward spar cap strips and the hat section stiffeners have been installed.)

Once all the holes through the forward spar have been drilled and Clecoed, use the pilot holes in the outboard end of the lower inboard main skin to drill **#40** rivet holes through the inboard end of the lower center skin and Main Rib at 69.0. Finally, use the pilot holes in the lower inboard skin as guides to drill **#40** rivet holes through Main Rib 1, the aft spar and the flap cove ribs, in that order. (The #40 holes through the spars and Main Ribs 1 and 2 will be enlarged to #30 diameter in a later step.)

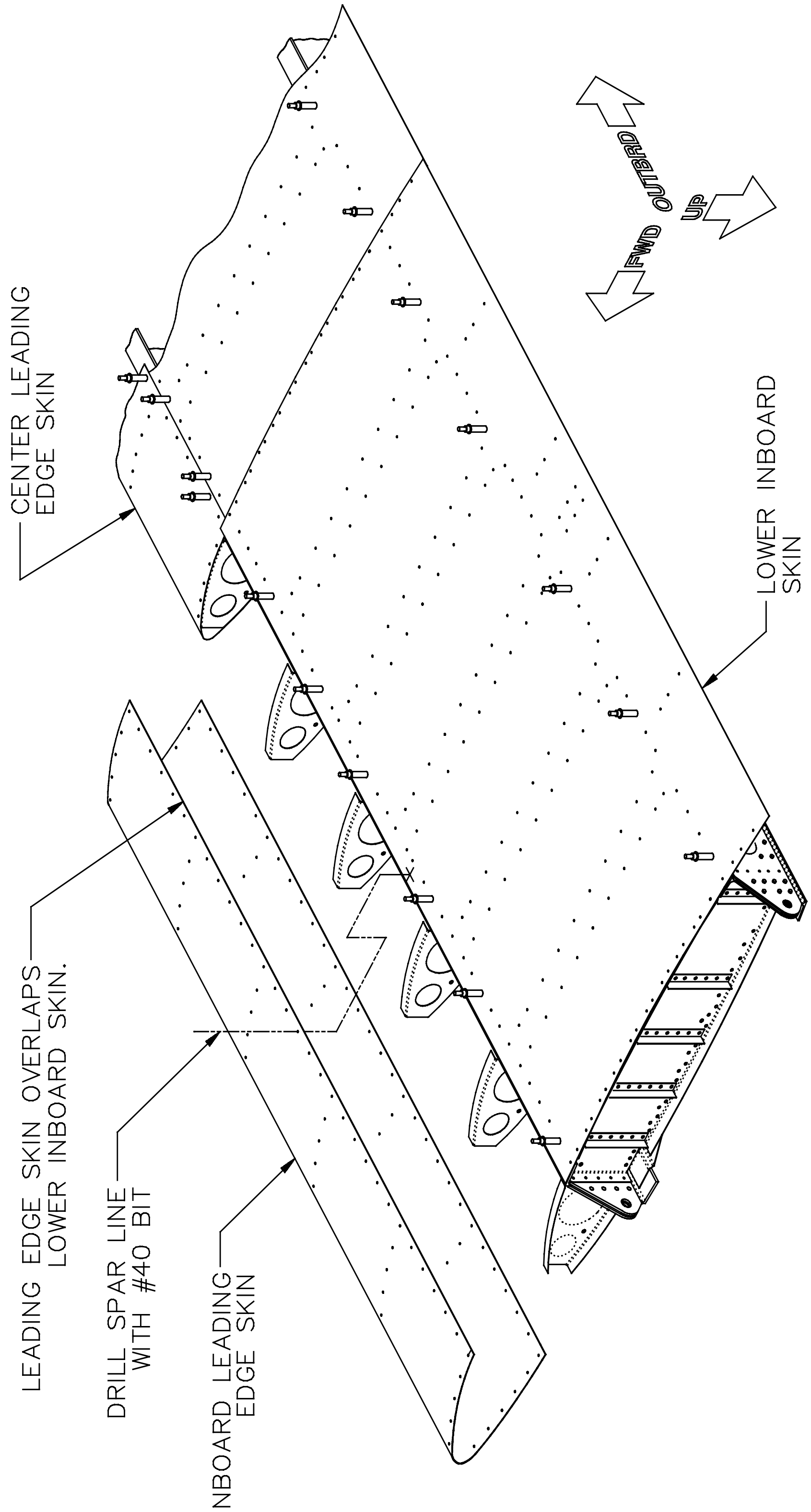

Figure 37: Fitting the Leading Edge Skin over the Lower Inboard Skin

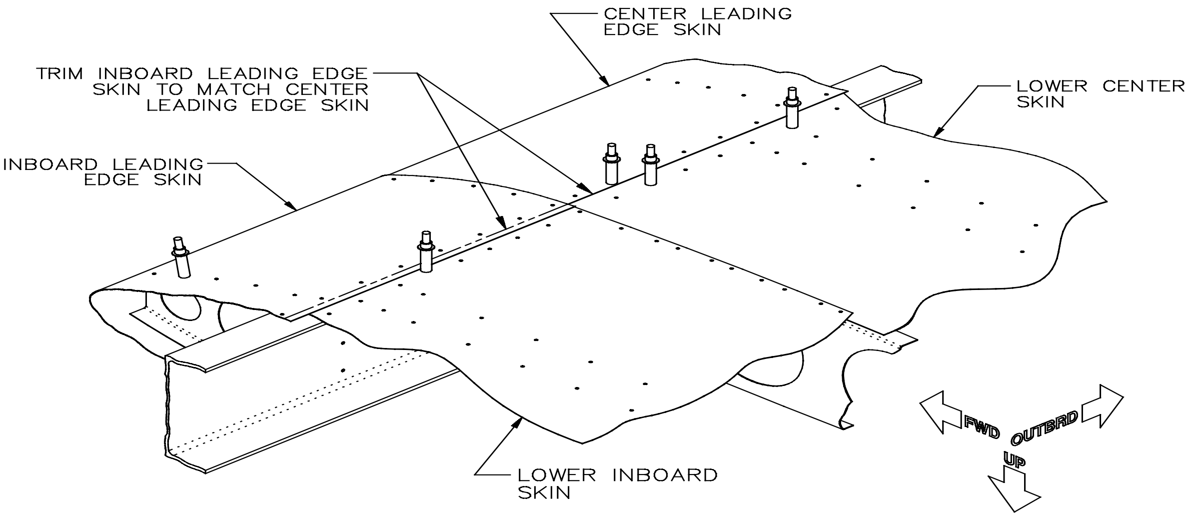

Figure 38: Inboard Leading Edge Skin Lower Trim Line

The trim line for the lower aft edge of the inboard leading edge skin is an extension of the center leading edge skin trim line, as shown in Figure 38. Use a long straightedge to mark the trim line onto the lower edge of the inboard leading edge skin. Remove the leading edge skin and trim its lower aft edge as was done for the other leading edge skins.

> **Note** The only real reason to trim the inboard leading edge skin as described here is aesthetics—the unbroken split line between the skins from root to tip looks better. As long as you maintain the minimum edge distance for the rivets (5/16" or 2-1/2 times the rivet diameter) and as long as there is room to set the spar rivets just aft of the leading edge skin, you can trim the leading edge skin anywhere, or even leave it untrimmed.

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Note: Steps 26-33 have been omitted

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INSTALL THE HAT SECTION STIFFENERS AND LOWER WING SKIN STIFFENERS

Step 34: Adjust the Flanges of the Stiffeners

In the inner and outer most bays of the wing, the Sportsman relies on **upper** [15] and **lower hat section stiffeners** [16] to reinforce the wing skins and to give them their airfoil shape. The stiffeners are referred to as "hat sections" because of their cross-sectional shape.

Double rows of pilot holes oriented in the chordwise direction have been pre-drilled in the wing skins (between the main ribs) for the hat section stiffeners. The two rows in each double row are spaced 1-1/2" apart. There are a total of seven stiffeners for the upper and lower skins of each wing panel.

To be effective in providing the necessary rigidity, these stiffeners must lie flat against the wing skins. The stiffeners have been stamped to fit the curvature of the airfoil, but you need to inspect them to make sure that the flanges are flat. If they're not, the skin will dimple when it's riveted.

Check for flatness by placing the stiffeners convex side down on a flat surface. Beginning at one end, rock the stiffener on the surface over its entire length, watching to see if the flanges lie flat on the surface at all points (see Figure 39). Alternatively, hold a straightedge against the flanges and slide it along the length of the stiffener to check for gaps. If the flanges do not lie flat on the surface, adjust them with a pair of duck bill pliers (or even with your fingers—the aluminum should bend easily).

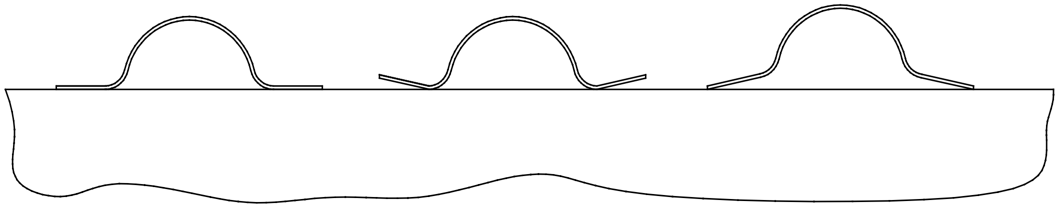

Figure 39: Adjust Stiffener Flanges to Lie Flat

Note This is an area where you can spend a lot of unnecessary time trying to achieve absolutely perfectly flat flanges. Especially if your goal is a good utility airplane rather than a Grand Champion, just do the best you can to get the flanges flat without fretting over them too much. Even with minimal efforts to flatten the flanges, the Sportsman wing will be straighter and have fewer peaks and valleys than most production airplanes.

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Step 35: Trim Stiffener Flanges and Mark Rivet Lines

As with the wing ribs, you need to mark rivet lines on the hat sections so that the flanges can be centered under the pilot holes in the wing skins. Mark the first rivet line onto the flange with the pre-drilled pilot hole, centering the rivet line on the pilot hole, as shown in Figure 40. Then mark a second rivet line onto the other flange **1-1/2"** from the first line. Mark both rivet lines on the **convex side** of the stiffener (the side that contacts the wing skin) so that they will be visible through the pilot holes in the wing skin.

Note When the hat section stiffeners are formed, the flanges tend to flare out at the ends, as shown by the dashed lines in Figure 40. The flared edges will be trimmed off straight, but not until **after the rivet holes have been drilled**, as described in the next step, to make sure that the minimum edge distance for the rivets is maintained.

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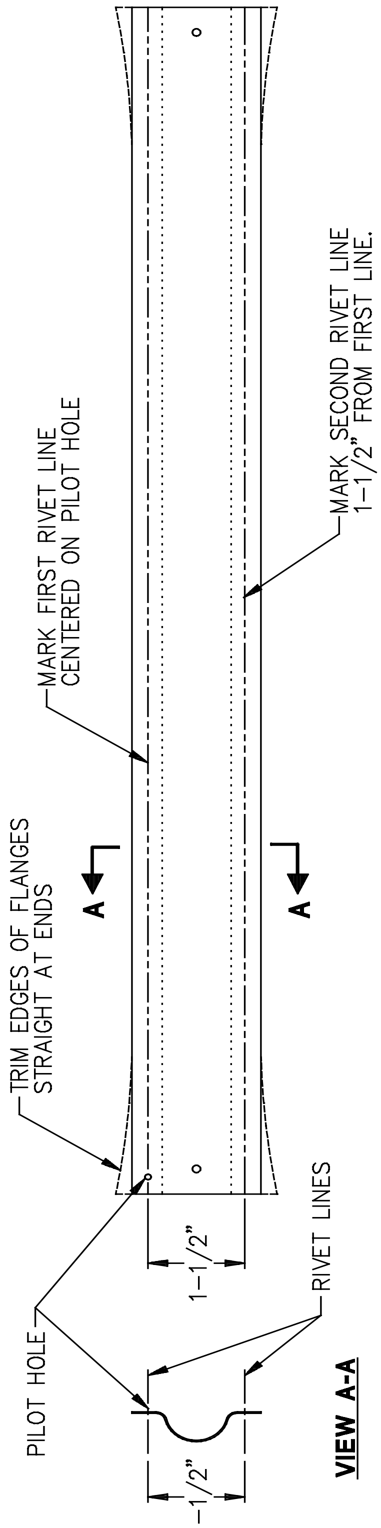


Figure 40: Rivet Lines on Stiffener Flanges

Step 36: Position and Drill the Lower Skin Stiffeners

> **Note** You will need a helper to drill the rivet holes in the hat sections, but by now you should have many friends who are all amazed at how fast your Sportsman is coming together and who would be more than willing to help! Your helper adjusts the position of the stiffener and holds it securely while you drill holes and insert Clecos.

Remove the upper main wing skins to provide access to the interior of the wing for positioning the lower hat section stiffeners.

> **Note** To orient the upper and lower stiffeners, refer to Figure 41. The single hole drilled through one flange on each stiffener is at the **forward** end of the stiffener. Also, the joggle in the stiffener flange for fitting over the spar flange is shorter at the **forward** end than at the aft end. To distinguish between the upper and lower stiffeners, refer to their stamped part numbers or hold them next to the main rib flanges and compare the contours of the stiffeners to the contours of the rib flanges. The upper stiffeners are formed to a sharper curvature than the lower stiffeners.

Using the pre-drilled pilot hole in the forward end, Cleco each stiffener to the wing skin and the forward spar, as shown in Figure 41, through one of the holes drilled when the lower main skins were installed.

With the first corner Clecoed, adjust the position of the stiffener until the rivet lines marked on the flanges appear in the pilot holes in the skin. Hold the aft end of the stiffener tightly against the aft spar flange.

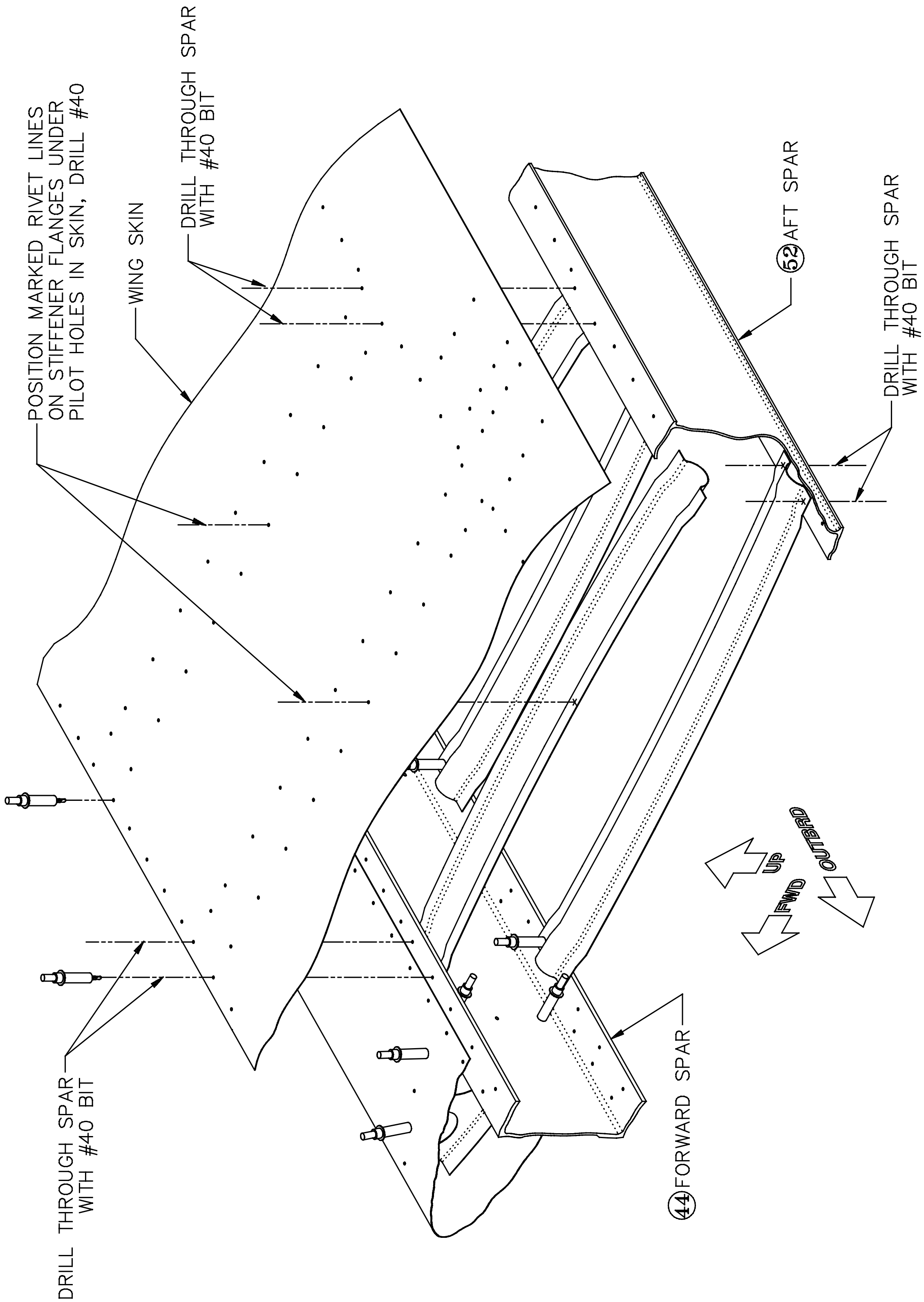
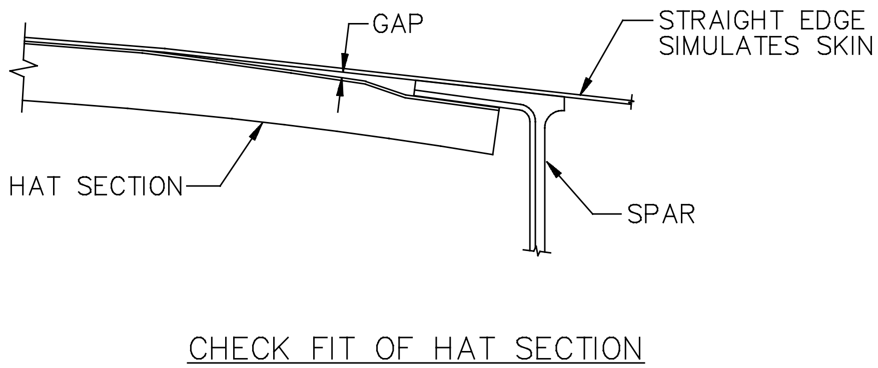


Figure 41: Skin Stiffener Installation



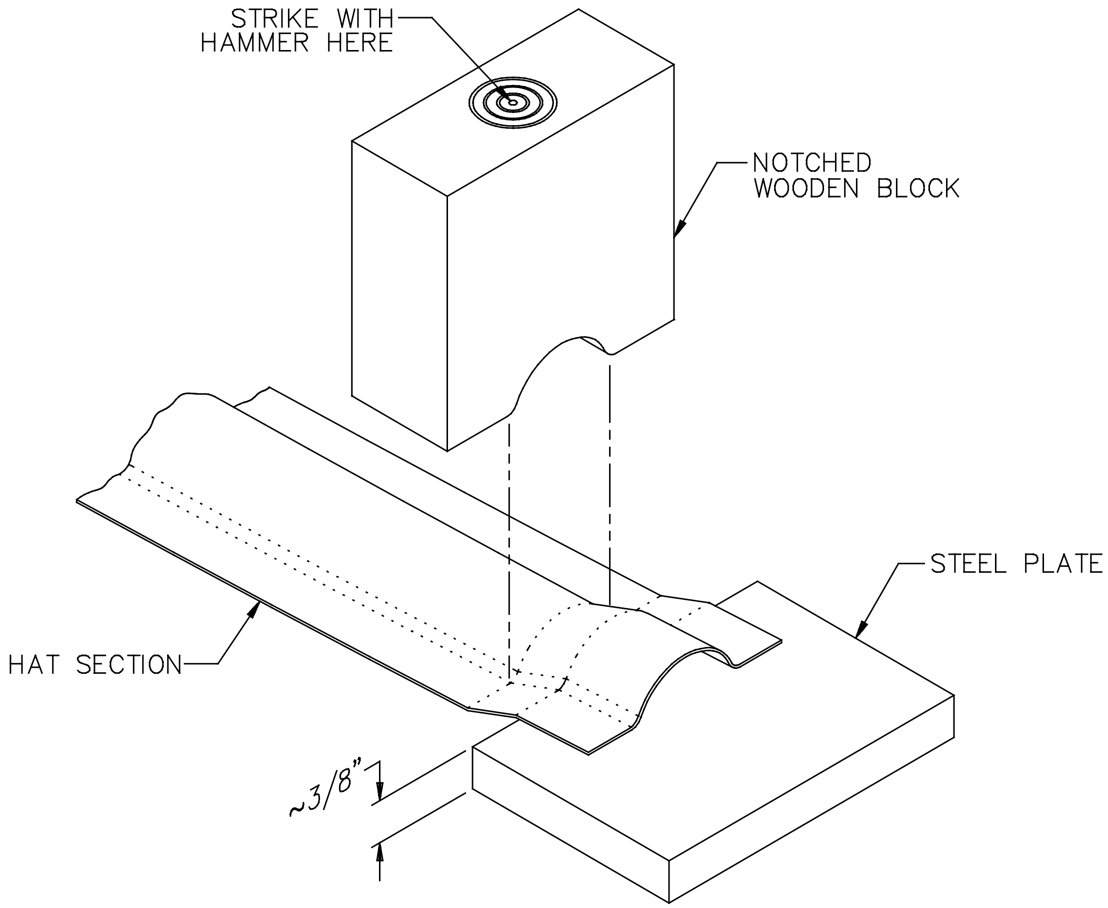


Figure 42: Adjusting the Hat Section Stiffeners

Check for gaps between the hat sections and the wing skins at each end of each hat section, as shown in Figure 42. The depth of the joggles at the ends of the hat sections may have to be increased to eliminate gaps between the skin and the hat sections and to achieve a smooth transition of the skin from the hat sections to the spar flanges. If you feel that adjustment is necessary, remove the offending hat section and clamp the hat section joggle to an approximately **3/8"** thick steel plate, as shown in Figure 42. Then use a **hardwood** block with a semi-circular notch cut in it to hammer on the hat section next to the joggle, as shown. Two or three sharp blows with a hammer should do the job. After adjustment, fit each hat section back into place and re-check the fit. Repeat as needed until you are satisfied with the fit of all the hat sections.

With any adjustments completed, re-Cleco the hat section to the forward spar and have your helper hold the stiffener tightly against the inside of the spar flanges while you drill some rivet holes. Drill two **#40** holes through each spar flange, and insert a Cleco in each after drilling.

With the stiffeners pinned to the spar flanges, use the pilot holes in the skins to drill **#40** holes through the skin-stiffener assembly. Drill the first hole in the center of the stiffener, halfway between the spars, and then continue drilling halfway between already drilled holes until all holes have been drilled. Have your helper apply back pressure to the stiffener with a piece of scrap 2 X 4 where you are drilling. Cleco each hole as you proceed to make sure the stiffener is held tightly to the skin while drilling.

The five hat section stiffeners for the **lower inboard** main skin need additional rivets, as shown in Figure 43. Lay out the locations of the extra hat section stiffener rivet holes in line with and halfway between the existing holes, as shown. These dimensions are not critical.

After all the stiffeners have been drilled, mark each one for position and orientation so that it can be returned to its original location after disassembly.

With all the **lower** skins and hat sections in position, take the time now to enlarge all the rivet holes through both the **forward spar, spar caps** and the **aft spar and the leading edge skins** to **#30** diameter, using the #40 holes in the skins as a guide. Also, enlarge all the rivet holes common to the skin splices at station 69.0 and 141.75 to **#30** diameter. Leave the holes through the other main ribs, the hat section stiffeners and the flap and aileron cove ribs at #40 size.

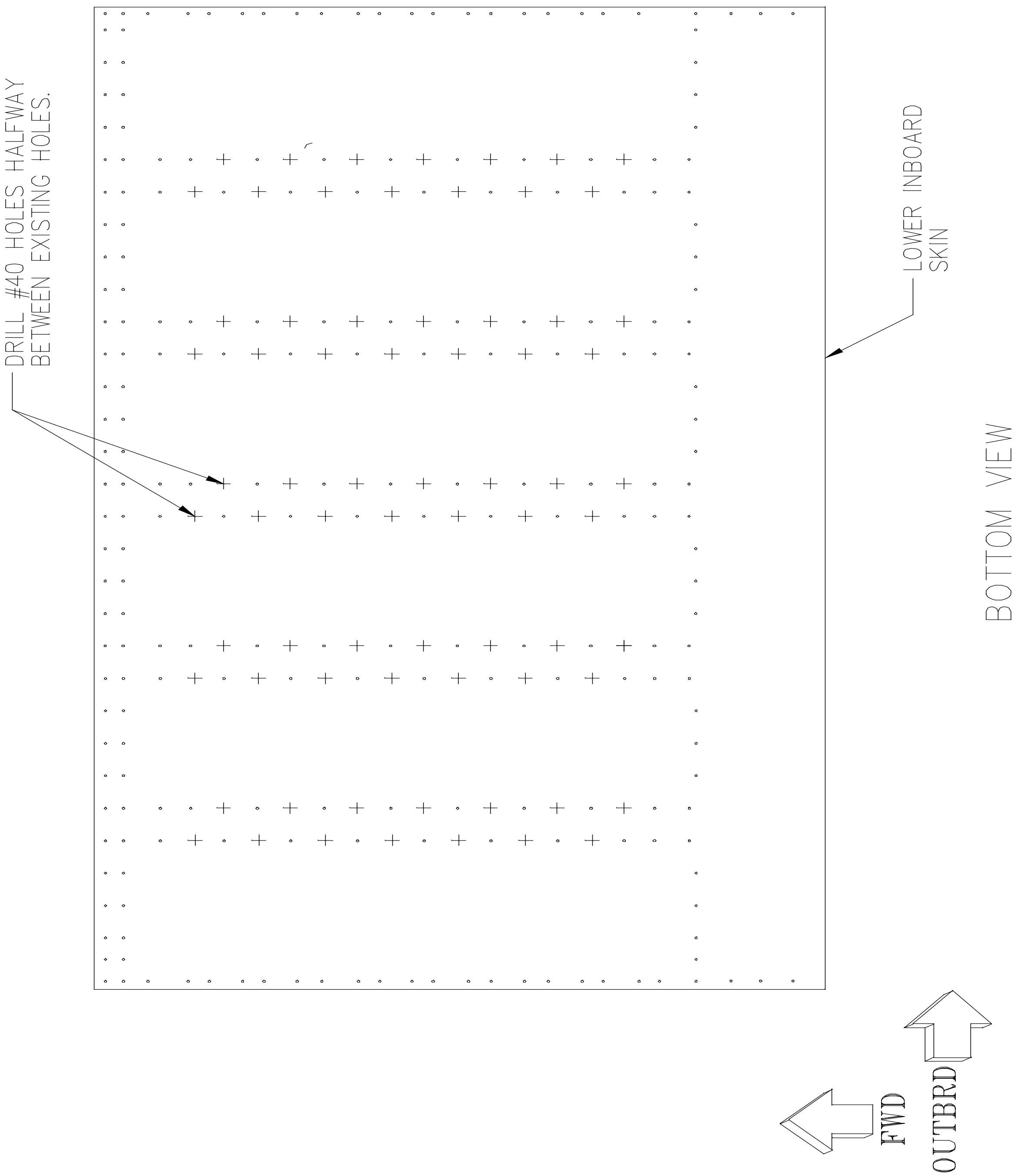


Figure 43: Additional Rivets for Lower Inboard Main Skin

As shown in Figure 44, relieve the **aft** ends of the stiffener flanges, where necessary, to eliminate interference with adjacent rivets through the spar flanges. Be sure to provide enough clearance to form shop heads on adjacent rivets.

Also, trim the edges of the flanges straight, as shown in Figure 40 and as mentioned in the note in Step 35, being careful to maintain the minimum edge distances for the rivets (twice the rivet diameter).

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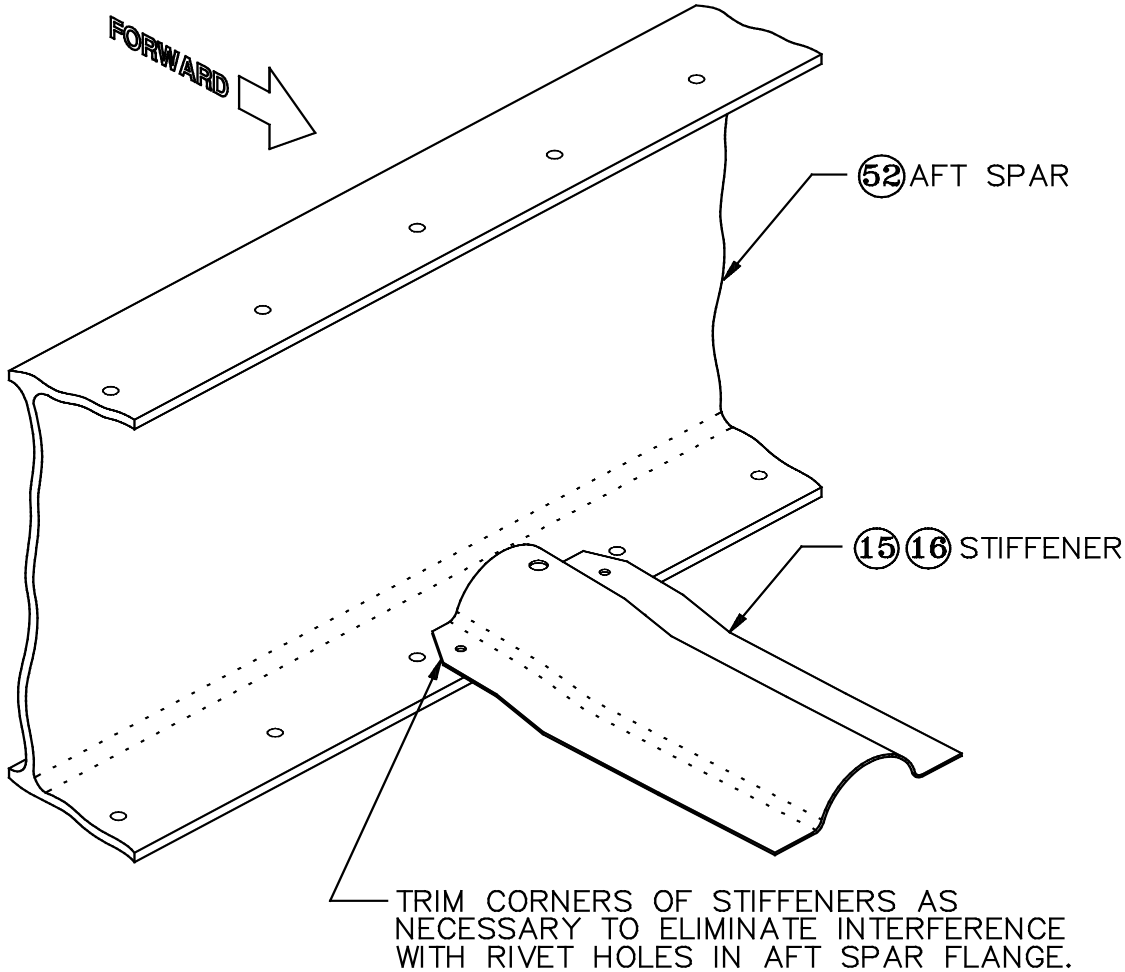

Figure 44: Relieve Stiffener Flanges for Rivet Clearance

Step 37: Position and Drill the Upper Hat Stiffeners

Remount the upper skins to the rib/spar assembly. Remove the lower skins and stiffeners to provide access to the interior of the wing.

Repeat the procedures described in Step 36 to mount, drill and mark the **upper hat section stiffeners** [15].

Note The additional rivets described in Step 36 for the lower inboard skin stiffeners (between Main Ribs 1 and 2) are **also** needed for the **upper** inboard skin stiffeners.

With all the **upper** skins and hat sections in position, enlarge all the rivet holes through both the **forward spar** and the **aft spar** to **#30** diameter, using the #40 holes in the main skins as a guide. Also, enlarge the holes through **Main Ribs 1 and all those common to a skin splice (station 69.0 and 141.75) to a #30** diameter. Leave the holes through the other main ribs, the hat section stiffeners and the flap and aileron cove ribs at #40 diameter.

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Step 38: Position and Drill the Lower Skin Stiffener Channels

Two rows of span-wise pilot holes have been pre-drilled in the **lower** center and outboard skins. These pilot holes are for riveting on the **skin stringer channels [35, 48, 49, 55],** which reinforce the skin, as shown in Figure 45.

To position and drill the stiffener channels, the lower center wing skin must be installed on the wing structure. Remove the upper center wing skin, if necessary, to provide access to the interior of the wing. Remove the clecos from the rear spar and the ribs in order to easily insert the stringers into the spaces provided in the ribs.

The forward stringer [55] should overlap the outboard rib at 69.0 and extend out to station 141.75 picking up the skin splice. If your stringer is short, then let it fall short at station 141.75. Stringer [35] should overlap the rib at 141.75 and 156.75. Stringer [48] will just fit between the two outboard ribs on the outboard end and will overlap the rib at station 84.0 and fall short at station 69 on the inboard end. Finally, the aft stringer [49] will fit into the space provided on ribs 84 and 141.75. Use the pre-punched holes in the skin to drill #40 holes through all the stringers. Cleco as you go.

If you notice that the skin is being deformed where the stringer overlaps a rib or skin splice, insert a thin shim (.016 or .02) between the skin and stringer to lesson the step off the rib.

When all the holes have been drilled, remove the stiffeners and deburr the rivet holes in both the wing skins and the stiffeners. Chamfer the corners on the stringers as well.

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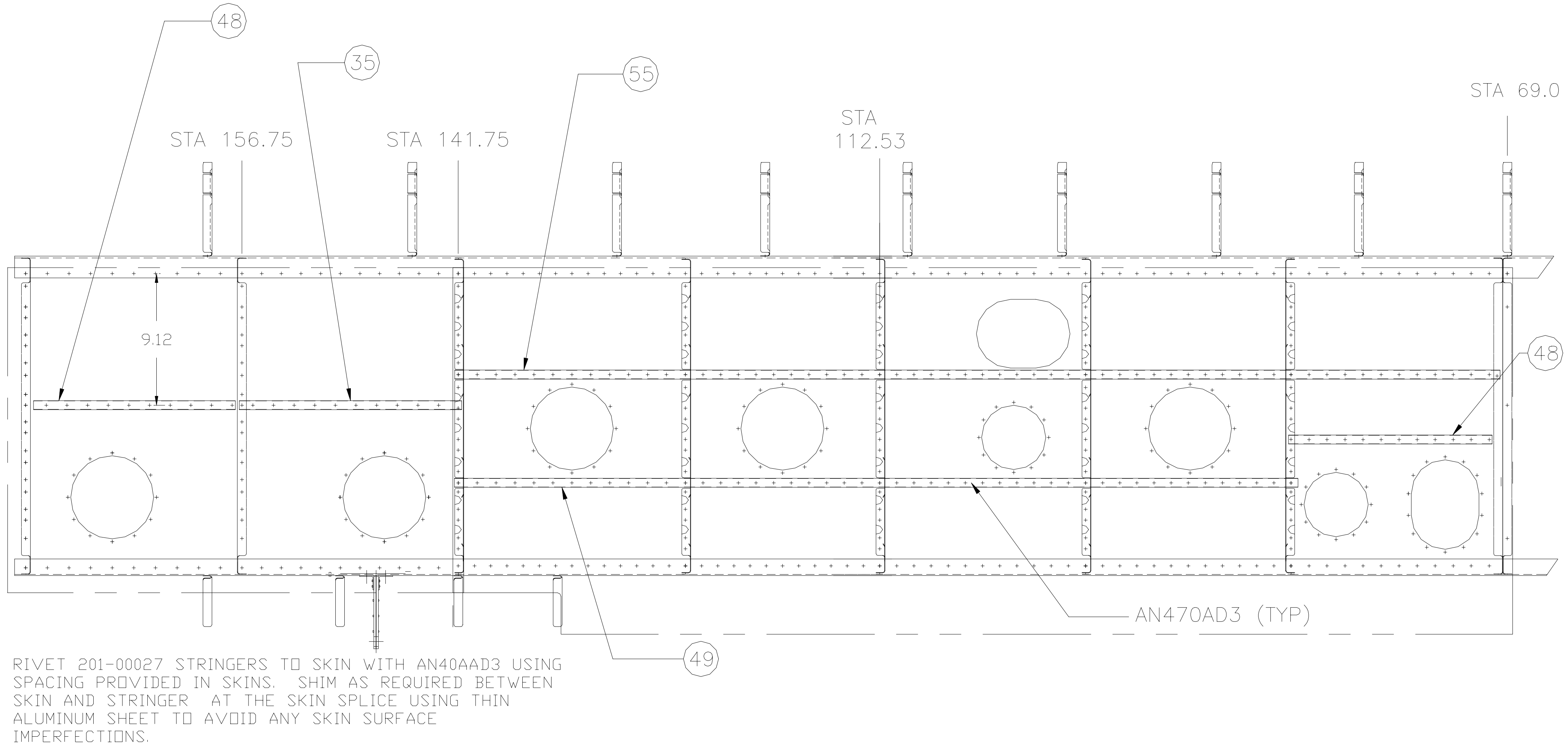

Figure 45: Lower Skin Stringer Layout

Pitot/Static System Options If you are installing either of Glasair Aviation, LLC's Pitot/Static System Options (Heated, P/N 912-02000-01, or Non-Heated, P/N 912-01000-01), **turn to the options instructions now**. Return to this *Assembly Manual* when the specified option steps have been completed.

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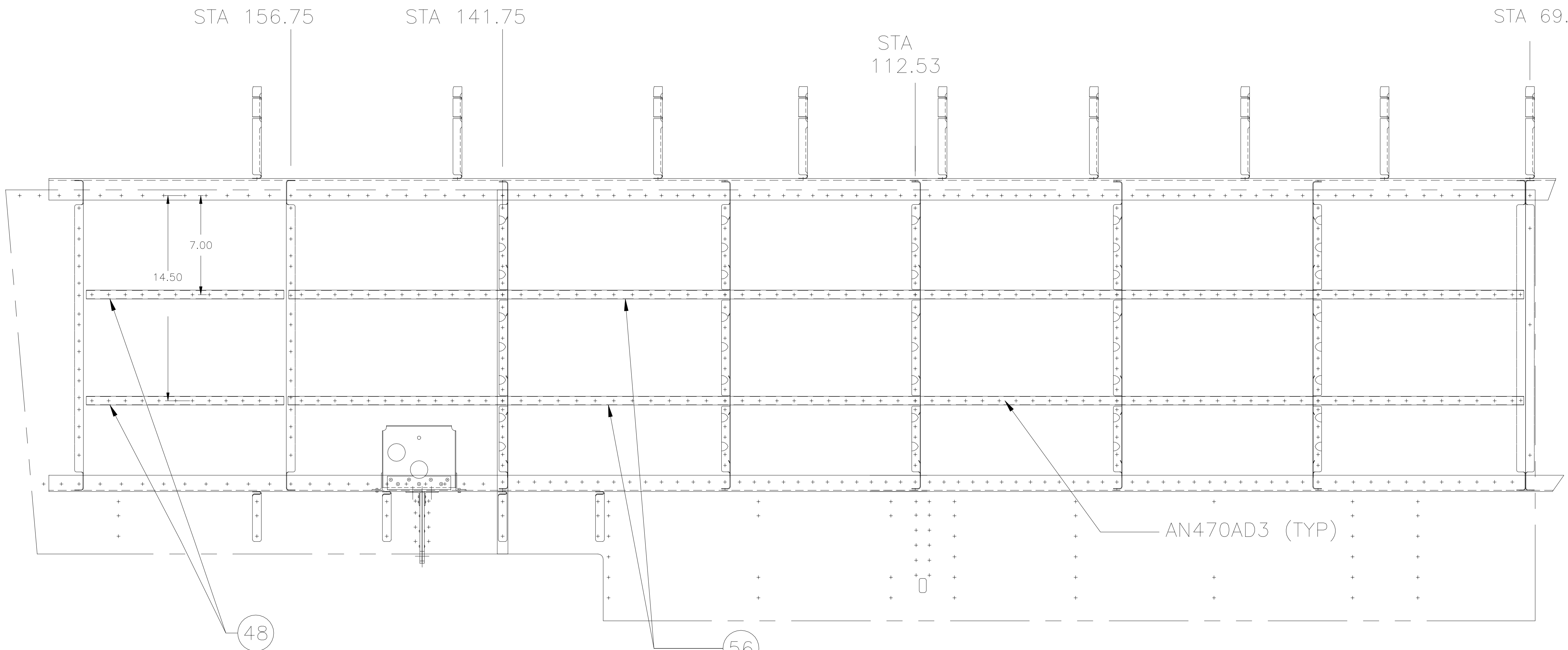

Figure 46: Upper Skin Stringer Layout

Step 39: Position and Drill the Upper Skin Stringer Channels

Two rows of span-wise pilot holes have been pre-drilled in the **upper** center and outboard skins. These pilot holes are for riveting on the **skin stringer channels [48, 56],** which reinforce the skin, as shown in Figure 46.

To position and drill the stiffener channels, the upper skins must be installed on the wing structure. Remove the lower center wing skin, if necessary, to provide access to the interior of the wing. Remove the clecos from the rear spar and part way up the ribs in order to easily insert the stringers into the spaces provided in the ribs.

The stringers [56] should overlap the outboard rib at 69.0 and extend out to and overlap the rib at station 156.75. Stringer [48] will just fit between the two outboard ribs at 156.75 and 171.75. Use the pre-punched holes in the skin to drill #40 holes through all the stringers. Cleco as you go.

If you notice that the skin is being deformed where the stringer overlaps a rib or skin splice, insert a thin shim (.016 or .02) between the skin and stringer to lesson the step off the rib.

When all the holes have been drilled, remove the stiffeners and deburr the rivet holes in both the wing skins and the stiffeners. Chamfer the corners on the stringers as well.

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Step 40: Finish Drilling the Root Rib

The root rib's primary structural attachment comes from four countersunk AN509 screws in the flanges of the spars and the flanges of the root rib assembly. Careful attention to spacing is required.

There is not much room for this screw so a few compromises are necessary. Figure 47 shows the position of the screw in the upper flange. The position for the lower flange is the same. Because the location of the screw is inboard of the skin edge, it must be flush for when the wing is in position with the wing root fairing on the fuselage.

Mark the position of the screws on all four spar flanges. Next mark an 11/32" diameter at this location, which represents the countersink diameter for the screw head. If there is more than .06" overlap onto the skins, adjust the center inboard slightly but do not go under the 5/16" minimum as shown on the drawing.

The edge margin on the skin in this immediate are can be as low as .25", which is two times the diameter of the skin rivets. The end result is a screw, which can be installed after the skins have been riveted on the spars.

When you are satisfied that the screw fits well, can be countersunk and meets the minimum edge distance requirements, drill this hole up to 3/16" diameter.

Finally, open up the holes all along the skin edge and the root rib between the two spars to a #30 hole. After the skins are drilled, remove them and countersink the four 3/16" diameter holes in the spar flanges 11/32" diameter for the head of the AN509-10R10 screws.

Completed: Left [ ] Right [ ]

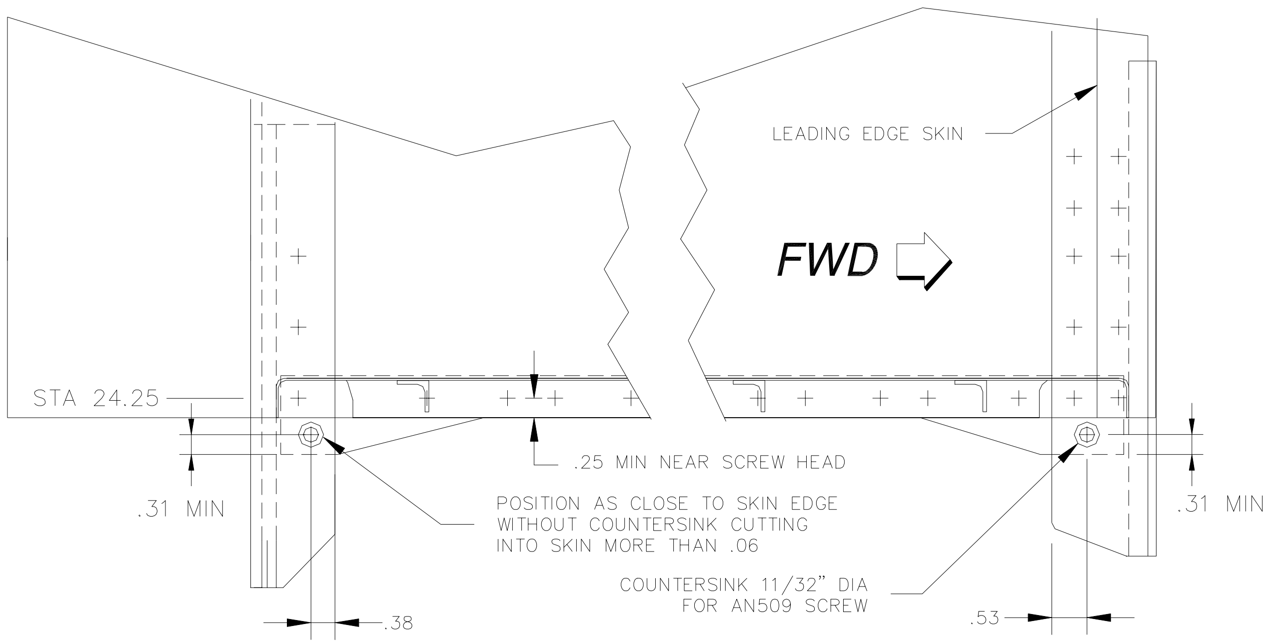


Figure 47: Screw Locations for the Root Rib

DIMPLE THE SKINS AND COUNTERSINK THE FORWARD SPAR FLANGES

Step 41: Dimple the Wing Skins and the Nose Ribs

Note At this time, double check that all the rivet holes in the wing structure have been drilled to the correct sizes. Refer to figures 18-21 as well.

1. All **skin rivet holes** through the **forward and aft spars** should be **#30** diameter.
2. All **nose rib/spar** holes from station 33.2 – 144.95 should have **(5) #30** holes for 1/8" diameter blind rivets. The rest only require (3) #30 diameter holes.
3. **Main rib 1** at station 24.25 should have **(3) .190** diameter holes in both the forward and aft spar for AN3 bolts. All the skin holes common to this rib (and noserib) should be **#30 diameter** holes. There should be four countersunk holes in the spar flange common to the root rib doubler flanges.
4. **Main ribs from station 84.0 – 141.75** should have **(5) #30** holes in both the forward and aft spars.
5. **Nose Ribs at station 69.0 and 144.95**, should have **#30** diameter on both the upper and the lower surfaces of the skin at the splice.
6. All other rivet holes in the nose ribs, main ribs, the flap and aileron cove ribs, the hat section stiffeners and the stringer channels should be #40 diameter.

Completely disassemble the wing. Double check that all holes drilled so far have been adequately deburred and deburr those that still need it.

Dimple all the rivet holes in the **leading edge skins** and along the **forward spar rivet lines of the upper and lower main skins**. Also dimple the rivet holes in the **nose rib flanges**. Finally, dimple the rivet holes where the main skins fasten to tip rib; dimple both the skins and the rib flanges for both the upper and the lower skins. (Flush rivets will be used to secure the skins to tip rib to ease installation of the wing tip fairings.)

> **Note** Since the rivet holes for the spars and the ribs are different diameters, be sure to choose the correct dimple dies for each location. Use **1/8"** dimple dies for the rivet holes that secure the leading edge and main skins to the forward spar flanges and for the rivet holes that secure the leading edge skins to Nose Ribs 6 and 12; use **3/32"** dimple dies for the rivet holes that secure the leading edge skins to the rest of the nose ribs and for the rivet holes that secure the main skins to the tip rib.

Completed: Left [ ] Right [ ]

Step 42: Countersink the Forward Spar Flanges

Figure 48: Countersinking the Spar

Use your microstop countersink with a **1/8" 100°** pilot to countersink the main spar flanges to accept the dimples in the skins. To achieve the maximum structural strength of each rivet, be careful to adjust the countersink to the proper depth of cut.

Use **scrap pieces** of aluminum to adjust your countersink, as follows:

A) Choose a piece of scrap aluminum the same thickness as the skin you're working on. Drill a #30 hole through this piece and dimple the hole.

B) Drill a #30 hole in another piece of thicker scrap (1/16" minimum), and countersink the hole. This piece simulates the spar flange.

C) Fit the dimple formed in Step A into the countersink formed in Step B, and check the fit. If, when the dimple is pressed tightly into the countersink, the two pieces are held apart so that a gap exists between them, the countersink is too shallow. Refer to Figure 48. If the pieces fit tightly together without gaps but the dimple is loose in the countersink so that the pieces can shift laterally relative to each other, the countersink is too deep. If the dimple fits snugly in the countersink and the parts fit tightly together without gaps, the countersink depth is just right.

D) Adjust the depth of the countersink, if necessary, and repeat Steps B and C until you have achieved the proper countersink depth.

Now that your countersink tool is adjusted properly, you can use it to cut the countersinks in the spar flange rivet holes.

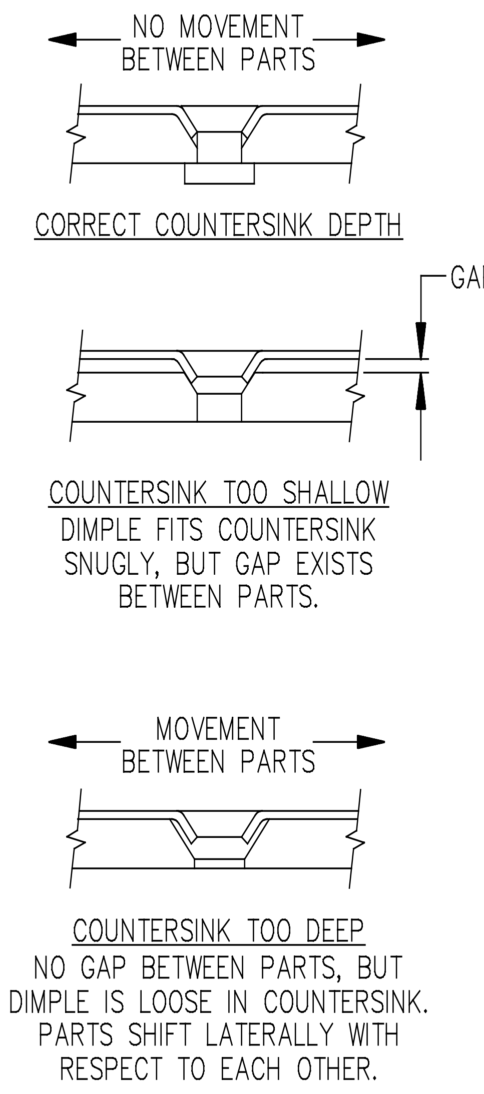


Figure 49: Countersink Adjustment

Note Since the wing skins are of various thicknesses, you must readjust your countersink tool, following the procedures described above, for each skin location on the spar. For example, you can use the same countersink adjustment for the rivet holes for the inboard leading edge, which are .032" thick, but you must change the adjustment for the center leading edge skin, which is .025" thick. Refer to Table 6 for a list of skin thicknesses so you can choose the proper scrap thickness to adjust your countersink tool for each skin.

WING SKIN:	THICKNESS:
Inboard Leading Edge	.032"
Center Leading Edge	.025"
Outboard Leading Edge	.020"
Upper Inboard	.040"
Upper Center	.032"
Upper Outboard	.025"
Lower Inboard	.040"
Lower Center	.032"
Lower Outboard	.025"

Table 6: Wing Skin Thicknesses

Completed: Left [ ] Right [ ]

Step 43: Corrosion-Proof the Parts

When you have finished deburring, dimpling and countersinking all the rivet holes in the wing skins and spars, apply corrosion protection to all of the wing components, including the insides of the wing skins, the ribs, the hat-section stiffeners, the spar cap strips and the lower skin spanwise stiffener channels.

Note We recommend painting a single coat of acid etch wash primer similar to (PPG DX 1791/1792 yellow) on all parts.

Completed: Left [ ] Right [ ]

Step 44: Fit and Drill the Aileron Hinge Components

Figure 50: Assembling the Aileron Hinge

The **outboard** aileron hinge is made from an **aileron hinge arm** [81], a **left-flange aileron hinge rib** [83], a **right-flange aileron hinge rib** [84], a **left-flange aileron hinge attach angle** [85] and a **right-flange aileron hinge attach angle** [86], as shown in Figure 50. Lay out the rivet pattern on the hinge rib and hinge attach angle on one side, as shown, maintaining a minimum distance of 1/4" (twice the rivet diameter) from the centers of the rivet holes to the edges of all the parts. Cleco the assembly together through the two pre-drilled holes in each part.

Assemble the **inboard** aileron hinge in a similar manner, except install an **inboard aileron hinge attach angle** [87] on the **outboard side**, as shown in Figure 52. Also, install the **Antiservo tab horn [89]** on the outboard side of the bearing arm doubler **for the left aileron only**.

Lay out the rivet pattern shown in Figures 51 and 52 on one aileron hinge **bearing arm doubler** [82] for each hinge assembly, and then clamp a bearing arm doubler on each side of each aileron hinge arm. Press an aileron hinge **bearing** [94] into the large hole in each hinge assembly to keep the holes concentric while drilling the rivet holes. Centerpunch and drill **#30** rivet holes at all marked rivet locations. Install Clecos as you go.

Completed: Left [ ] Right [ ]

Note: If you are installing the Aileron Trim Installation, refer to the the installation instructions at this time. Contact our Order Desk for ordering and shipping information.

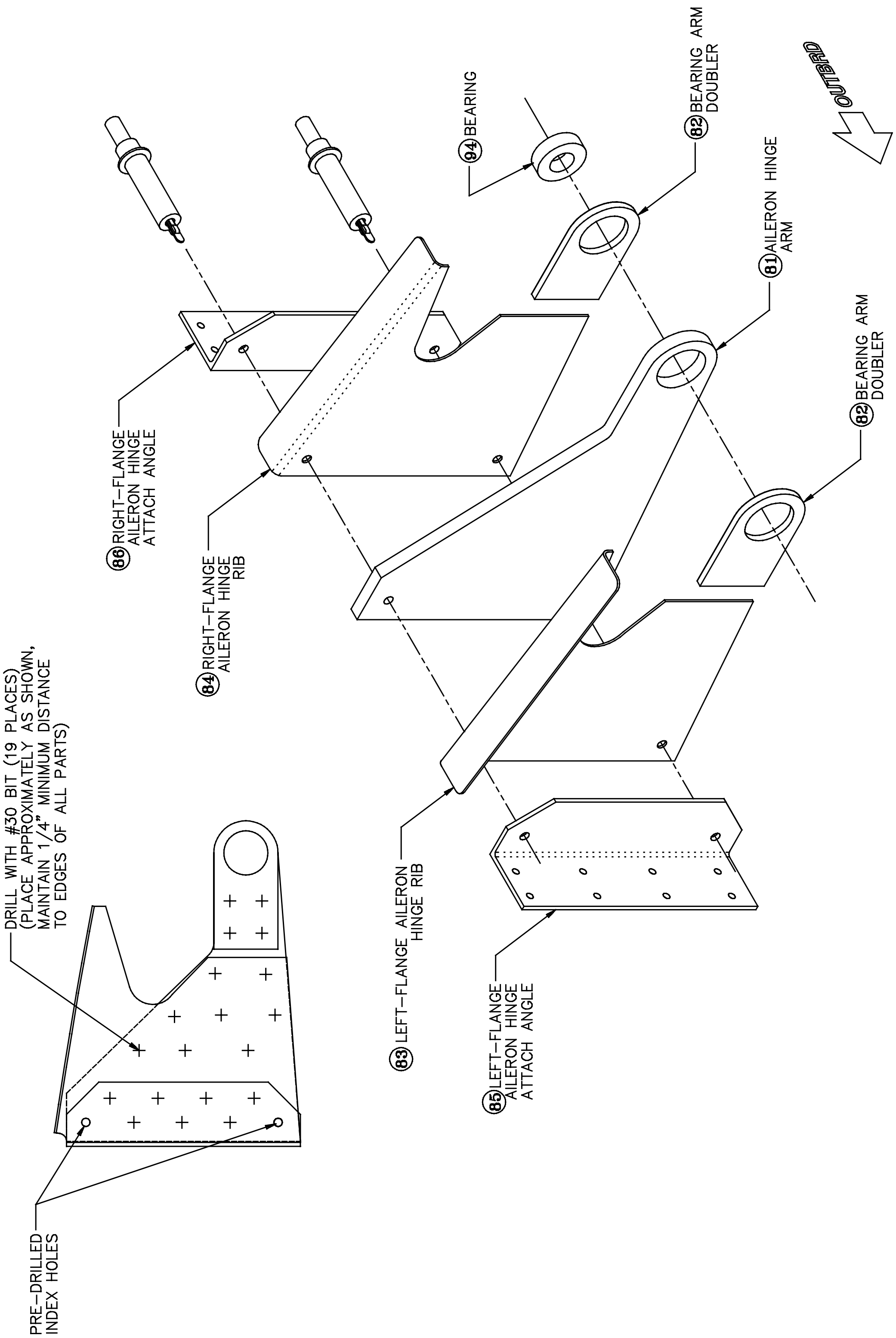


Figure 51: Outboard Aileron Hinge Assembly

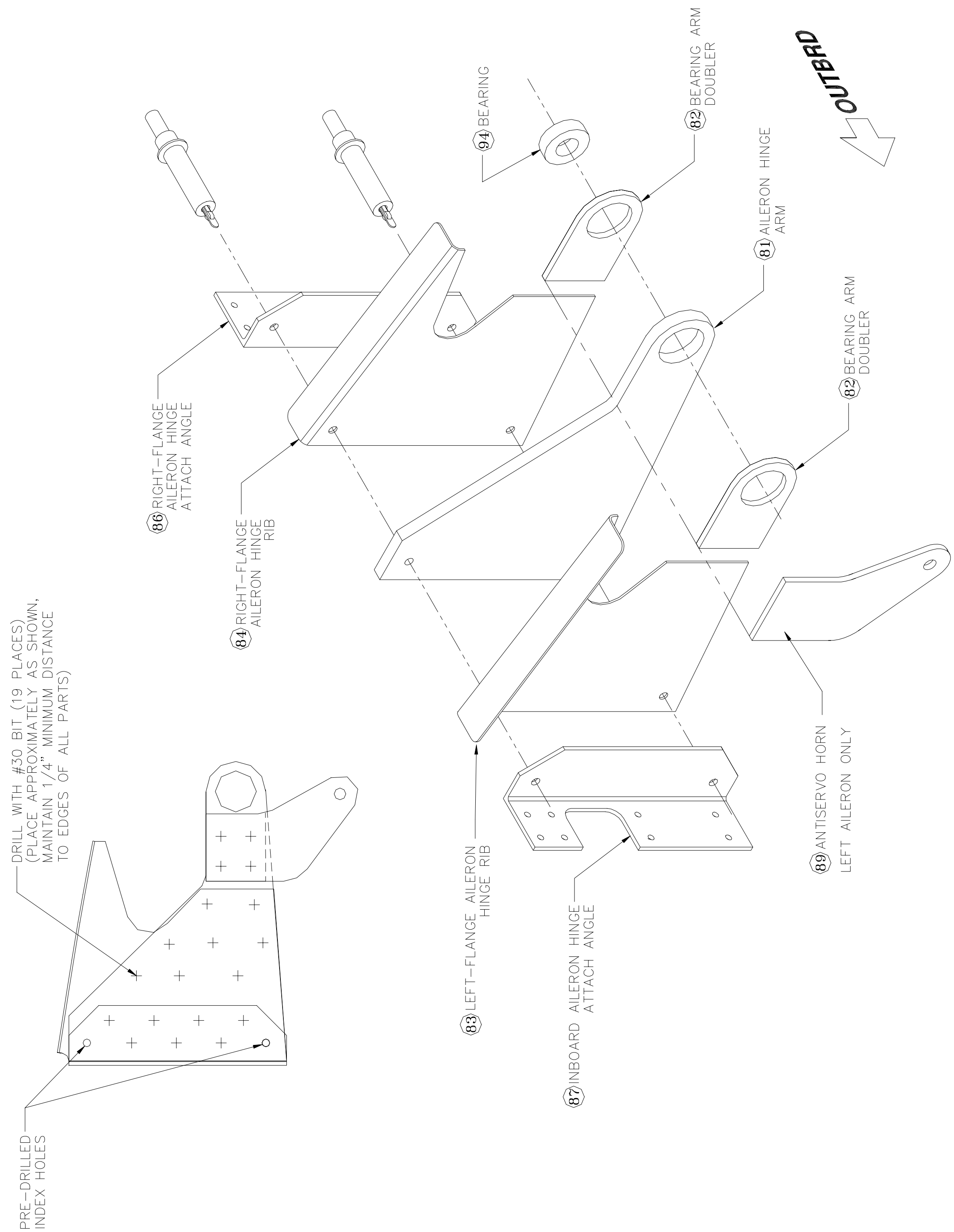


Figure 52: Inboard Aileron Hinge Assembly

Step 45: Rivet and Finish the Hinge Assemblies

Disassemble the hinges, making sure that you don't mix up the parts for each assembly. Deburr all the rivet holes and corrosion-proof the parts.

Hint Although we specify corrosion-proofing the aileron hinges at this time, you will save considerable time in the long run by assembling, drilling and deburring all the various wing control components (the aileron hinges and bellcrank, the flap tracks and bellcrank, and the flap and aileron pulley brackets) and then corrosion-proofing them all at the same time, instead of setting up to corrosion-proof each component separately.

Reassemble the hinges and clamp the hinge assemblies tightly together. Press an aileron hinge **bearing** [94] into each hinge assembly using Loctite bearing retaining compound (either low- or medium-viscosity, high-strength) to secure it. (The bearing is pressed in first to maintain alignment of the large bearing holes in the parts while riveting.)

Rivet each hinge assembly together, using 1/8" AN470AD4 universal-head rivets.

In addition, "stake" each bearing by placing the point of a centerpunch on the metal of the bearing arm doubler just outside the perimeter of the bearing and striking the centerpunch with a hammer hard enough to make about a 1/16" dimple. Repeat in four to six places around the bearing on both sides. This process slightly deforms the metal in the bearing arm doublers to crimp the bearing securely in place.

Completed: Left [ ] Right [ ]

ASSEMBLE THE AILERON BELLCRANK AND MOUNT THE HINGES AND THE BELLCRANK

Step 46: Assemble the Aileron Bellcrank

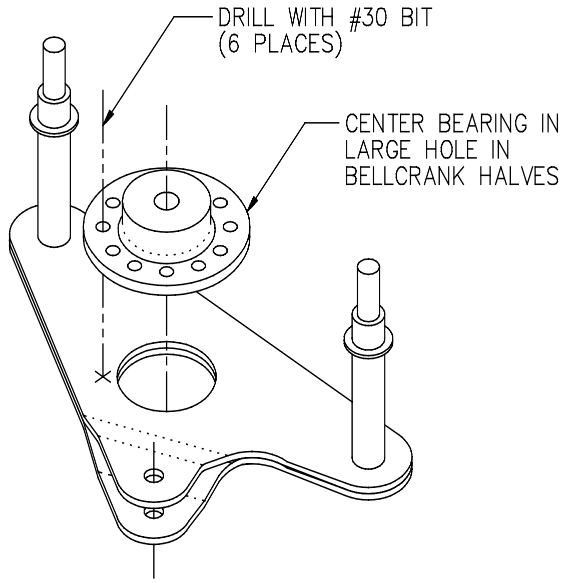
Position an **upper aileron bellcrank half** [92] against a **lower aileron bellcrank half** [93] with the bent arms away from each other as shown in Figure 53. Use Clecos or 3/16" (AN3-) bolts to align the three pre-drilled holes in the arms of the bellcrank halves. Position a **bellcrank bearing** [98] on the outside of the assembly, centered in the large holes in the bellcrank halves, and clamp the assembly together with Cleco side-grips or small C-clamps. Use every other of the twelve holes in the bearing flange as guides to drill **six #30** rivet holes through the assembly. Insert Clecos in the first two or three holes and remove the clamps to finish the drilling.

Disassemble the bellcrank and deburr the holes in all the parts. Corrosion-proof the parts.

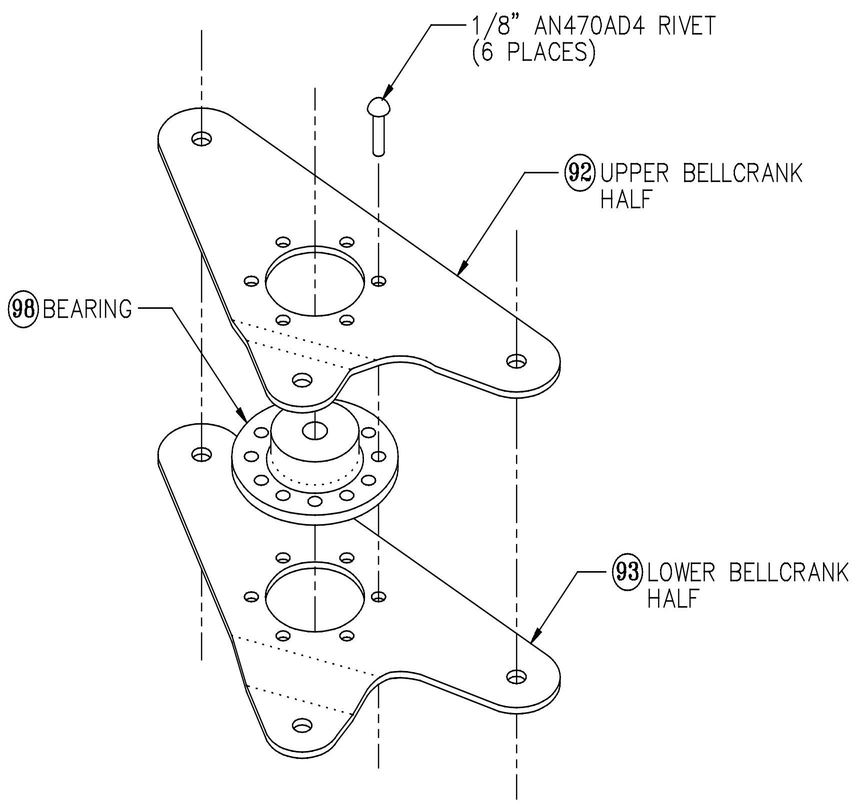
Note We recommend against using standard procedures to corrosion-proof the bellcrank bearing. The chemicals and rinse water used could penetrate into the bearing, doing more harm than good. To provide some corrosion protection, brush a coat of primer onto the bearing flange where it contacts the bellcrank halves.

Reassemble and Cleco the bellcrank assembly with the bearing sandwiched **between** the two halves. Rivet the bellcrank halves to the bellcrank bearing, using six 1/8" AN470AD4 universal-head rivets.

Completed: Left [ ] Right [ ]



DRILLING THE BELLCRANK ASSEMBLY



RIVETING THE AILERON BELLCRANK

Figure 53: Aileron Bellcrank Assembly

Step 47: Assemble the Aileron Bellcrank Brackets

Note Both the **upper** and the **lower aileron bellcrank attach angles** [64 and 66] have two holes spaced 4" apart in one flange; these **horizontal** flanges fasten to the bellcrank brackets. The **upper** attach angle also has a single hole in the other flange of the angle (the **vertical** flange that fastens to the spar). The single hole is closer to the **inboard** end of the angle and is used to position the bellcrank assembly relative to the aileron hinge.

Note In some instances, the pre-drilled pilot holes in the bellcrank attach angles may be centered less than the minimum two rivet diameters from the edges of the parts. This is acceptable here, both because of the thickness of the material and the total number of rivets used to rivet the bellcrank assemblies.

Lay out the rivet patterns shown in Figure 54 on both the horizontal and the vertical flanges of the **upper** and **lower aileron bellcrank attach angles** [64 and 66]. Centerpunch the hole locations in preparation for drilling. Use the laid-out rivet pattern to drill four **#40** pilot holes through the **vertical** flange of each attach angle, as shown.

Cleco the upper attach angle to the **upper aileron bellcrank bracket** [62], using the two pre-drilled holes in each part, as shown in Figure 54. Similarly, Cleco the lower attach angle to the **lower aileron bellcrank bracket** [63].

Note Make sure you choose two opposite (mirror image) support brackets so that the two 3/4"-diameter access holes in each bracket are positioned opposite their counterparts in the other bracket, when the brackets are held back-to-back. If necessary, the 3/4"-diameter hole can be cut into the opposite bracket so the holes line up to access the hardware on the bellcrank.

Use the laid-out rivet pattern and the two pre-drilled holes in the horizontal flanges of the attach angles as guides to drill **#30** rivet holes through the angles and the brackets. Cleco as you go.

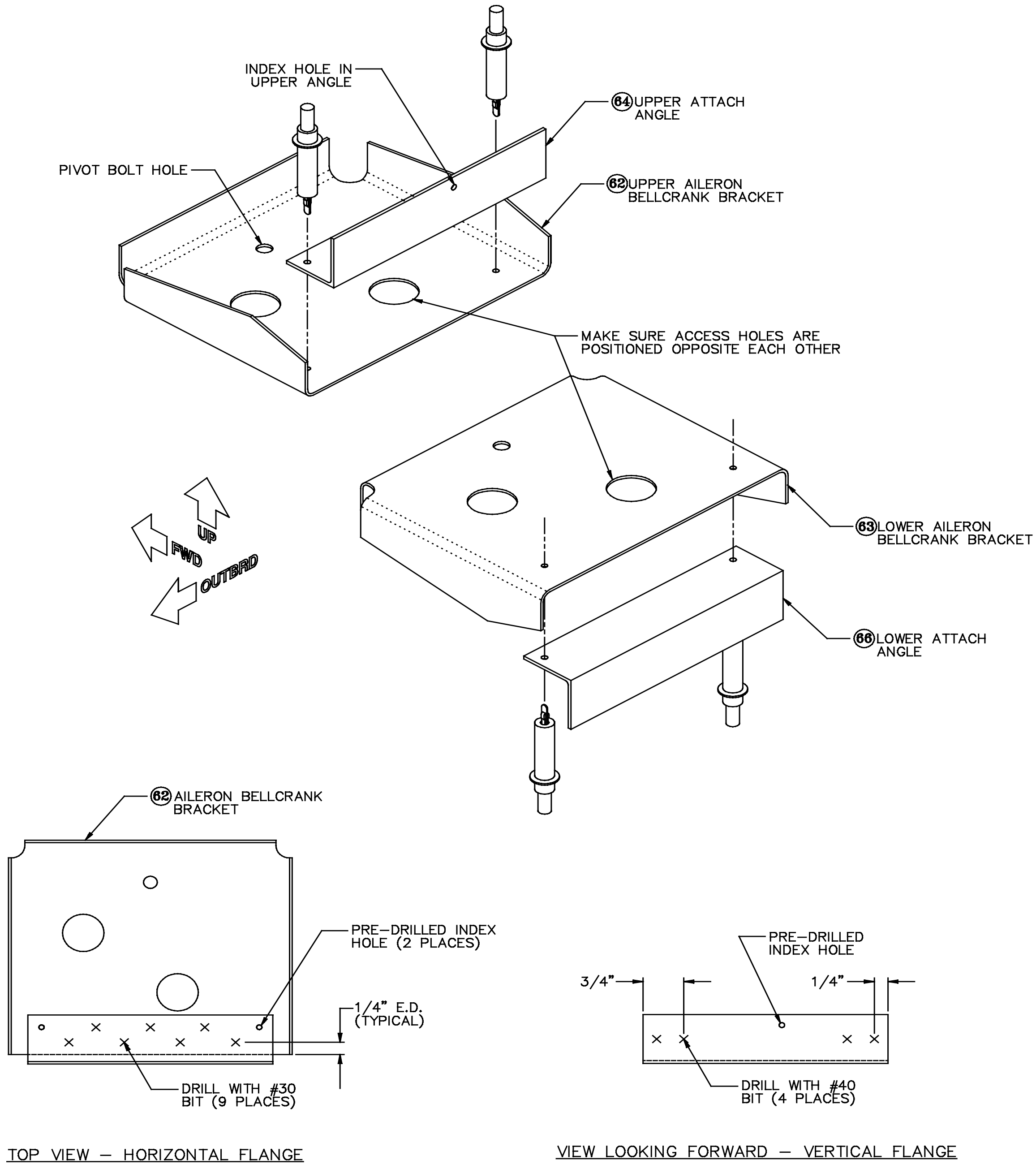


Figure 54: Aileron Bellcrank Support Bracket Assembly

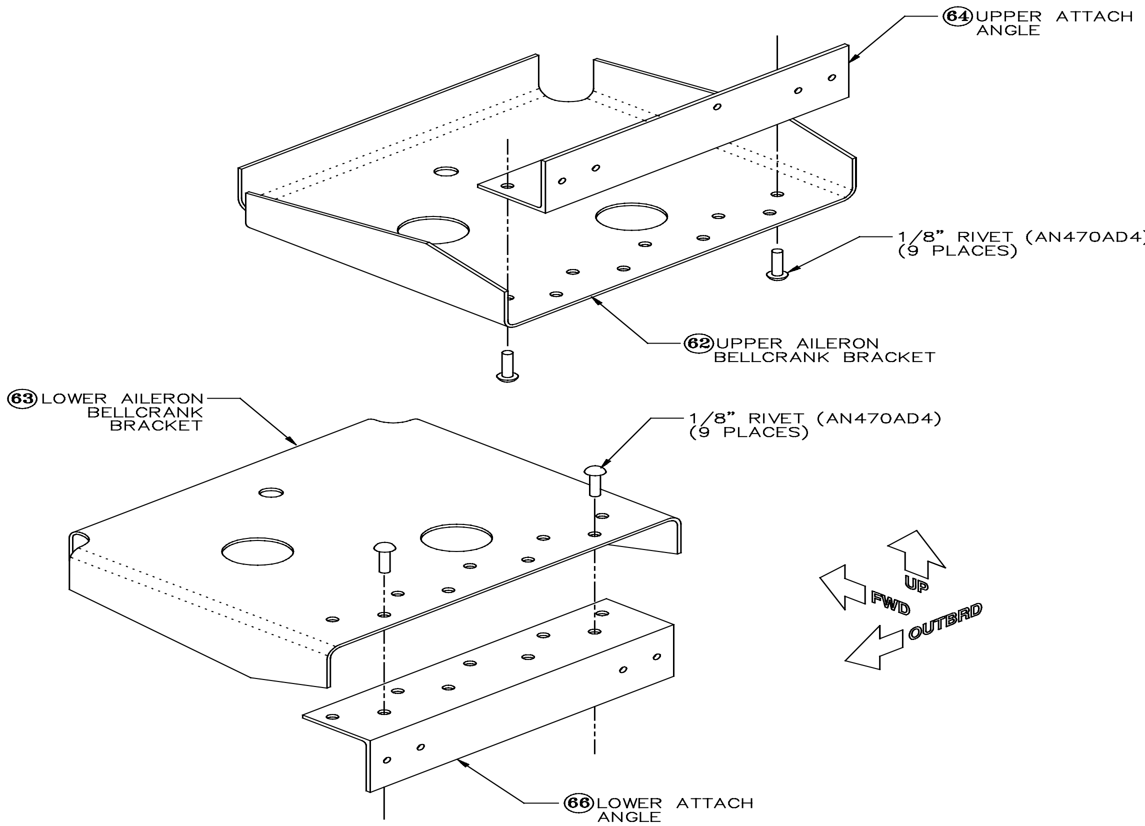


Figure 55: Riveting the Aileron Bellcrank Brackets

Disassemble the parts and deburr the rivet holes. Corrosion-proof the parts. Rivet each attach angle to its bellcrank bracket using 1/8" universal head rivets (AN470AD4) with the manufactured head on the bracket, as shown in Figure 55.

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Step 48: Assemble, Position and Drill the Aileron Bellcrank Assembly and the Inboard Aileron Hinge Assembly

Use an AN4-21 **bolt** [109], an AN310-4 **castle nut** [102], an AN960D416L **washer** [116] under the bolt head and an AN960D416 **washer** [115] under the nut to bolt the aileron bellcrank assembly to the upper and lower aileron bellcrank bracket assemblies, as shown in Figure 56. Install an NAS42DD8-20 **spacer** [118] on the upper side and an NAS42DD8-43 **spacer** [119] on the lower side of the bellcrank, as shown. (The spacers' dash numbers indicate their length in 64ths of an inch.) Secure the castle nut with an AN380-2-2 **cotter pin** [106].

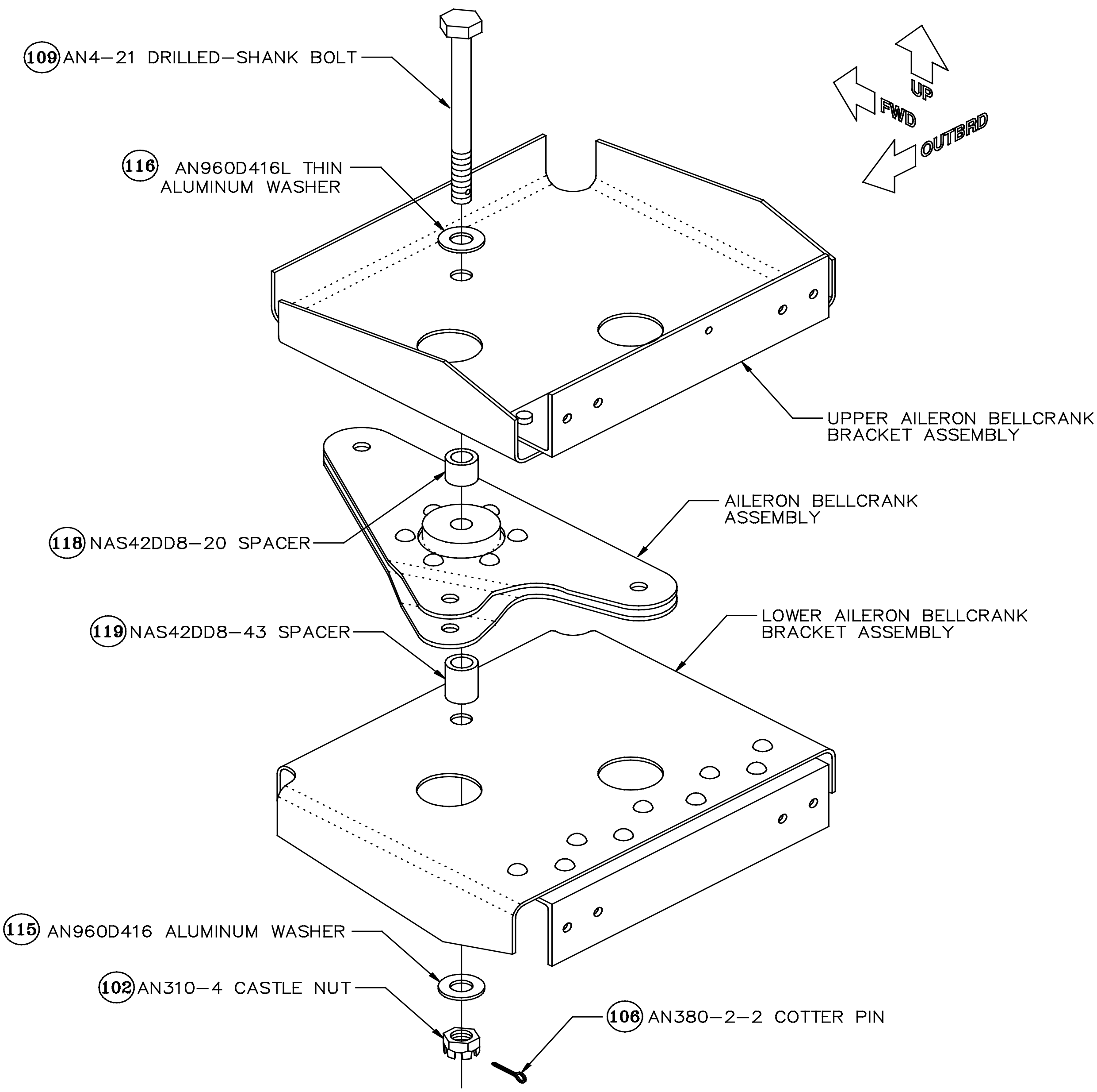


Figure 56: Mounting the Aileron Bellcrank Between the Bellcrank Brackets

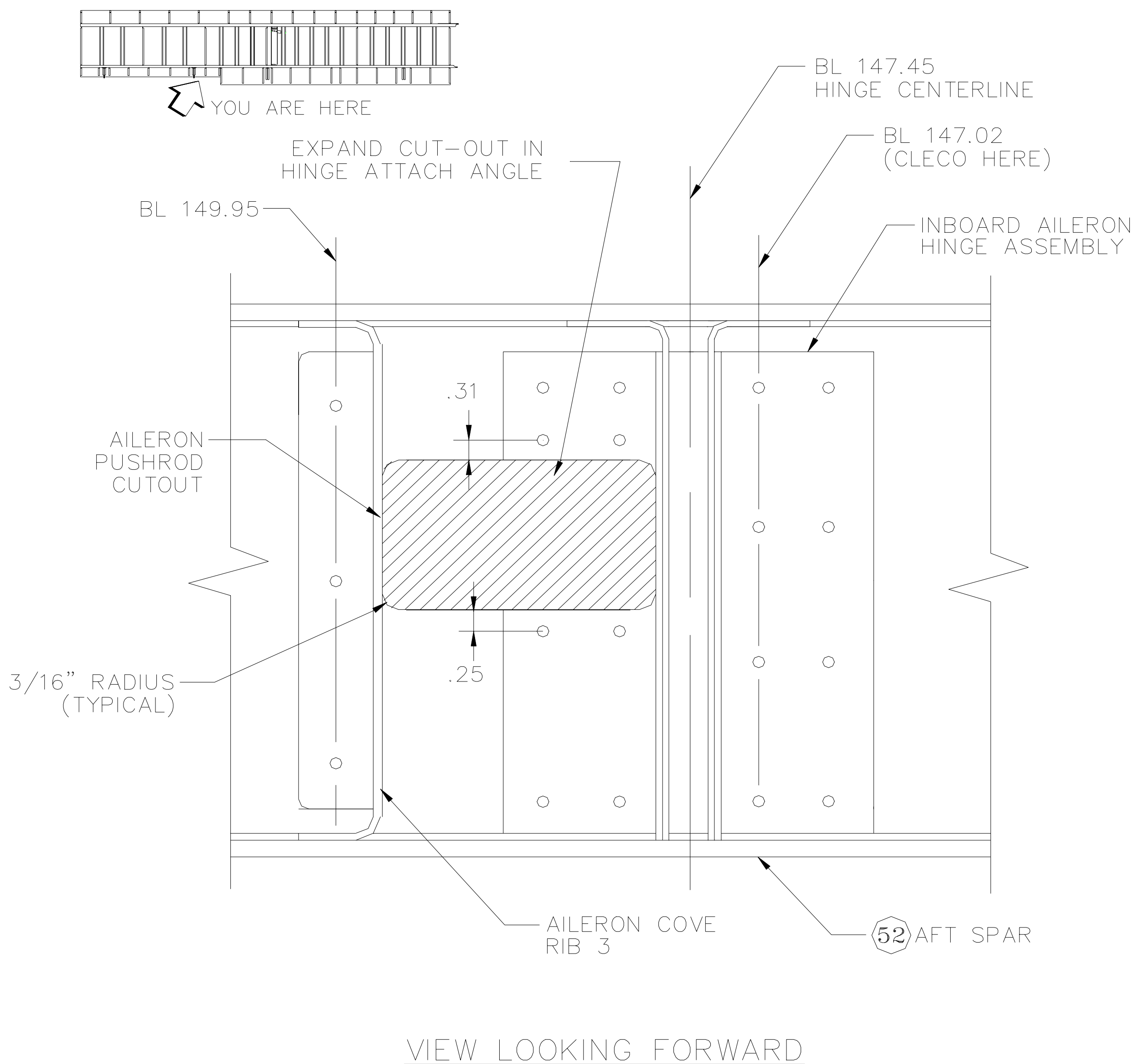


Figure 57: Aileron Pushrod Cutout

> **Note** You will probably find it much easier to complete this and some of the subsequent procedures if you remove the aft spar from the wing jig. Use your own judgment in this regard. You will need to return the spar to the jig when you begin riveting the structure together, as described in Step 60.

Cleco the **inboard** aileron hinge assembly to the aft side of the aft spar, as shown in Figure 57, using the four pre-drilled holes located at **BL 147.02**.

Mark the aileron pushrod cutout onto the aft spar between the hinge assembly and Aileron Cove Rib 3, as shown in Figure 57, using the pre-cut notch in the attach angle as a guide, (it must be expanded to the dimensions shown.) Use a die grinder with a good bit for cutting aluminum to open the cutout as shown. Bring the cutout right up to the angle (into the radius) of the hinge [87] and to within 1/4 " of the rivets.

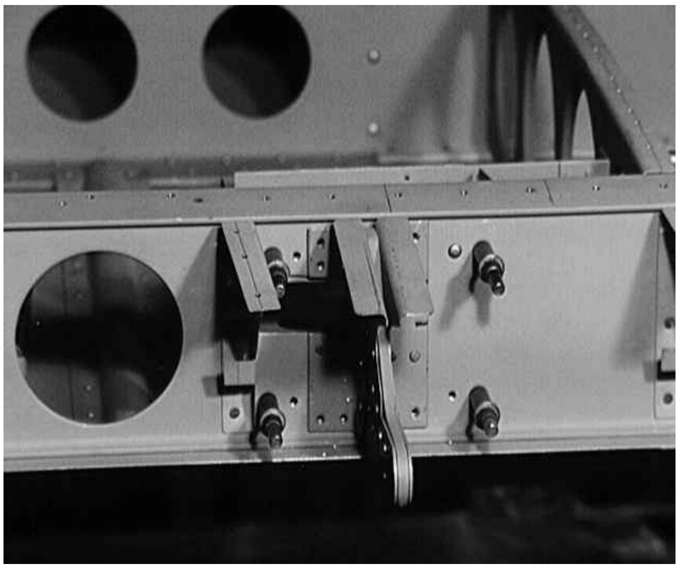


Figure 58: Inboard Aileron Hinge Assembly

Once the cutout is finished, deburr all the parts .

Cleco the bellcrank bracket assembly to the forward side of the aft spar, aligning the single pre-drilled hole in the **upper** bellcrank bracket attach angle with the **top outboard** hole for the **inboard** hinge attach angle, as shown in Figure 59. Level the bellcrank bracket assembly relative to the spar, and clamp it securely.

Note Make sure you choose the correct bellcrank bracket assembly for each wing. The single, pre-drilled pilot hole in the **upper** bellcrank attach angle should be closest to the **inboard** end of the angle, as shown in Figures 56 and 57.

Use the holes in the aileron hinge attach angles as guides to drill **#30** rivet holes through the spar and the bellcrank bracket attach angles. (This includes the four holes at BL 147.02.) In addition, use the two #40 pilot holes at each end of the bellcrank bracket attach angles to drill **#30** rivet holes through the angles and the spar. Install Clecos as you go.

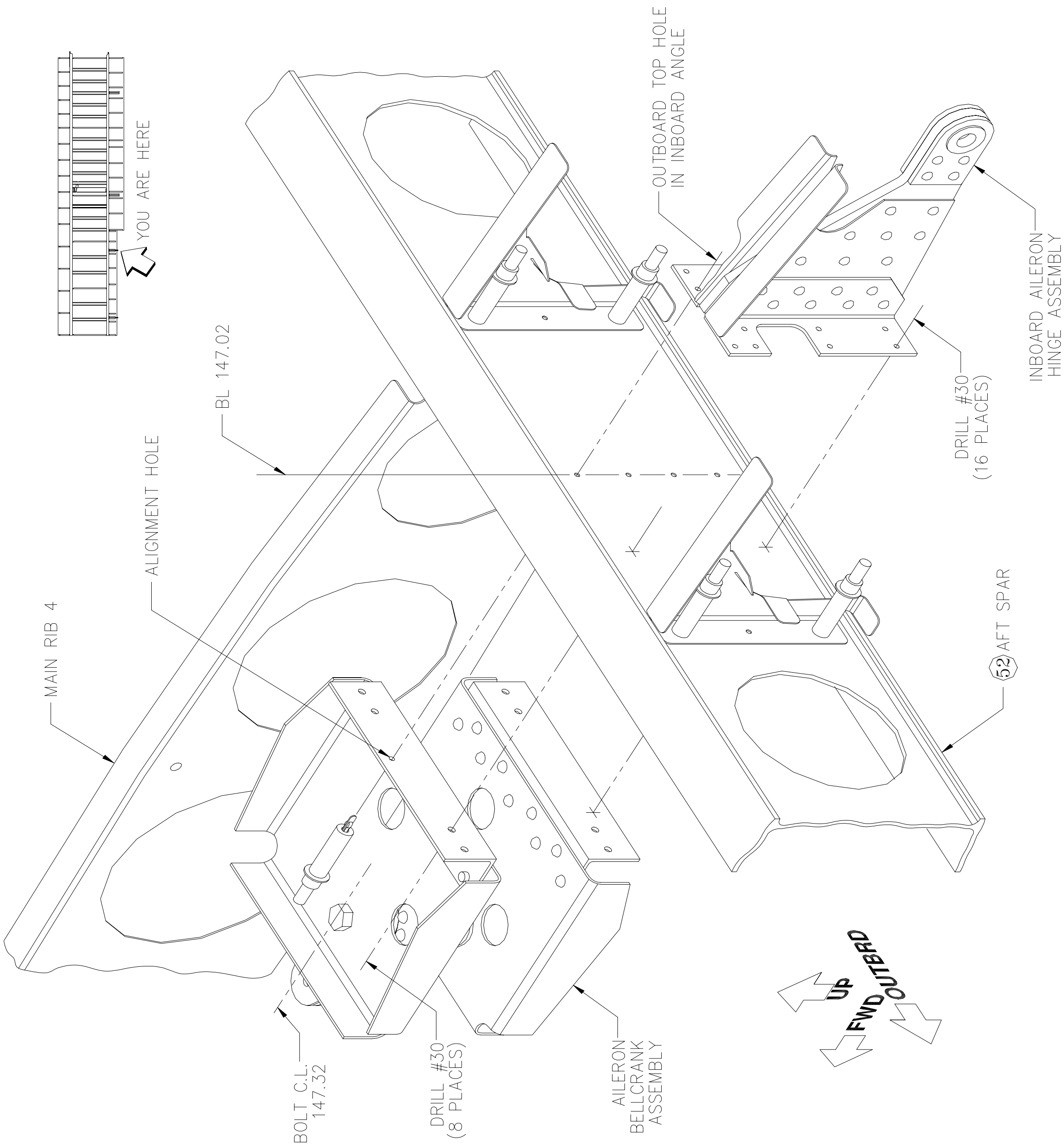
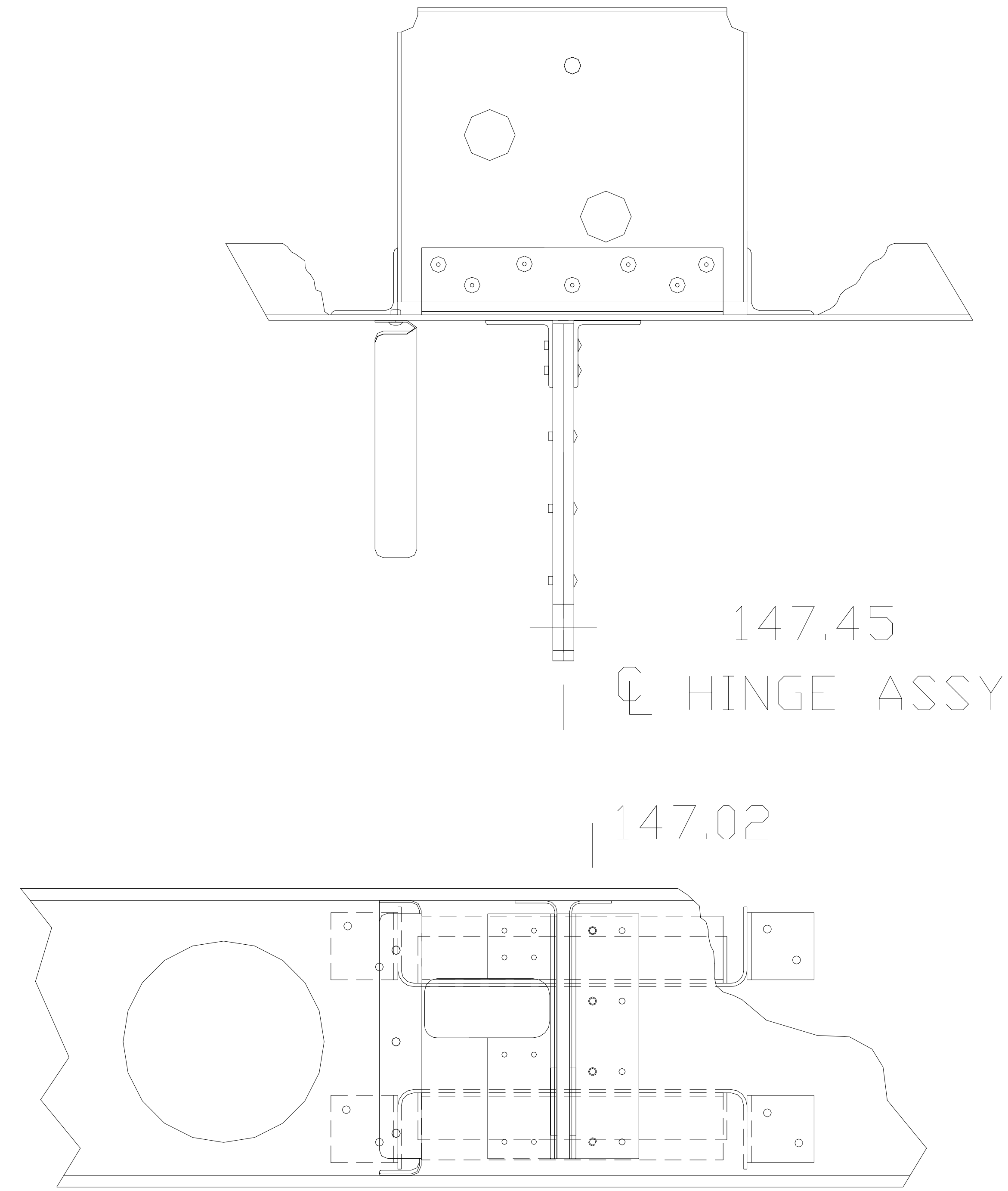


Figure 59: Aileron Bellcrank Assembly and Inboard Hinge Installation



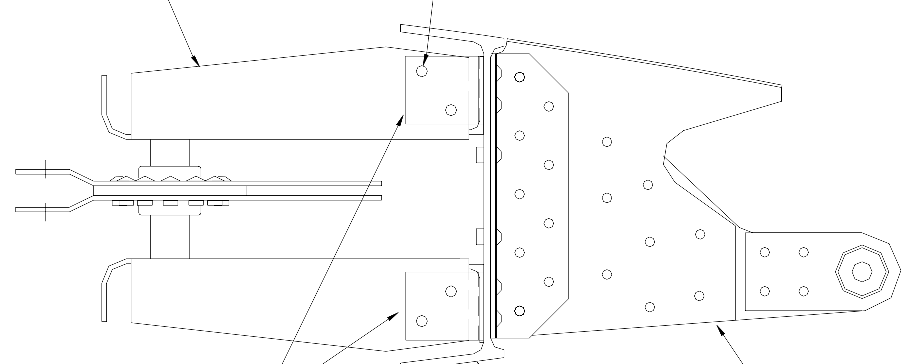


Figure 60: Bellcrank Bracket/Spar Flange Attach Angles

Fabricate four **bellcrank bracket/spar web attach angles** from the supplied **.063" X 1" X 1" 6061-T6 aluminum angle** [96]. Cut the attach angles **7/8"** long, as shown in Figure 60, and smooth the cut edges with files and sandpaper. Mark the rivet pattern approximately as shown in Figure 60 onto one leg of each attach angle. Dimensions here are not critical. The goal here is two rivets on each leg of the angle with adequate edge margins.

Clamp the four spar web attach angles in place against the bellcrank brackets and the web of the spar (one on each side of each bracket). Drill **#30** holes through the attach angle/bellcrank bracket assembly and the spar.

The rivets on the 149.95 rib will interfere with the small attach angle. Use a die grinder or file to relieve the angle of this area of interference or drill out the rivets and replace them with AN426AD3 flush rivets with the heads on the forward side of the spar.

Completed: Left [ ] Right [ ]

Step 49: Position and Drill the Outboard Aileron Hinge Assembly

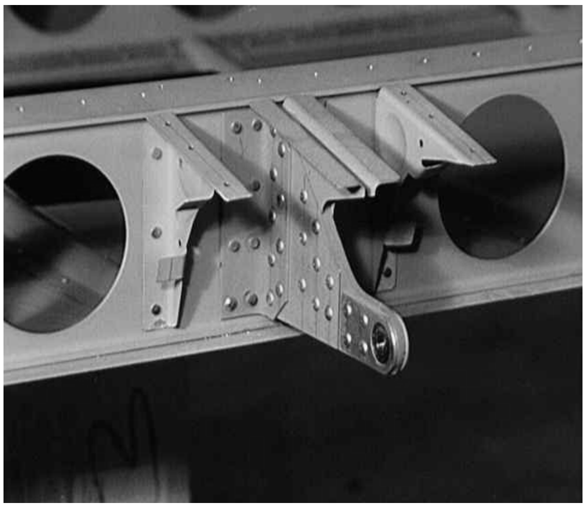


Figure 61: Outboard Aileron Hinge Assembly

Cleco the **outboard** aileron hinge assembly to the aft side of the aft spar using the pre-drilled holes located at **BL 190.14**, as shown in Figure 62. Use the holes in the attach angles to drill **#30** rivet holes through the spar.

Completed: Left [ ]
Right [ ]

Step 50: Mount the Aileron Bellcrank and Hinges

When all the holes have been drilled in both aileron hinge assemblies and the aileron bellcrank assembly, mark each assembly with its location and orientation. Remove the hinge assemblies and the bellcrank bracket assembly, and deburr and corrosion-proof the rivet holes.

Cleco and then rivet the hinge assemblies and the aileron bellcrank assembly to the aft spar using 1/8" AN470AD4 universal-head rivets. Rivet the bellcrank bracket/spar flange attach angles to the bellcrank brackets with 1/8" AN470AD4 universal-head rivets. Following standard procedures, position the manufactured heads of the rivets against the **thinner** material where possible.

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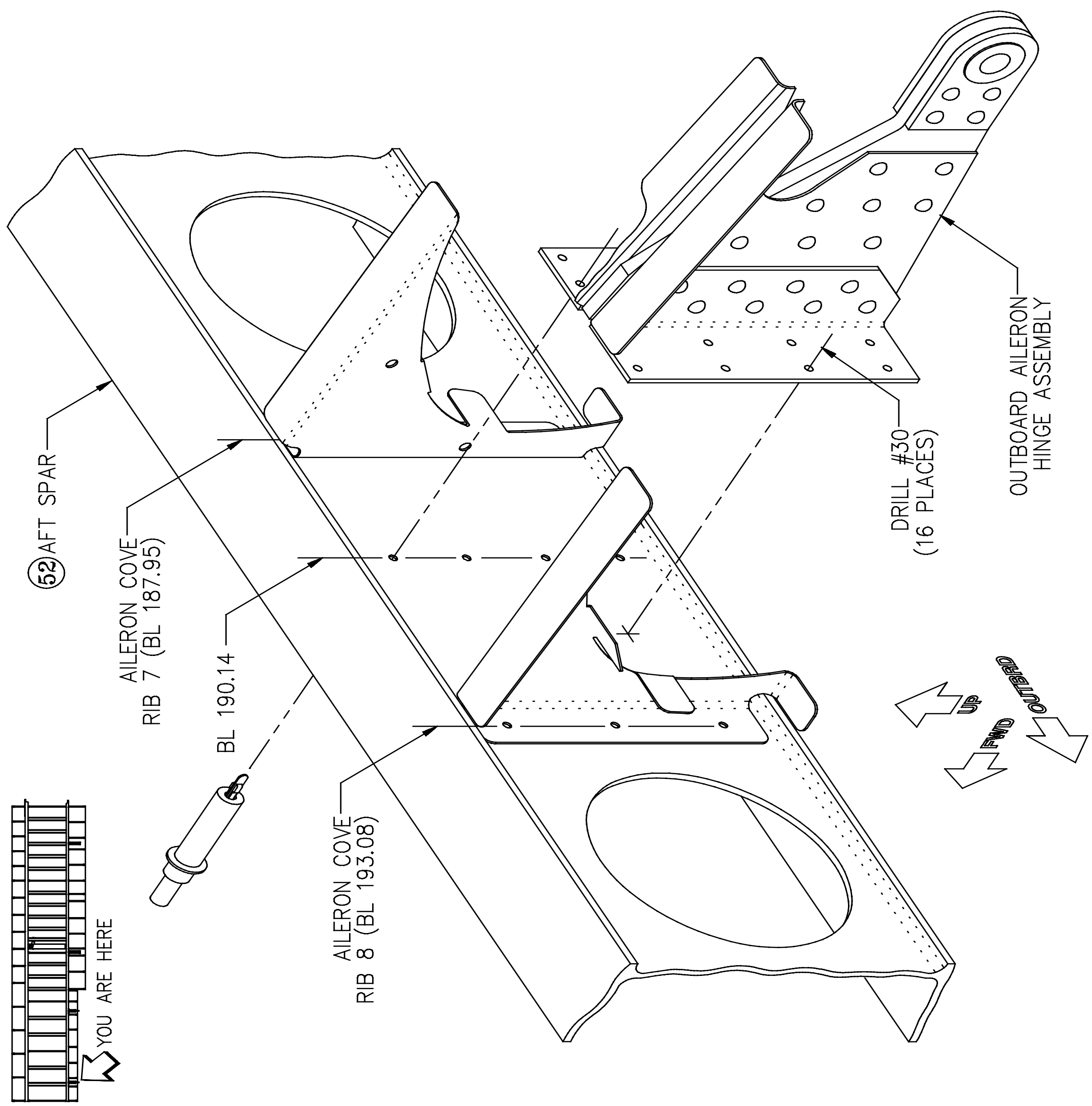

Figure 62: Outboard Aileron Hinge Installation

FABRICATE AND MOUNT THE AILERON PULLEY BRACKETS

Step 51: Fabricate and Mount the Outboard Pulley Brackets

Fabricate the two outboard aileron pulley bracket angles from the supplied **outboard aileron pulley bracket angle** stock [91], as shown in Figure 65. (The angle is .063" thick X 7/8" X 2-1/2" formed aluminum angle.) Use a hacksaw or a band saw to rough cut the angles and finish them with a belt sander or a file.

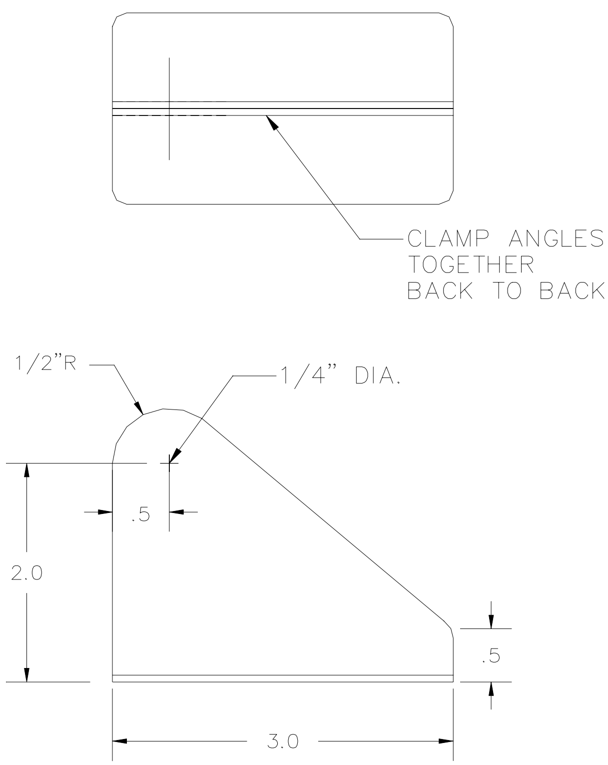

Figure 63: Drilling the Pulley Bracket Angles

To drill the 1/4" pulley pivot holes through the angles, mark and centerpunch the location of the pulley pivot hole on one of the angles. Place the two angles back-to-back, as shown in Figure 63. Clamp the angles together, and use the centerpunched mark as a guide to drill the **1/4"-**diameter hole through both angles at the same time, preferably with a drill press.

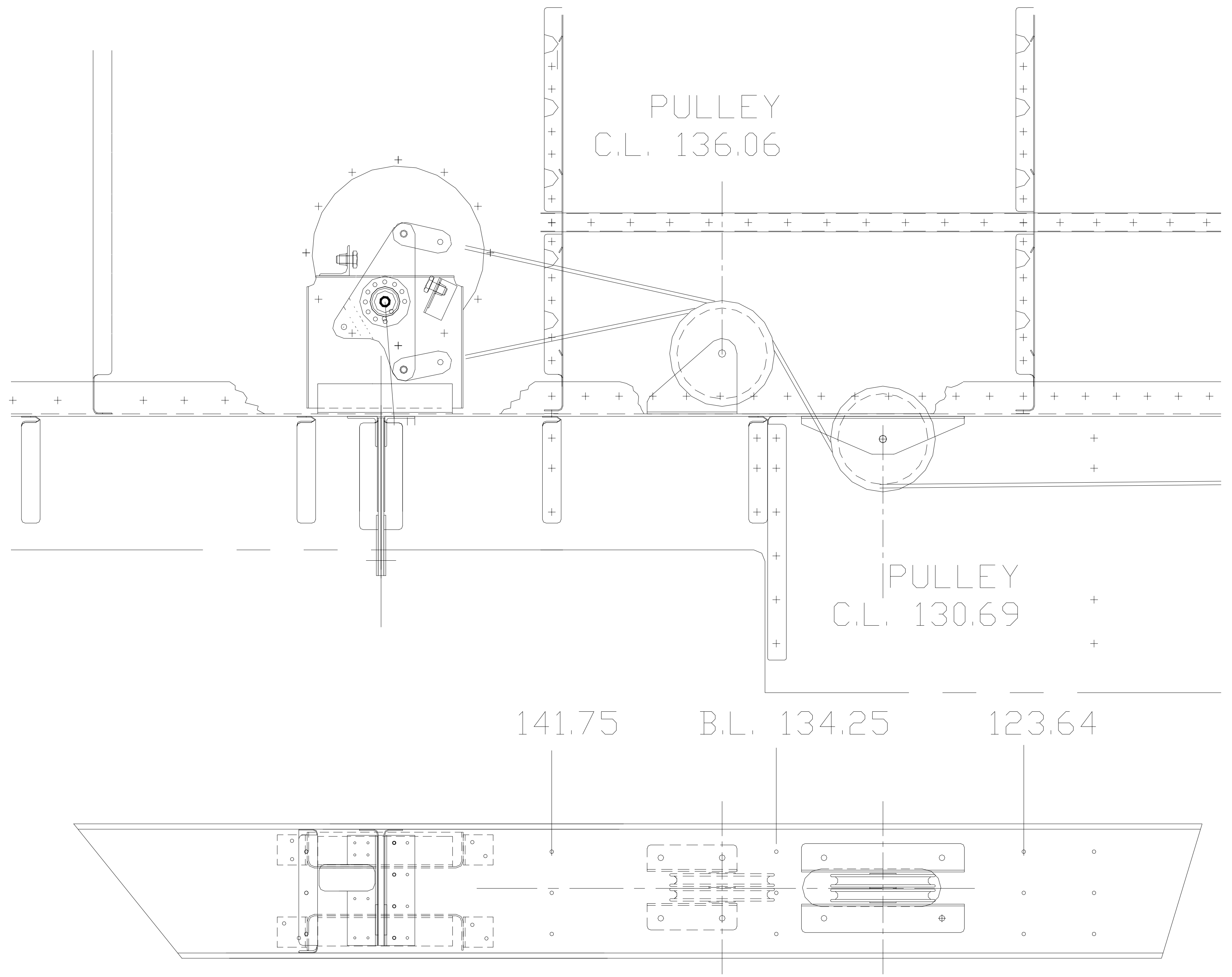

Figure 64: Outboard Aileron Pulley Brackets

Mount the two AN210-4A **pulleys** [100] between the pulley bracket angles, as shown in Figures 64 and 65, using the AN4-15 **drilled-shank bolt** [107], AN310-4 castle nut and AN960D416L thin aluminum washers under both the bolt head and the nut.

> **Note** Instead of the **AN210-4A** pulleys specified in the preceding paragraph and in Figure 65, some Sportsman kits include **MS24566-4B** pulleys. Both types of pulleys are aircraft-grade, 3-1/2" phenolic pulleys and are thus completely interchangeable. Which pulley is supplied simply depends on current pricing and availability from our vendors.

Clamp the pulley bracket assembly to the **forward side** of the aft spar, as shown in Figure 65. Position the angles parallel to the spar flange, with the pulleys' pivot axis at **Wing Buttock Line 136.06**. Center the two pulleys vertically on the **centerline of the aileron bellcrank**; this will provide the best routing of the cables from the pulleys to the bellcrank. Don't get hung up over small tolerance deviations here. What you are trying to achieve here is the general plan shown in Figure 64.

Drill four **#10** mounting holes through the pulley bracket angles and the aft spar, as shown in Figure 65; Cleco each hole as it is drilled. Drill all mounting holes in the centers of the angle flanges vertically.

When all the holes have been drilled, remove the pulley bracket assembly from the spar and disassemble it. Deburr all holes and corrosion-proof the parts.

Install the pulleys and brackets as shown in Figures 64 and 65.

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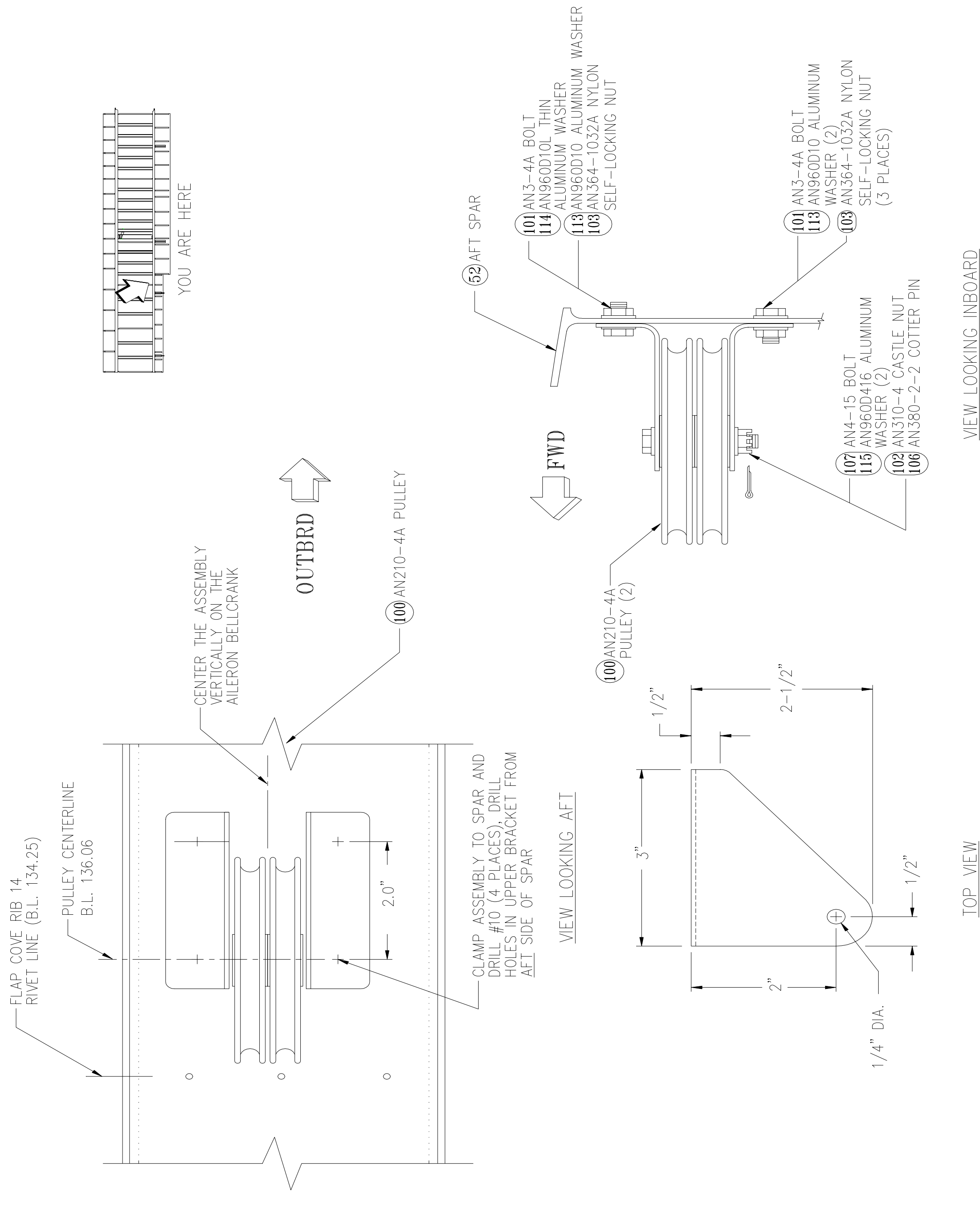

Figure 65: Outboard Aileron Pulley Brackets

Step 52: Fabricate and Mount the Inboard Pulley Brackets

The inboard aileron pulleys, centered at B.L. 130.69, protrude through a slot in the aft spar web as shown in Figure 64.

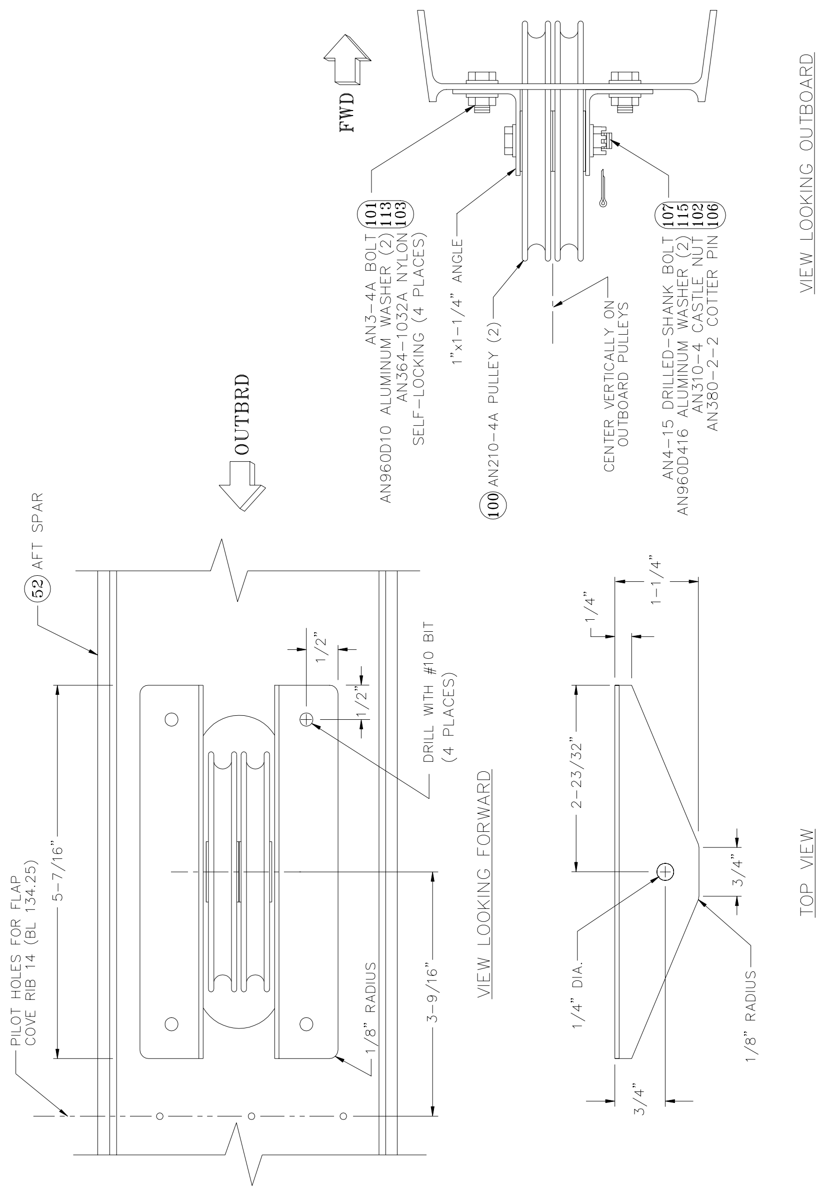

Figure 66: Inboard Aileron Pulley Brackets

Fabricate two inboard aileron pulley bracket angles from the supplied **.063" X 1" X 1-1/4" angle** [97], as shown in Figure 66. The two angles are symmetrical and identical. Cut the angles to rough shape with a hacksaw or a band saw and finish with files and sandpaper to remove saw marks. Clamp the two angles together back-to-back to drill the **1/4"**-diameter pulley mounting holes through both angles at the same time.

Mount the two AN210-4A pulleys between the pulley bracket angles, as shown, using the AN4-15 drilled-shank bolt, two AN960D416 aluminum washers and an AN310-4 castle nut.

Clamp the inboard pulley bracket assembly to the **aft** side of the aft spar, as shown in Figures 64 and 66. Position the bracket angles parallel to the spar flange, with the pulleys' pivot axis **3-9/16" inboard** of the rivet line for Flap Cove Rib 14. Center the inboard pulleys vertically on the line between the two outboard pulleys. Make sure there is adequate clearance between the pulleys and the spar cutout, especially on the inboard side. Check for alignment with the string mentioned earlier.

Drill two **#10** mounting holes through each pulley bracket angle and the aft spar, as shown. When the holes have been drilled, remove the bracket assembly from the spar and disassemble it. Deburr the holes and corrosion-proof the parts.

Assemble the pulley bracket using the hardware described previously, and bolt the assembly to the aft spar using AN3-4A bolts and AN960D10 aluminum washers under both the bolt heads and the AN364-1032A nylon self-locking nuts. At final assembly, after the cables have been routed and the cable retainer installed, secure the castle nut on the pivot bolt with an AN380-2-2 cotter pin.

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Step 53: Assemble the Flap Tracks

Lay out and center punch the rivet pattern shown in Figure 67 onto a **left-flange flap track rib** [74], being careful to maintain a minimum edge distance of 1/4" (twice the rivet diameter) from the centers of the rivet holes to the edges of the **rib**. (This may position the rivet holes less than 1/4" from the edge of the flap track, but this is acceptable, since the track is made from such thick material.)

Cleco a **left-flange** and a **right-flange flap track rib** [74 and 75] to the sides of each **flap track** [73] with the flanges of the ribs oriented away from the flap track, as shown in Figure 69. Use 1/8" Clecos in the two pre-drilled holes in each part. Use the center-punched rivet pattern as a guide to drill **#30** holes through the assembly.

Before you rivet the assembly, it is recommended that you check the clearance between the guide bushings and the corner of the rib as well as the length of the upper track slot. The bushings are 3/4" diameter (reference figure 67) and should just clear the rib all along the track slot. It would also be a good idea to make sure the guide arm on the flap clears as well.

Disassemble and deburr the rivet holes, and corrosion-proof the parts. Rivet the assembly together with 1/8" AN470AD4 universal-head rivets. Repeat for both the inboard and the outboard flap track assemblies.

Completed: Left [ ] Right [ ]

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques

[illegible]

Page 101-1[illegible]: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN5[illegible]-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

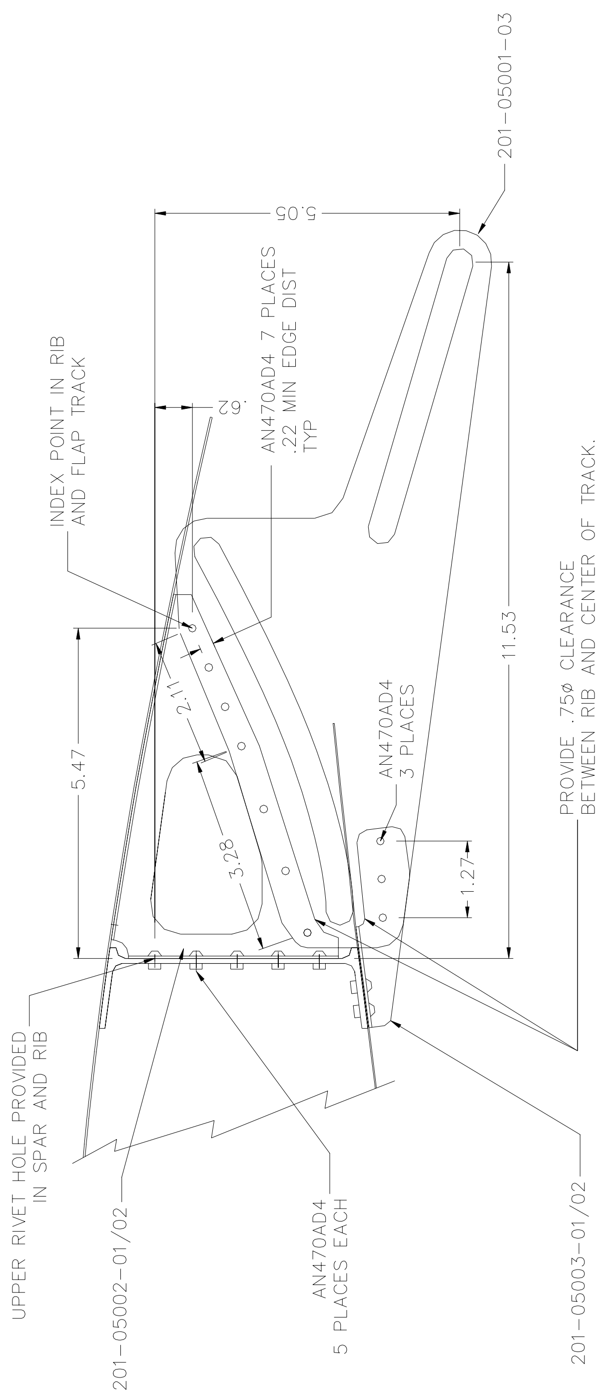

Figure 67: Flap Track Assembly

Step 54: Mount the Flap Tracks

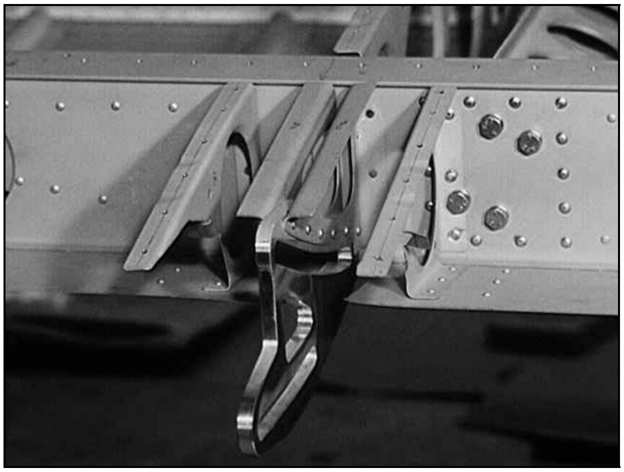

Figure 68: Flap Track Installation

The **outboard** rib of the **outboard** flap track assembly shares rivets with the aft end of Main Rib at **BL 112.53**, as shown in Figures 68 and 69. The **outboard** rib of the **inboard** flap track assembly is riveted to the pre-drilled holes in the aft spar at **BL 47.03**, approximately half way between Flap Cove Ribs 3 and 4. Cleco the flap track assemblies to the aft side of the aft spar, using the appropriate pre-drilled holes in the spar. When installed correctly, the two flap tracks are **65-1/2"** apart, center-to-center.

Use the pilot holes in the flap track rib flanges as guides to drill **#30**-diameter rivet holes through the aft spar.

Note When drilling the rivet holes for the **inboard** flap track rib of each track assembly, take care to hold the inboard rib's web parallel to the web of its mate. Since the flap track separates the two ribs at the bottom only, it's easy to let the top of the inboard rib drift too close to or too far away from its mate, which will complicate later installation of the plastic cable guides.

After drilling, remove the flap track assemblies from the spar and deburr the rivet holes. Rivet the flap track assemblies to the aft spar with 1/8" AN470AD4 universal-head rivets. As always, place the manufactured heads against the thinner material.

Note Do not rivet the **outboard** rib of the **outboard** flap track at this time. The outboard side will be riveted with Main Rib 3 in Step 60, when the rest of the wing structure is riveted together.

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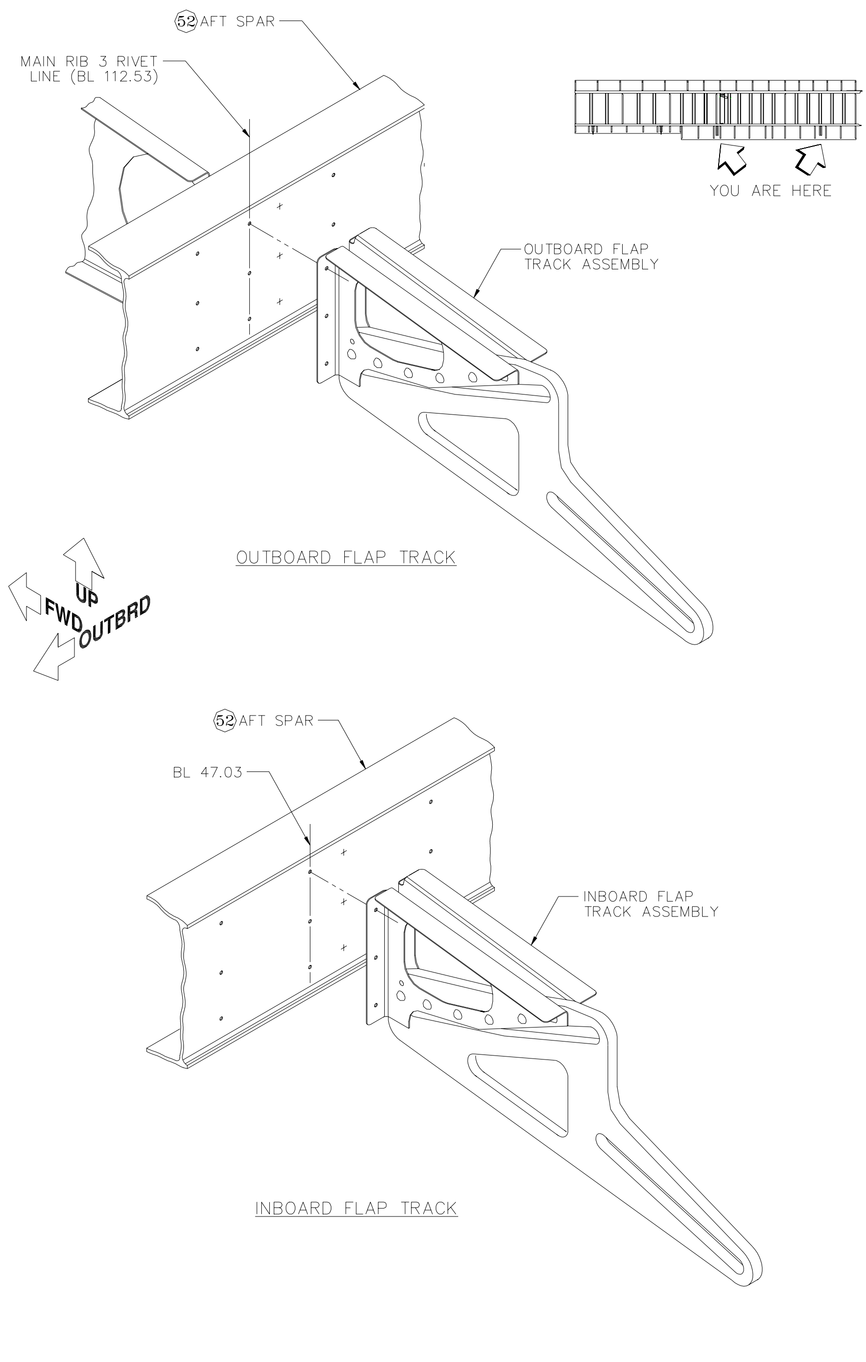

Figure 69: Flap Track Mounting

Step 55: Assemble the Flap Bellcrank

The Sportsman bellcrank assembly is clocked slightly different than that of the GlaStar, therefore slight deviations need to be made from the index holes provided in the parts. Position the **flap bellcrank arm** [77 or 78] on the **flap bellcrank pulley** [76] and **mark** the pulley through the two index holes in arm, as shown in Figure 70. Pay attention to the pulley orientation, as it is not symmetric. Reversing the pulley will not make the part wrong, it will just not match the illustrations and perhaps add confusion. Next, mark the rest of the eight points that form the rivet pattern on the arm. Tolerances are not critical. The two holes that are close to each other along the 16° line, can be drilled from the pulley side where there already exists a hole, thus ignoring the one marked on the arm. In the area where two index holes are close to each other, drill from the arm side so as to have one good hole in the thinner material.

Note It is recommended that you trace this on a piece of paper to help line up the 83° and the 16° lines

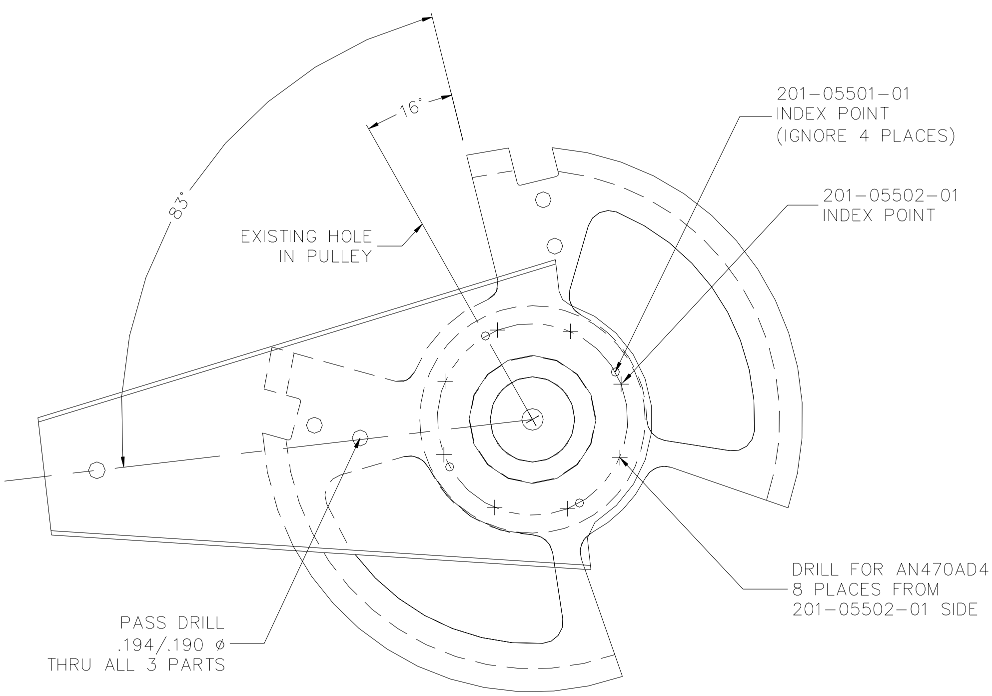

Figure 70: Positioning and Drilling the Left Hand Bellcrank Assembly

Once you have marked the holes, drill #40 holes through two locations and cleco the arm to the pulley. Flip the assembly over and drill from the two pulley holes that are on the 16° line. Now position and clamp the opposite arm to the assembly and insert a bolt through the actuation hole at the end of the arms. Pass drill all the holes through the two arms and the pulley, inserting clecos as you go.

Remove one arm and pass drill the two **#10** holes from the pulley side through the bellcrank arm, and then again through the opposite arm.

Finally, transfer the rivet pattern through the **spacer rings [80]** similar to that shown in Figure 71 using the larger center holes for alignment. Ignore the quantity of holes (you only drilled 8) as well as the location of the two #10 hole, as those are for GlaStar kits only.

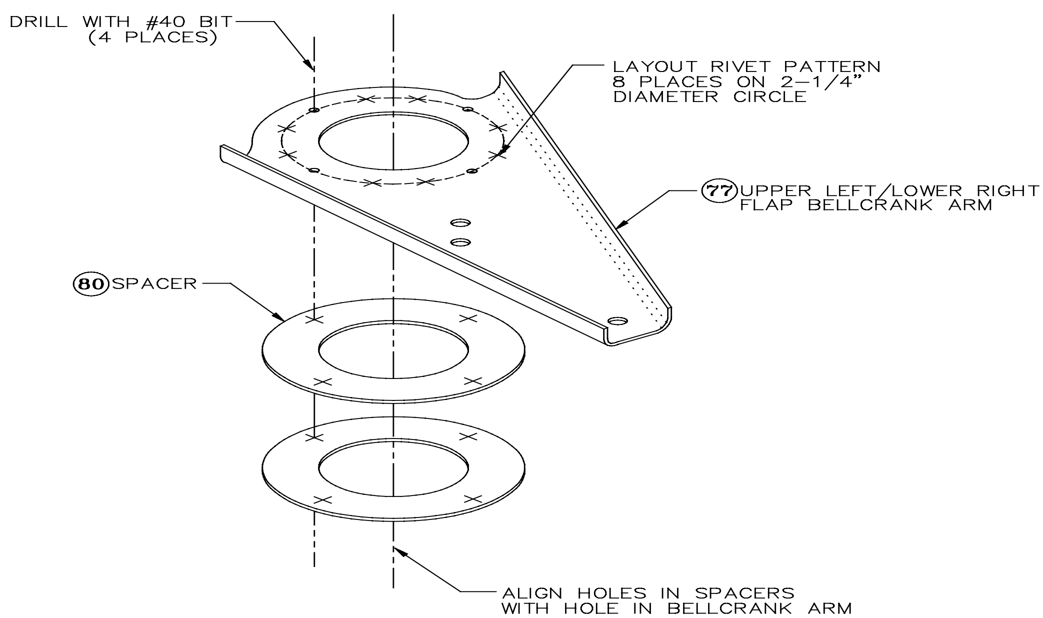

Figure 71: Drilling the Flap Bellcrank Spacers

Cleco the two bellcrank arms, the two spacers and the pulley together in their correct positions relative to each other as illustrated In Figure 70 (the spacers fit **between** the pulley and the arms as shown in Figure 72). Use the rivet pattern previously drilled, and pass drill all holes to a **#30.** Be sure you have the actuation bolt and the cable retainer bolts inserted to keep the assembly aligned.

Disassemble the bellcrank, deburr rivet holes in all parts, and apply corrosion protection. Rivet the assembly together with 1/8" AN470AD4 universal-head rivets. Again use bolts though the arms. Again Figure 72 shows a GlaStar pulley assembly, but the general principal applies.

Note Up to now the bellcrank assembly will work on either side of the airplane by simply flipping the assembly over. After the bearing housing and bearing are inserted, they must be kept as left and right hand assemblies.

In Figure 70, the view is looking down on the left wing, the arm is pointing outboard and the top of the page if forward.

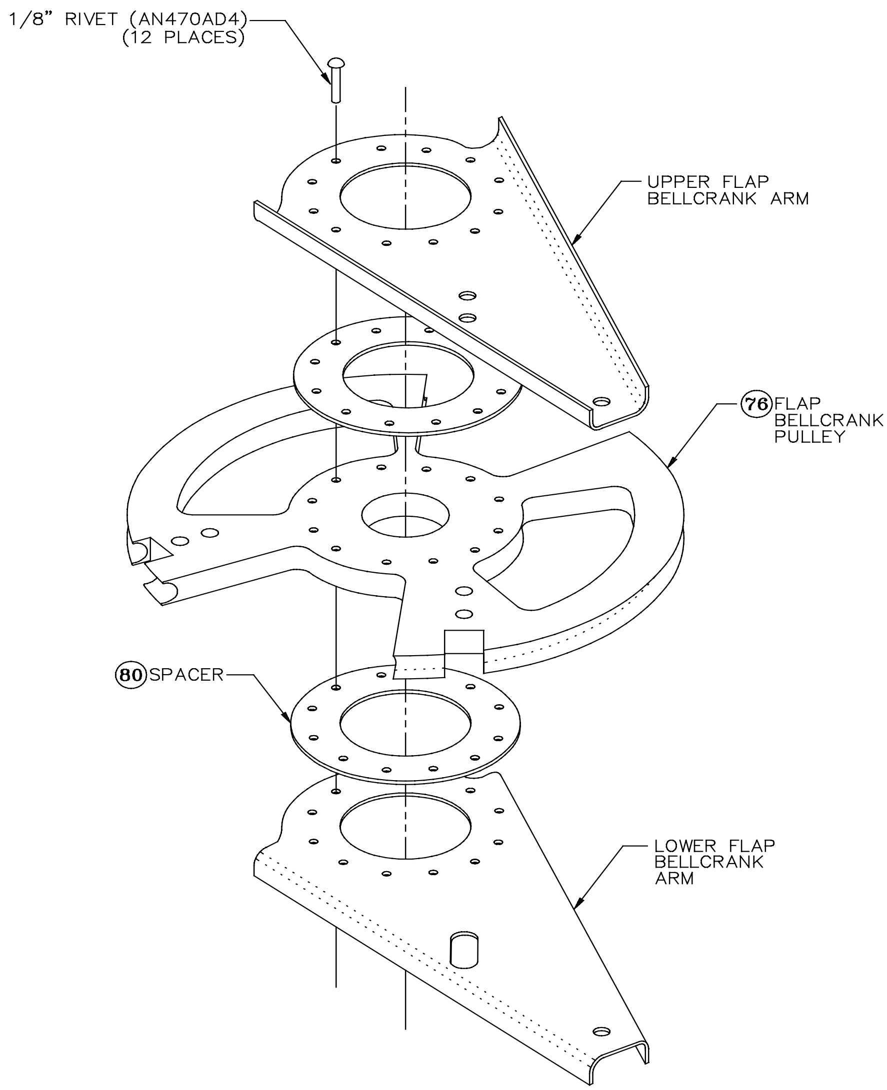

Figure 72: Riveting the Bellcrank Assembly

Hint Driving the long rivets used in the flap bellcrank can be difficult. We recommend **back-riveting** this assembly: clamp the universal head rivet set in a vise, place the rivet head in the set, and drive the rivet tail using either a hammer or a flush rivet set in a rivet gun. An assistant to hold things steady while you rivet will make this easier.

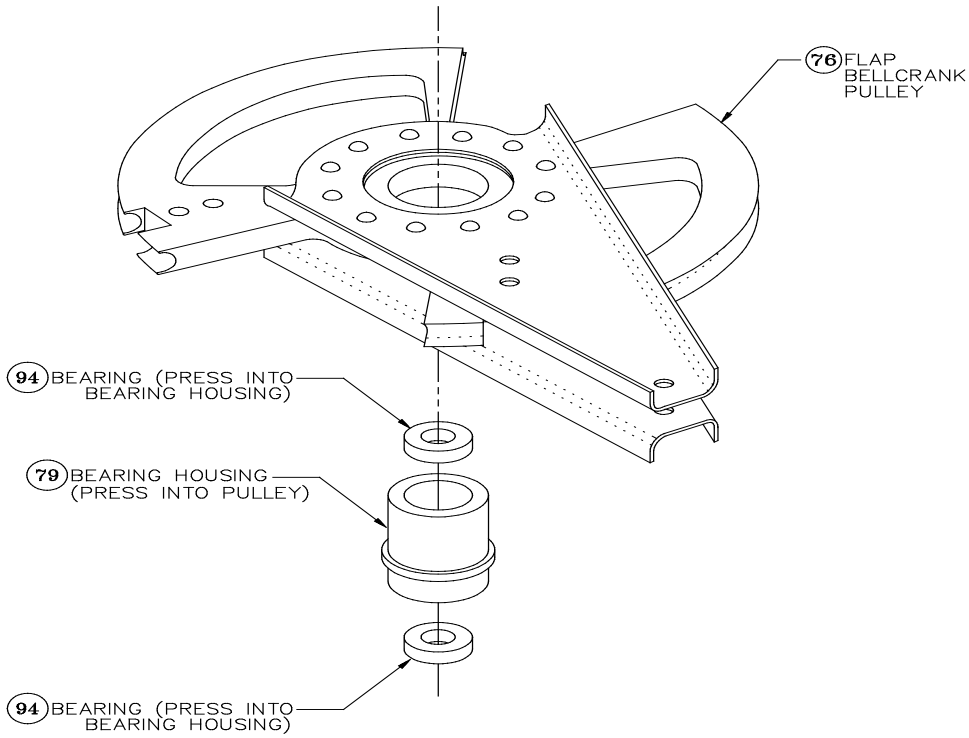

Figure 73: Install the Bellcrank Bearing Assembly

Use an arbor press or a bench vise to press the **flap bellcrank bearing housing** [79] into the flap bellcrank assembly, as shown in Figure 73. (The ridge around the bearing housing goes on the **lower** side of the pulley.) Use Loctite bearing retaining compound to secure the bearing housing (either Loctite 609 low-viscosity or 680 medium-viscosity, high-strength). Press a **bearing** [94] into each side of the bearing housing until the outer bearing race contacts the shoulder inside the housing. Secure the outer race of each bearing with Loctite bearing retaining compound.

Completed: Left [ ] Right [ ]

Step 56: Assemble the Flap Bellcrank Bracket

Lay out and centerpunch the rivet patterns onto both legs of the **upper** and **lower flap bellcrank attach angles** [60 and 61], as shown in the top and front views of Figure 74. Use the rivet pattern to drill **#40** pilot holes through the **vertical** legs of the angles.

> **Note** As with the aileron bellcrank attach angles, the pre-drilled pilot holes in the flap bellcrank attach angles may be centered less than the minimum two rivet diameters from the edges of the parts. This is acceptable here, both because of the thickness of the material and the total number of rivets used to rivet the bellcrank assemblies.

Cleco the **upper flap bellcrank attach angle** [60] to a **flap bellcrank bracket** [59], using the two holes in the horizontal leg of the angle to align the two parts, as shown in Figure 74. Similarly, Cleco the **lower flap bellcrank attach angle** [61] to another **flap bellcrank bracket** [59]. Make sure that the pre-drilled index holes in the vertical legs of the attach angles are positioned opposite each other, as shown. Use the center punched rivet hole locations and the two pre-drilled holes in the horizontal legs of the angles as guides to drill the nine **#30** rivet holes through each angle and bracket assembly, Clecoing as you go.

Disassemble the parts, deburr, corrosion-proof and rivet the angles to their respective brackets with 1/8" AN470AD4 universal-head rivets. Following standard procedures, place the rivet heads against the thinner material (the bracket).

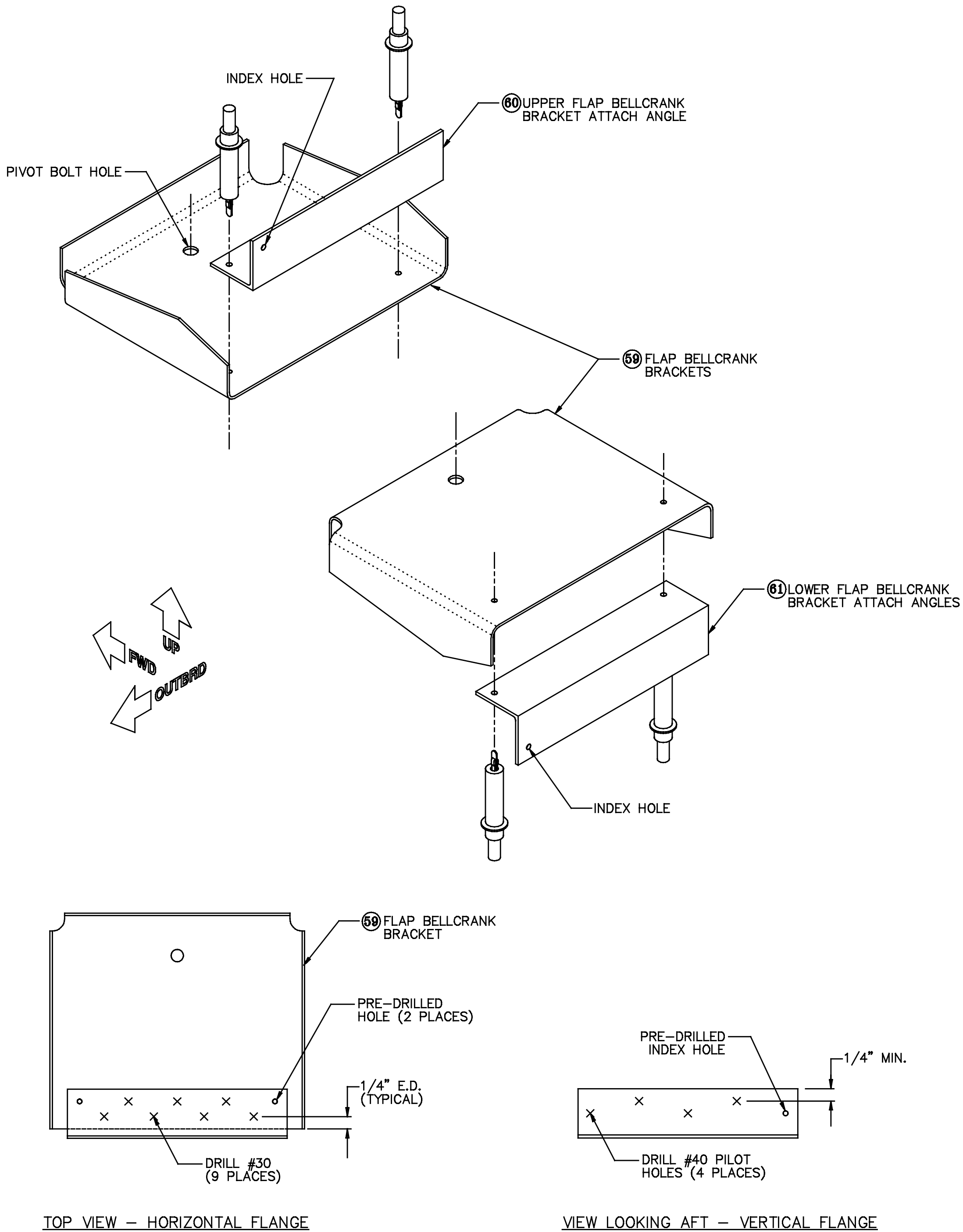

Figure 74: Flap Bellcrank Bracket Assembly

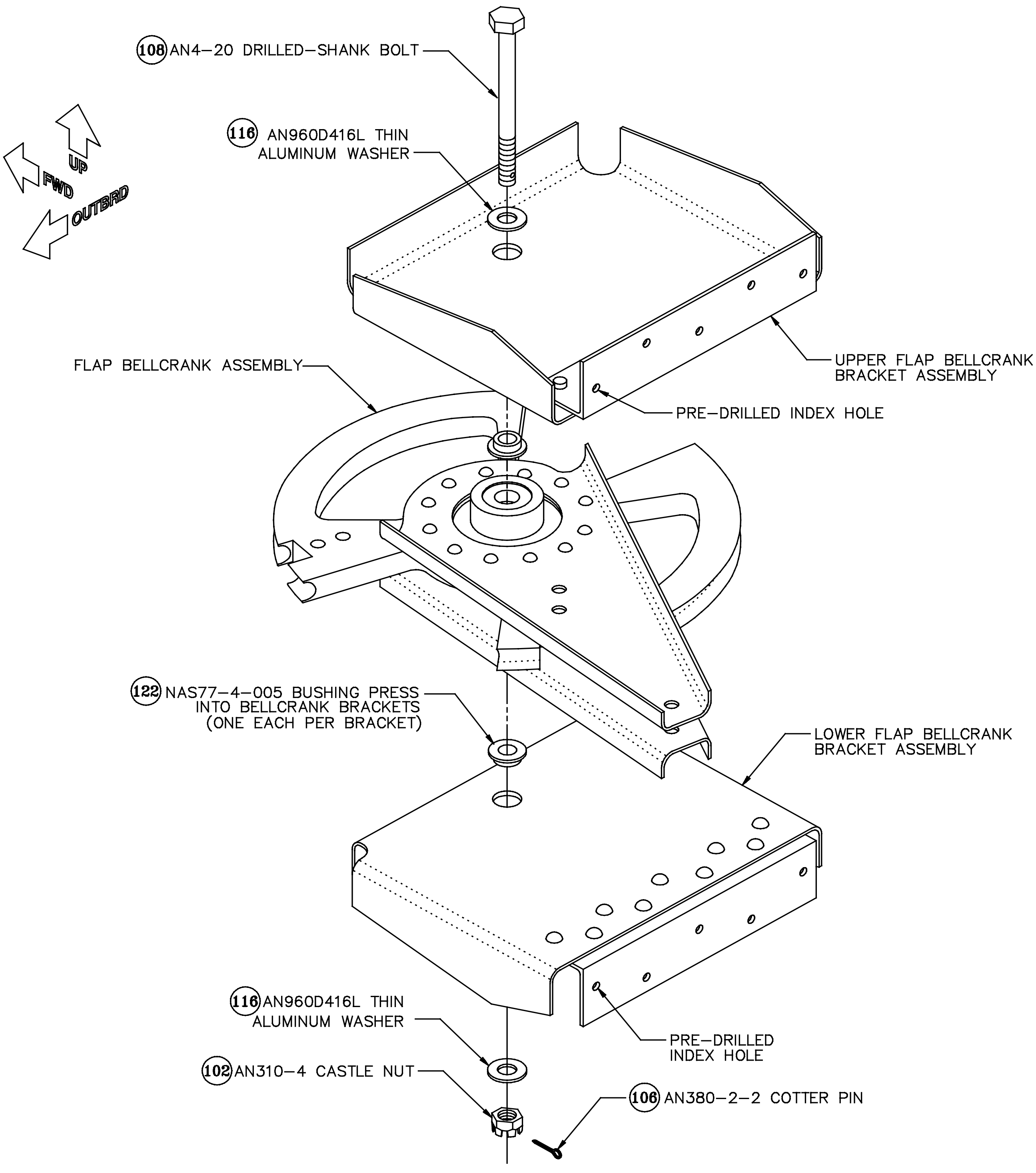

Figure 75: Mounting the Bellcrank Assembly Between the Bellcrank Brackets

Press an NAS77-4-005 **bushing** [122] into each flap bellcrank bracket, as shown in Figure 75. Position the bushing flanges toward the bellcrank, as shown. Secure the bushings with Loctite bearing retaining compound.

Use an AN4-20 **drilled-shank bolt** [108] to mount the flap bellcrank assembly between the upper and lower flap bellcrank brackets, as shown in Figure 75. Secure the bolt with an AN310-4 castle nut, an AN960D416L thin aluminum washer (under both the bolt head and the nut) and an AN380-2-2 cotter pin.

Caution Tighten the AN310-4 castle nut on the AN4-20 drilled-shank bolt only to the point at which there is no up-and-down play in the bellcrank. The bellcrank bearings are not designed to handle the loads imposed by an over-tightened bolt.

Completed: Left [ ] Right [ ]

Step 57: Mount the Flap Bellcrank Assembly

Position the flap bellcrank assembly on the forward side of the aft spar, as shown in Figure 77, and Cleco the pre-drilled index holes in the bellcrank attach angles through the upper and lower rivet holes for Flap Cove Rib 7 at **BL 76.94**.

Make sure the bellcrank assembly is square to the spar, and use the #40 pilot holes in the bracket attach angles as guides to drill **#30** holes through the angles and the spar. Cleco as you go.

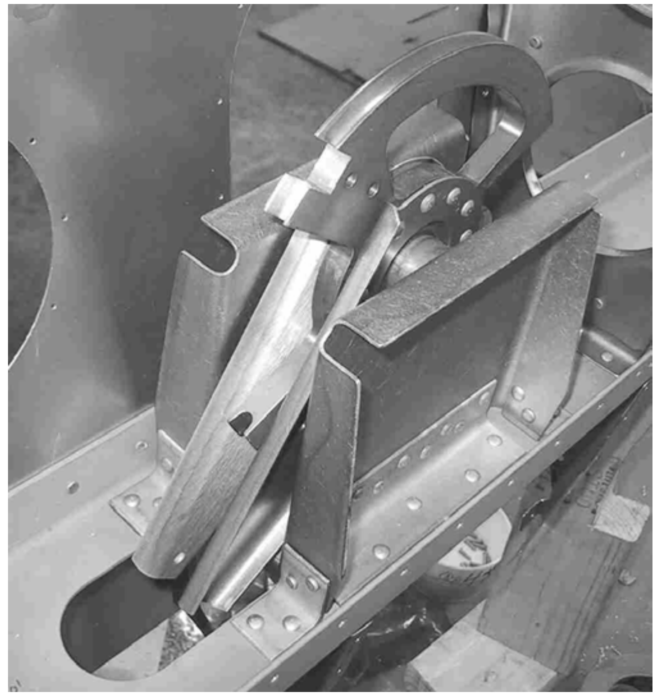

Figure 76: Flap Bellcrank Bracket Installation

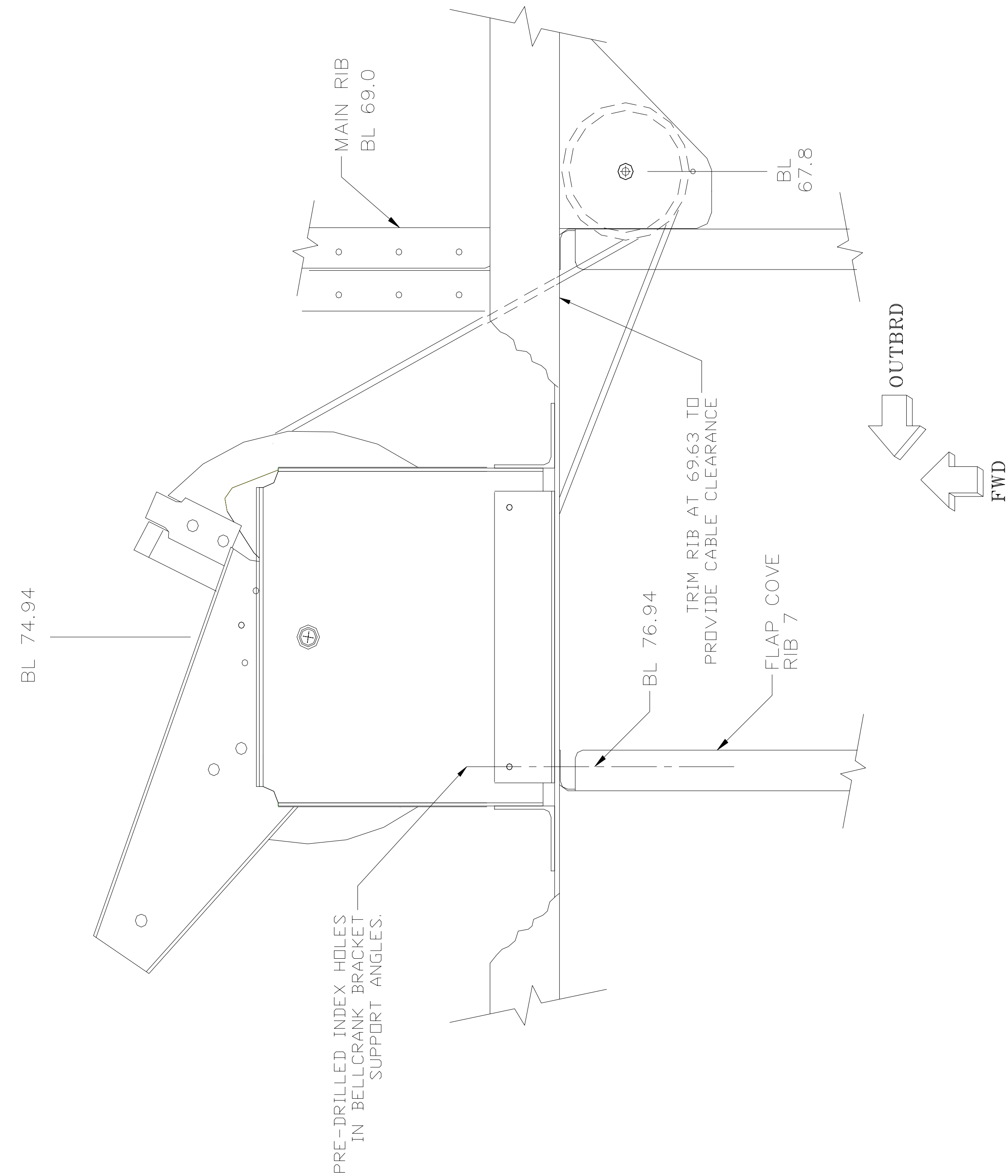

Figure 77: Mounting the Flap Bellcrank Assembly

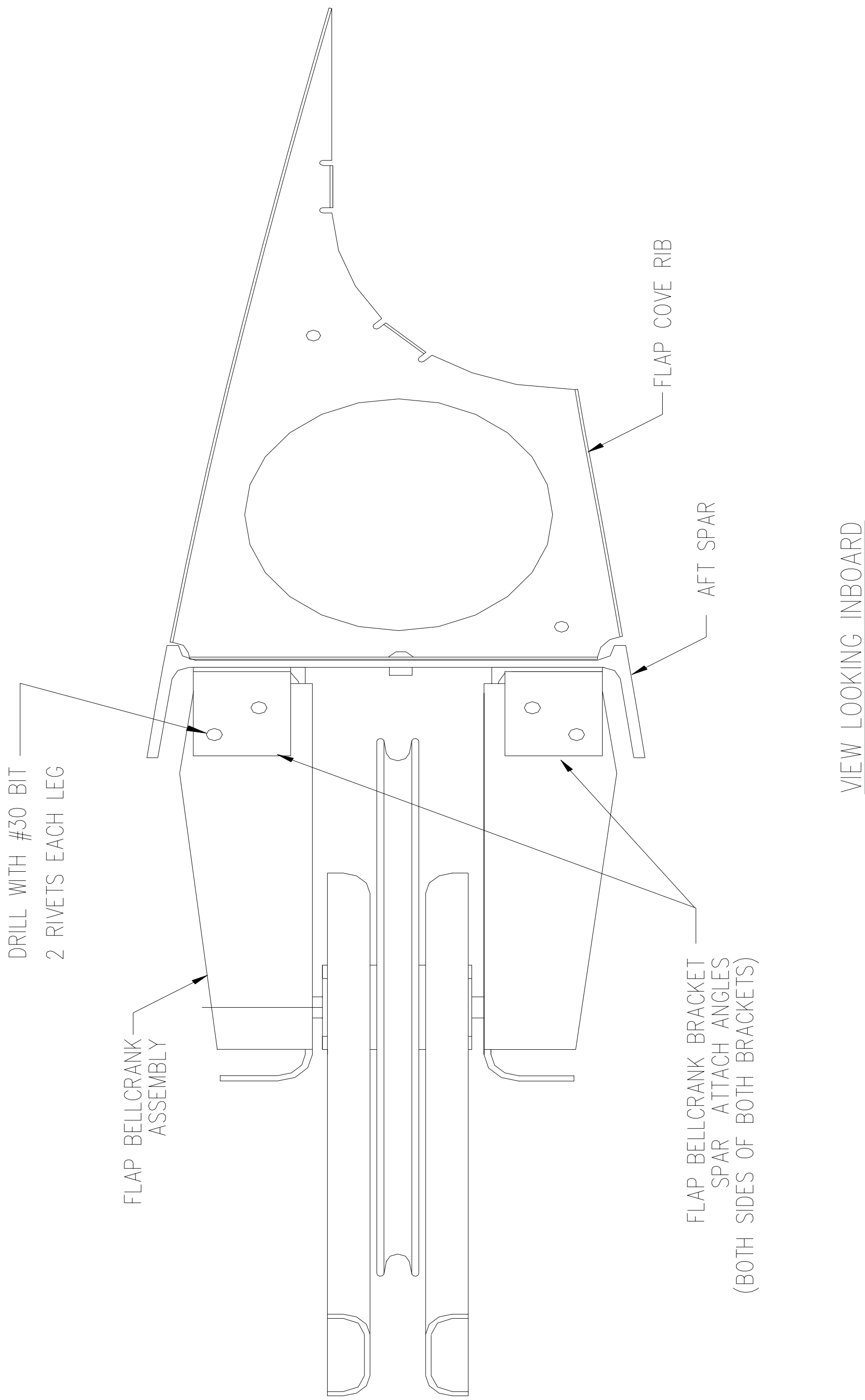

Figure 78: Flap Bellcrank Bracket/Spar Flange Attach Angles

Fabricate four **flap bellcrank bracket/spar attach angles** from the supplied .063" X 1" X 1" 6061-T6 aluminum angle. (These are identical to the **aileron** bellcrank bracket/spar attach angles described previously in Step 48.) Cut the attach angles **7/8"** long, as shown in Figure 78, and smooth the cut edges with files and sandpaper. Mark the rivet pattern shown in Figure 78 onto one leg of each attach angle.

Clamp the four spar flange attach angles in place against the bellcrank brackets and the web of the spar (one on each side of each bracket) with the marked legs against the bellcrank brackets. Use the marked rivet pattern on the angles as a guide to drill **#30** holes through the attach angle/bellcrank bracket assembly. Then drill two **#30** holes through each of the four angle legs common to the rear spar. The goal is two rivets in each leg of the angles with adequate edge margins.

When all the holes have been drilled, remove the bellcrank assemblies, deburr all holes and corrosion-proof any unprotected components.

Rivet the bellcrank assembly and Flap Cove Rib 7 to the aft spar using 1/8" AN470AD4 universal-head rivets. Rivet the bellcrank bracket/spar flange attach angles to the bellcrank brackets.

Completed: Left [ ] Right [ ]

Fabricate and Install the Flap Pulley Brackets

Step 58: Fabricate and Mount the Flap Pulley Brackets

Fabricate the two flap pulley bracket angles from the supplied .063" X 1" X 2-3/4" formed aluminum **flap pulley bracket angle** stock [90], as shown in Figure 79. Use procedures similar to those used to fabricate the aileron pulley brackets.

> **Note** Figure 79 shows the pulley bracket for the **left** wing; the **right** wing pulley bracket is a mirror image.

> **Note** The maximum allowable clearance between the cotter pin cable guard and the pulley to be 1/16". Reference Fig 79.

Mount the two AN210-3A **pulleys** [99] between the pulley bracket angles, using an AN4-15 drilled-shank bolt, AN310-4 castle nut and AN960D416 aluminum washers under both the bolt head and the nut.

Butt the pulley bracket assembly against the inboard side of Flap Cove Rib 6 and center it vertically on the spar web, as shown in Figure 79. Clamp it to the aft side of the aft spar.

Align the pulley bracket with the flap bellcrank. Run string from the bellcrank through the spars and rib onto the pulleys, making sure there is proper clearances and the bracket is aligned. Make any adjustments necessary.

Drill three **#30** mounting holes through each pulley bracket angle and the aft spar, as shown. When all the holes have been drilled, remove the bracket assembly from the spar and disassemble it. Deburr all holes and corrosion-proof the parts.

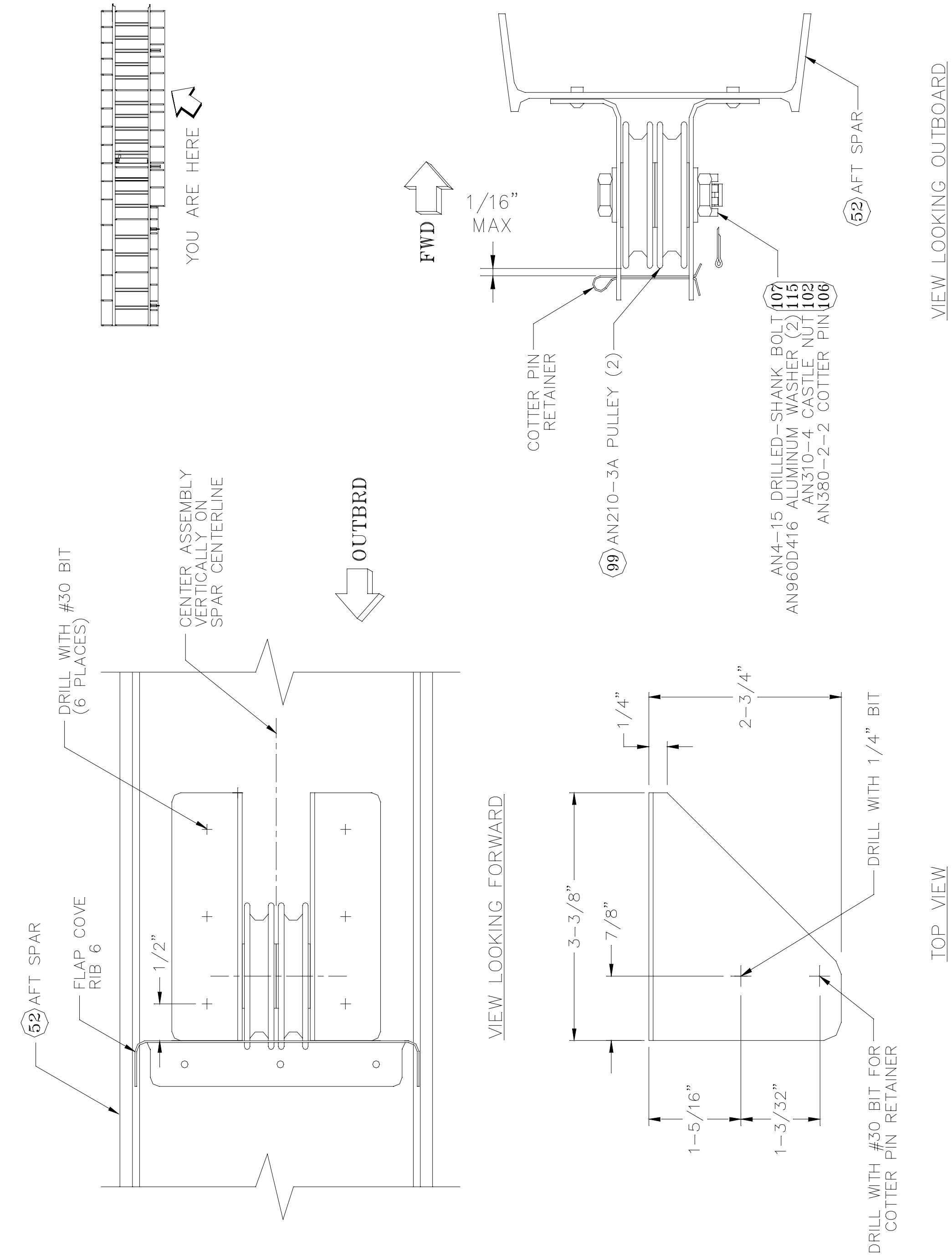

Figure 79: Flap Pulley Brackets

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Assemble the pulley bracket using the hardware shown in Figure 79, and rivet it to the aft spar with 1/8" universal head rivets (AN470AD4). At final assembly, secure the castle nut with an AN380-2-2 **cotter pin** [106].

Note The large cotter pin used as a cable retainer shown in Figure 79 will be installed when the cables are routed, as described in "SECTION IX: SYSTEMS INSTALLATION."

Completed: Left [ ] Right [ ]

RIVET THE RIBS AND THE LEADING-EDGE AND LOWER SKINS

At this time, we recommend riveting the ribs to the spars, installing the strut beam assembly for the final time, and then riveting the leading edge and lower skins to the spar/rib assembly. Once this has been done, the wing will be quite rigid so it can be taken out of the jig and mated to the fuselage to fabricate and install the control cables. The wing can also be placed on a table (or supported by a pair of padded sawhorses) to facilitate installation of the fuel tank vent lines, the pitot/static system and the navigation light wiring. The lower skins are riveted on first because they have several inspection holes that provide access for riveting the upper skins later.

Note Place the wing in the jig, and make sure the jig is plumb and true for the following operations. Place the aft spar supports under the aft spar and adjust them, if necessary, to achieve a straight aft spar.

Step 59: Rivet the Main and Cove Ribs to the Spars and Install the Strut Beam Assembly

Cleco the cap strips to the insides of the forward spar flanges.

Cleco the main ribs between the spars, making sure that you place each rib in its correct location.

Cleco all the cove ribs to the aft spar, again making sure that each rib is placed in its correct position and that the flanges are oriented properly.

Rivet the main ribs, flap cove ribs and aileron cove ribs (**except for the root ribs and the forward ends of Main Ribs 2 and the tip rib**) to the forward and aft spars, using 1/8" AN470AD4 universal-head rivets. Reference Figures 18-21 for rivet schedules.

Just loosely bolt the root ribs in place for now. Main Ribs 2 and the tip rib share rivets with the nose ribs and will be riveted with the leading edge assembly. When riveting the aft end of Main Rib 112.53, you will also rivet the rib for the outboard flap track assembly. Use a 1/8" AN426AD4 flush-head rivet, with the head on the forward side of the aft spar web/strut beam doubler, for the center hole of Flap Cove Rib 11 (see Figure 19). If interference exists between the upper outboard aileron pulley bracket and the center rivets of Flap Cove Rib 14 and Aileron Cove Rib 1, you may either notch the lower edge of the bracket angle for clearance, as described in Step 51 and Figure 64, or leave out these two rivets.

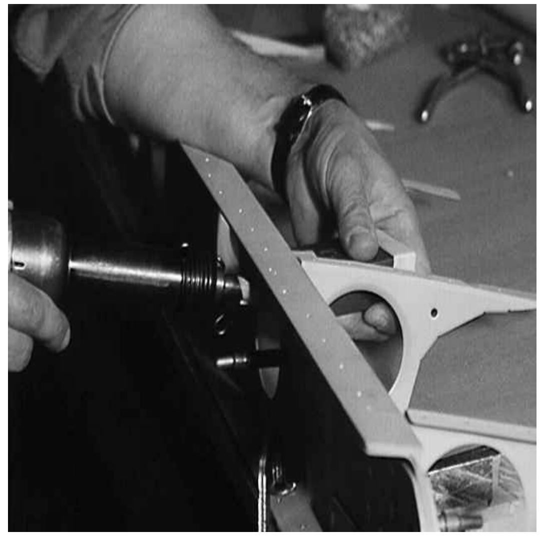

Figure 80: Riveting the Flap Cove Ribs

Bolt the strut beam assembly between the spars, using the hardware specified in Step14 and 15.

> **Caution** The strut beam assembly **must** be installed before the leading edge skins. Make sure that it is installed correctly and that the bolts are properly torqued; once the leading edge is riveted on, the bolts at the forward end will no longer be accessible. Make sure it is installed exactly how it was originally installed, using any shims or spacers in order to get the ribs to fit how they were when the main skins were drilled.

Completed: Left [ ] Right [ ]

Step 60: Rivet the Leading Edges Together

Figure 81: Riveting the Leading Edge

Cleco the nose ribs into the leading edge skins, **except for the ribs where the skins overlap at the joints** (Nose Ribs 6 and 12), making sure you place each rib at the correct location. Also make sure that the rib flanges are oriented properly (all flanges outboard except for the root rib). Use 3/32" AN426AD3 flush-head rivets to rivet the leading edge ribs into the leading edge skin sections, **except for Nose Ribs 6 and 12**. After all the ribs have been riveted into the individual leading edge skins, Cleco the skins to Nose Ribs 6 and 12, making sure that the outboard end of each skin overlaps the inboard end of the adjacent skin at each joint. Use 1/8" AN426AD4 flush-head rivets to rivet the leading edge sections together to Nose Ribs 6 and 12. When finished, you will have the full-span leading edge ready to rivet onto the forward spar.

Caution Be careful handling the leading edge assembly; it could bend, if picked up incorrectly, and buckle the skins. It's best to have a helper when moving the assembly.

Completed: Left [ ] Right [ ]

Step 61: Cut Flap Track Clearance Slots in the Lower Skins

Slots are necessary in the **center** and **inboard lower main skins** to provide clearance for the flap tracks in the wing and the flap track guide arms on the flaps. Cleco these skins in place, allowing them to lap over the flap tracks. Use a try square to set each flap track square to the aft spar, and then mark the centerline of each track onto its respective skin.

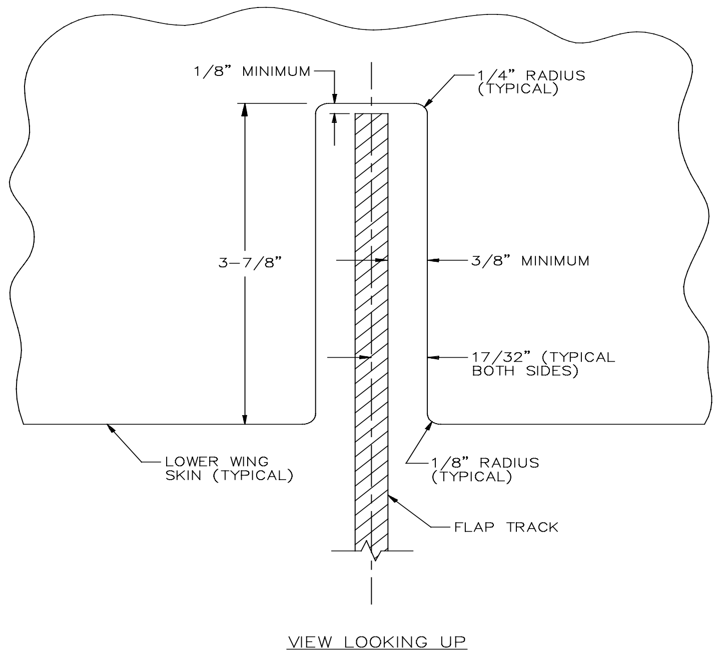

Figure 82: Flap Track Clearance Slots in Lower Skins

Remove the skins and mark parallel lines **17/32"** inboard and outboard of the flap track centerlines, as shown in Figure 82. Mark the leading edges of the slots **3-7/8"** forward of the skin trailing edges. Use a **1/2"** Unibit or Blair hole cutter to cut the **1/4"** radii for the inside corners of the slots and then cut along the marked lines with offset snips. Deburr the cut edges. Re-Cleco the skins to the spar/rib assembly and check for clearance around the flap tracks. There should be at least **3/8"** of clearance on each side and **1/8"** forward. Trim and file further as necessary to achieve these clearances.

Completed: Left [ ] Right [ ]

Step 62: Rivet the Leading Edge Assembly and the Cap Strips to the Forward Spar

Starting with the outboard skin, Cleco the lower skins and the lower stringer channels to the wing structure. When all of the lower skins have been installed, Cleco the hat section stiffeners in place.

Position the leading edge assembly on the forward spar, and then Cleco the leading edge assembly and the cap strips to the forward spar flanges from the outside.

Note The lower edge of the inboard leading edge skin fits over the forward edge of the inboard lower main skin.

Cleco the nose ribs to the forward spar.

Use 1/8" AN470AD4 universal-head rivets to rivet the nose ribs to the spar at the wing tip and near lightening holes where access to both sides for driving and bucking is possible. Where access is not possible for installing hard rivets (Nose Ribs 7 through 12), use 1/8" AAPQ-43 or AAPQ-44 structural blind rivets to rivet the nose ribs to the spar. (Use the longer, -44 rivets at the top and bottom edges of the spar web where the web is thicker and also for all three rivets at the strut beam doubler location.)

Use 1/8" AN426AD4 flush-head rivets to rivet the leading edge skin and the cap strips to both the upper and the lower forward spar flanges. However, do **not** rivet the holes that go through **both** the leading edge skin and the **inboard** lower main skin at this time. The inboard lower main skin must be removed in a subsequent step to drill the flap track reinforcement angles.

Note Do **not** rivet the inboard-most hole through the upper or lower spar flange. Rivets in these holes will also secure Main Rib 1 to the forward spar and will be driven in "SECTION X: FINAL ASSEMBLY" after the fuel tanks are installed.

Completed: Left [ ] Right [ ]

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section I[illegible] Tools and Techniques.

Page 7[illegible]: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 1[illegible]1-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section I[illegible]: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Step 63: Fabricate the Flap Track Reinforcement Angles

Fabricate two reinforcement angles for each flap track (eight total; four left-flange and four right-flange) from **.063" X 1" X 1" 6061-T6** aluminum angle [96], as shown in Figure 83.

Separate the flap track reinforcement angles into four pairs, with each pair consisting of a left-flange and a right-flange angle. Associate each pair of reinforcement angles with one specific flap track and mark both angles of each pair with the location of that track (left inboard, left outboard, right inboard and right outboard).

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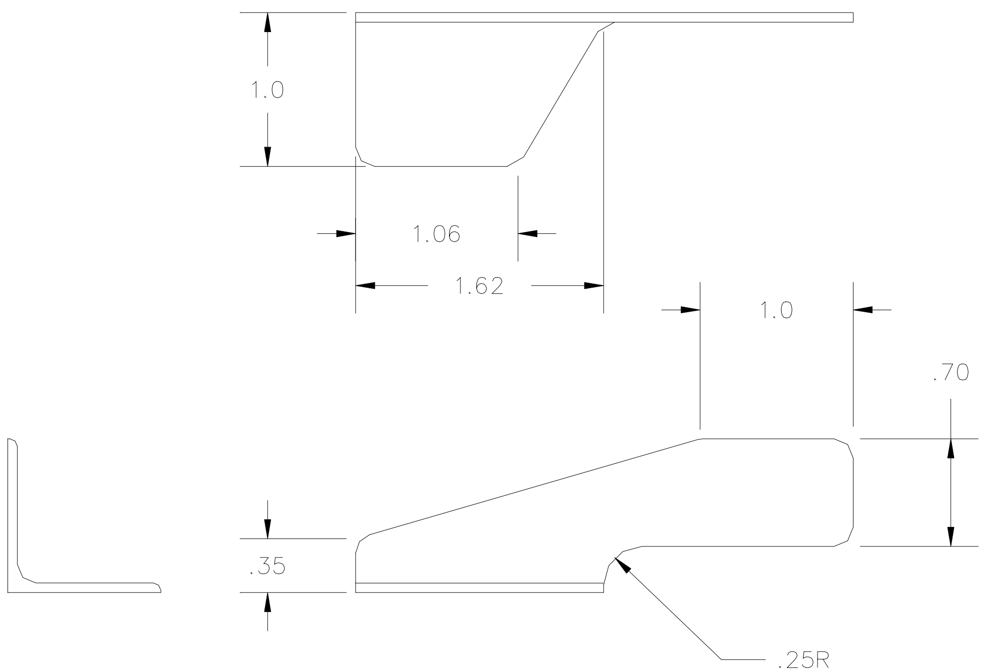


Figure 83: Flap Track Reinforcement Angles

Step 64: Drill Rivet Holes for the Flap Track Reinforcement Angles

Remove the inboard and center lower wing skins, if they are installed. Install the upper two skins if they are not installed and make sure the flap track ribs are clecoed to the upper skins.

At each flap track location, make sure the flap track is square to the aft side of the spar when viewed from above.

Note The flap tracks must be square to the spar after the reinforcement angles are installed. Make sure the tracks are parallel with each other by measuring with a smart level along the bottom edge of the flap. Do any shimming between the spar and the rib now before the reinforcement angles are installed. Otherwise, the flap will tend to bind in the track.

For each flap track, hold a pair of reinforcement angles in place between the flap track and the aft spar's lower flange, as shown in Figure 84a, with the forward end of the angle even with the forward edge of the spar flange. Clamp the angles to the flap track and to the spar flange.

The forward, horizontal flange of each reinforcement angle will be riveted with two 1/8" AN470AD4 universal-head rivets through the spar flange, as shown in Figure 84b. The aft, vertical flanges of each pair of reinforcement angles will be riveted to the flap track with two 1/8" AN470AD4 universal-head rivets. The locations of the reinforcement angle rivet holes are different for each angle, as described on the following pages.

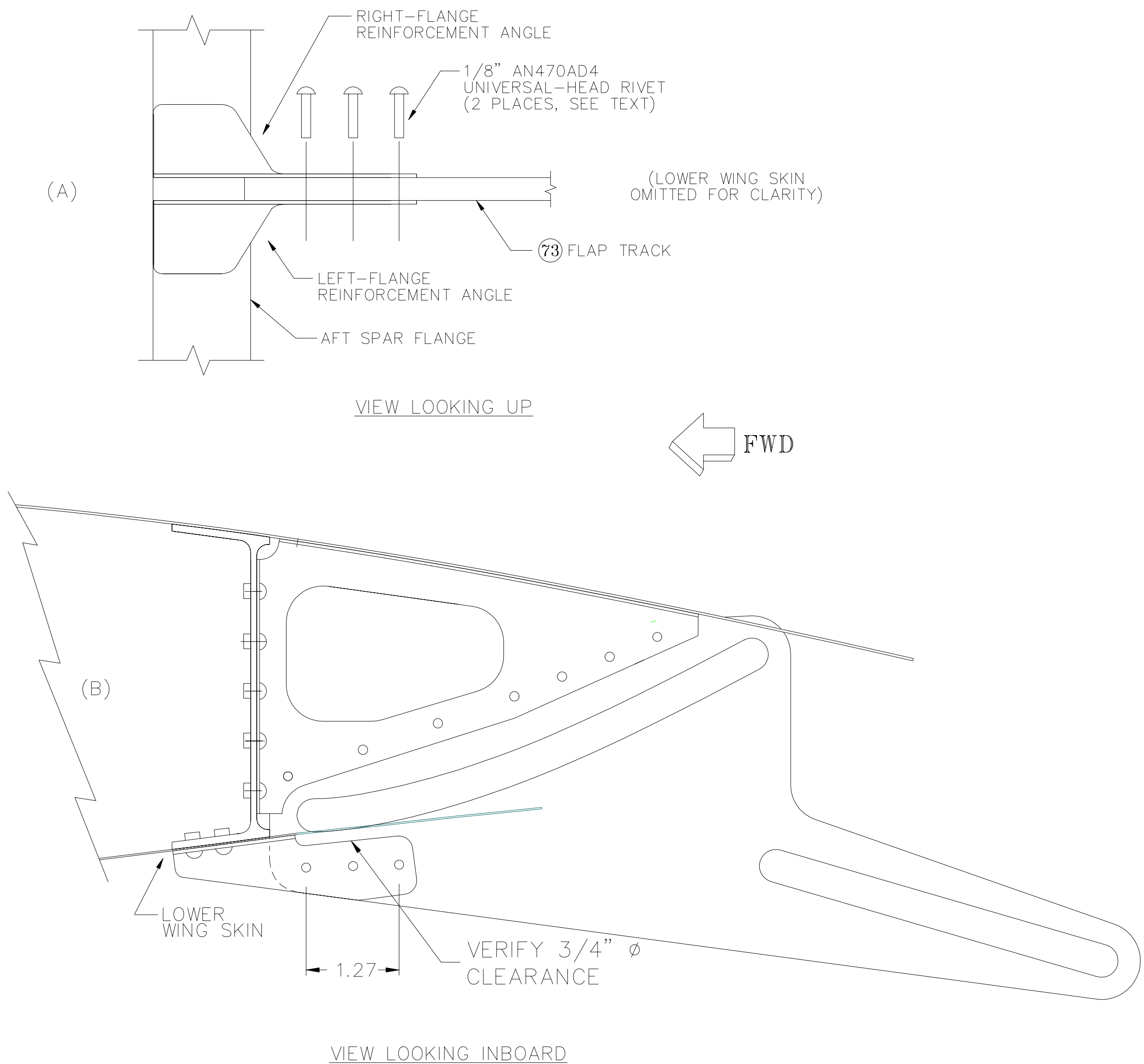
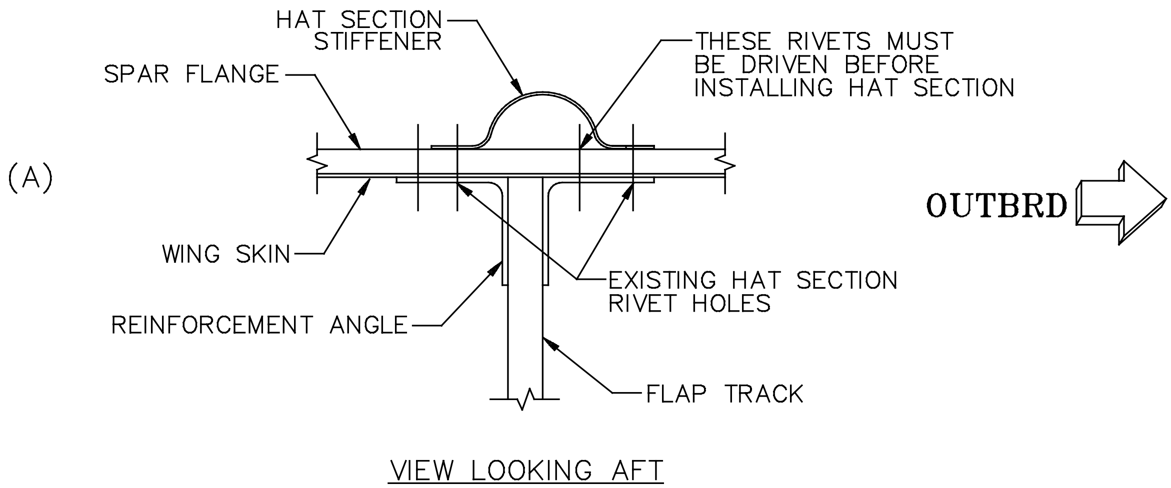


Figure 84: Flap Track Reinforcement Angle Installation

(A)



(B)

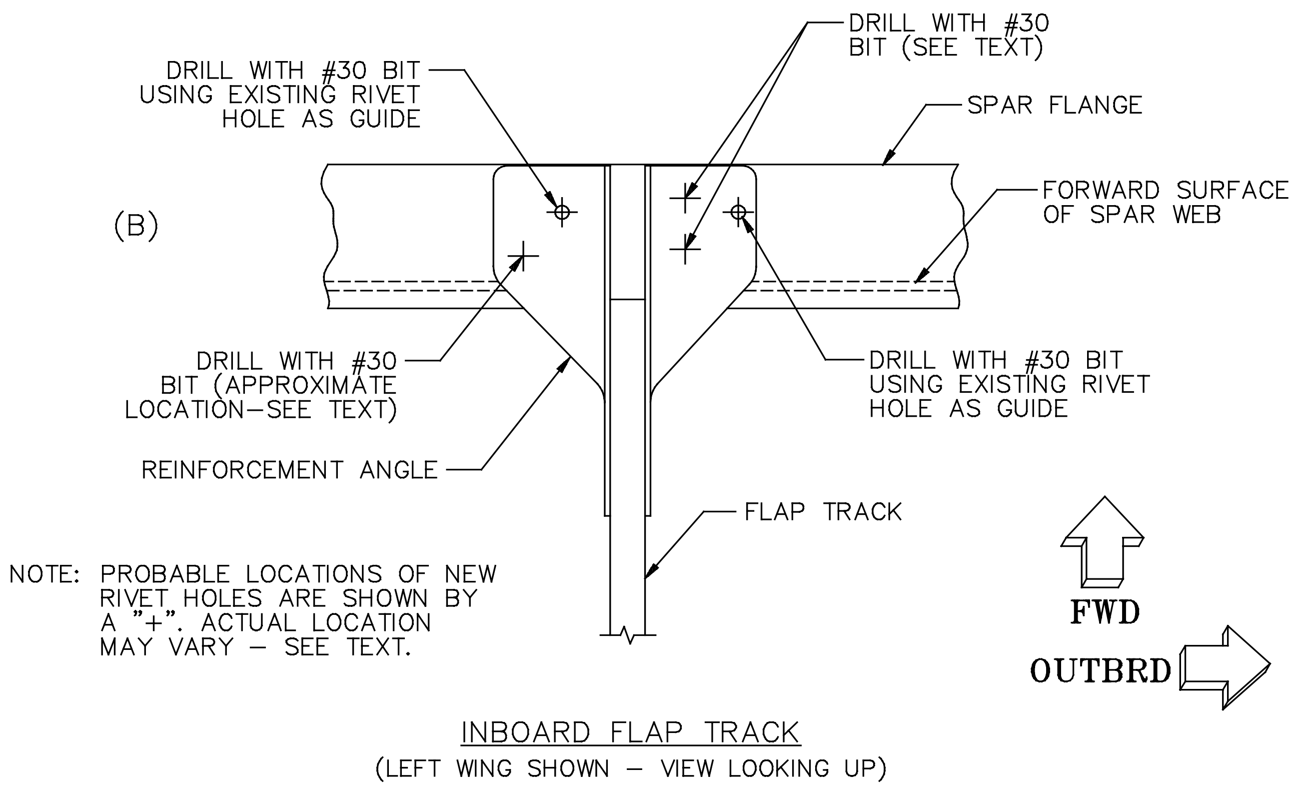


Figure 85: Inboard Reinforcement Angle Rivet Holes

The two 1/8" universal-head rivets that secure the reinforcement angles to the aft spar flange must satisfy standard spacing requirements: twice the rivet diameter (1/4") measured from the center of the rivet to the edge of all components and a minimum of three times the rivet diameter (3/8" center-to-center) between the rivets. Also, the centers of the rivets must not be located closer than about 1/4" to the spar web or to the vertical flange of the reinforcement angle; otherwise, rivet installation will be difficult. An existing spar/skin rivet location that satisfies these requirements can be used to secure the angle and will count as one of the two required rivets. You can install more than the two required rivets, if you wish; specifically, additional spar/skin rivets located by existing holes can be used, even if the extra rivets don't satisfy the edge-distance and spacing criteria.

Note Since there is no absolute index for the spanwise position of the wing skins relative to the spar, there can be slight variations among Sportmans for the spanwise position of the hat section and skins relative to the flap track. This makes it impossible for us to specify exact locations for the reinforcement angle rivet holes. You must determine the optimum locations for the rivets, using the guidelines described above.

So, for the **inboard flap track reinforcement angles**, first use the existing hat section rivet holes through the aft spar flange as a guide to drill one **#30** rivet hole through each reinforcement angle, as shown in Figure 85b. Insert a 1/8" universal-head rivet through the **outboard** hat section rivet hole from below. If the rivet head overhangs the edge of the angle, remove the angle and trim off its edge to allow installation of the rivet through just the skin and the spar next to the reinforcement angle. Then, mark, center punch and drill additional **#30** rivet holes through the reinforcement angles and spar flange, as necessary to satisfy the requirements described above. The approximate locations of the necessary rivet holes are shown in Figure 85b.

Note If positioned as shown in Figure 85b, the new rivet holes through the **outboard** reinforcement angle lie beneath the hat section stiffener inside the wing, as shown in Figure 85a. These rivets must be set before installing the hat section, as described in the next step.

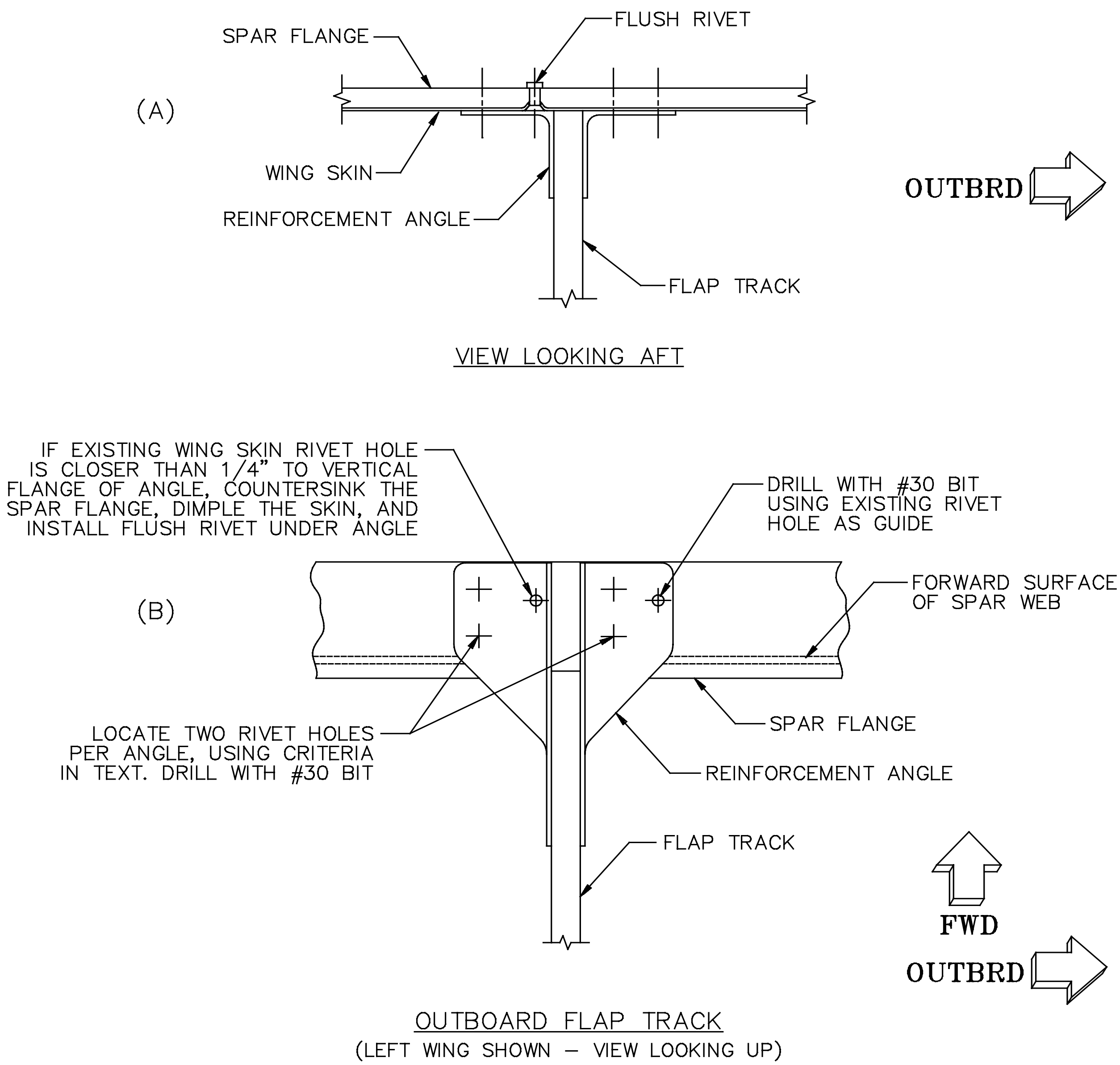


Figure 86: Outboard Reinforcement Angle Rivet Holes

For the **outboard flap track reinforcement angles**, use the existing wing skin rivet hole through the spar flange on the **outboard** side of the flap track as a guide to drill a **#30** hole through the outboard reinforcement angle, as shown in Figure 86b. Also, mark, center punch and drill two additional **#30** rivet holes through each reinforcement angle in the locations shown. Follow the standard spacing requirements described previously when laying out the locations of the rivet holes.

> **Note** The existing wing skin rivet hole on the **inboard** side of the flap track lies almost directly under the inside corner of the reinforcement angle, as shown in Figure 86b. If this rivet hole is closer than about 1/4" to the vertical flange of the angle, the spar flange must be countersunk, the skin dimpled and the skin flush-riveted to the spar before installing the reinforcement angle. The proper sequence will be described in the next step.

When all the spar flange rivet holes through the reinforcement angles for both the inboard and outboard flap tracks have been drilled, remove all the reinforcement angles. Reinstall the lower wing skins, and use the **new** rivet holes through the spar flange as guides to drill matching **#30** rivet holes through the wing skins.

Cleco the reinforcement angles in place, and clamp them to the flap tracks. Verify once again that the flap tracks are square to the aft spar web and, when satisfied, drill three **#30** holes through the aft, vertical flanges of the angles and the flap track in the locations shown in Figure 84b, being careful to maintain the minimum edge distance (twice the rivet diameter) to the centers of the holes in both the angles and the flap tracks.

Remove the reinforcement angles and the skins and deburr all the freshly drilled holes. Apply the corrosion protection of your choice to the flap track reinforcement angles.

Completed: Left [ ] Right [ ]

Step 65: Cleco and Rivet the Lower Skins, Flap Track Reinforcement Angles, Hat Section Stiffeners and Strut Area Stiffener Channels

If the original skin rivet hole through the aft spar flange just **inboard** of the **outboard** flap track is too close to the vertical flange of the flap track reinforcement angle to permit installation of a universal-head rivet, countersink the spar flange and dimple the skin for a flush-head rivet. Refer to Figure 86 and the previous step to identify this rivet.

Use 1/8" AN426AD4 flush-head rivets to rivet the lower skins and the forward ends of the hat section stiffeners to the forward spar flange, **with this exception**: do not install or rivet the hat section that straddles the **inboard** flap track. Then, use 1/8" AN470AD4 universal-head rivets to rivet the skins and the aft ends of the hat section stiffeners to the aft spar flange, **except** do not set rivets in any holes shared by the flap track reinforcement angles. If necessary, use a 1/8" AN426AD4 **flush-head** rivet to rivet the skin to spar flange hole just **inboard** of the **outboard** flap track, as shown in Figure 86a.

Now, Cleco the flap track reinforcement angles to the lower skin/spar flange and to the flap tracks. Use 1/8" AN470AD4 universal-head rivets to rivet the angles to the lower skin/spar flange, **except** in the rivet holes shared by the hat section that straddles the inboard flap track. Install this last hat section and rivet it to the forward spar with AN426AD4 flush-head rivets and to the aft spar and the reinforcement angles with 1/8" AN470AD4 universal-head rivets. Use 1/8" AN470AD4 universal-head rivets to rivet the aft, vertical flanges of the flap track reinforcement angles to the flap tracks.

Next, use 1/8" AN470AD4 universal-head rivets to rivet the skins to Main Rib 2. Use 3/32" AN470AD3 universal-head rivets to rivet the skins to the rest of the main ribs. Use 3/32" AN426AD3 **flush-head** rivets to rivet the outboard skin to the tip rib.

Use 3/32" AN470AD3 universal-head rivets to rivet the skins to the hat section stiffeners.

Pitot/Static System Option If you are installing a Pitot/Static System Option, **turn to the option instructions now**. Return to this *Assembly Manual* when the specified option steps have been completed.
☞

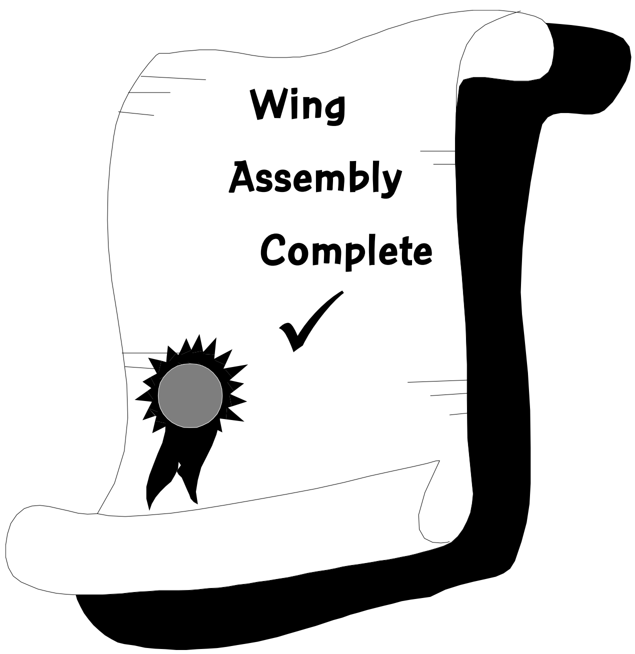
Rivet the stringer channels with 3/32" AN470AD3 universal-head rivets.

Rivet the lower wing skins to the flap and aileron cove ribs with 3/32" AN470AD3 universal-head rivets.

Completed: Left [ ] Right [ ]

CONGRATULATIONS!

The wings are ready for mounting to the fuselage so that the control system rigging (and other procedures) can be completed. Before you can do that, however, you need to fabricate the fuselage and the wing control surfaces. So, let's proceed to the next section—Aileron and Flap Assemblies!



SECTION VII: AILERON AND FLAP ASSEMBLIES

Note The ailerons and flaps can be built in any order, and if space permits, they can all be built simultaneously. However, the following instructions treat the assemblies separately for clarity. Flap instructions begin on Page 53.

AILERON ASSEMBLY PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Left skin	1	201-15001-01
2	Right skin	1	201-15001-02
3	Left spar	1	201-15002-01
4	Right spar	1	201-15002-02
5	Left-flange nose rib	8	201-15003-01
6	Right-flange nose rib	8	201-15003-02
7	Left-flange aft rib	7	201-15004-01
8	Right-flange aft rib	7	201-15004-02
9	Inboard hinge bracket	2	201-15005-01
10	Outboard hinge bracket	2	201-15006-01
11	Inspection hole doubler	4	201-15007-01
12	Inspection hole cover	4	201-15008-01
13	Left-flange counterweight nose rib	2	201-15009-01
14	Right-flange counterweight nose rib	2	201-15009-02
15	Screw	16	AN526-8R6
16	Nutplate	16	K1000-08
17	Nutplate	4	K1000-3
18	Nutplate	6	K2000-4
19	Forward spar, aileron servo (22.8")	1	201-15016-02
20	Aft spar, aileron servo (22.8")	1	201-15017-02
21	Skin, aileron servo (22.8)	2	201-15018-02
22	Horn, servo	1	201-15019-01
23	Clevis, pushrod	2	201-15021-01
24	Shaft, pushrod (9")	1	201-15022-01

25	Hinge, rolled with pin (24")	1	MS20257-4
26	Bolt	2	AN3-5
27	Nut	2	AN320-3
28	Cotter pin	2	AN380-2-2

TOOL LIST

1. Try square
2. Duck bill pliers (with jaws taped to protect aluminum parts)
3. Assorted flat and round files
4. Edge deburring tool (optional)
5. Rule, 12", graduated in 1/32nds of an inch
6. Fine-point marking pen
7. Clecos, 3/32" and 1/8" (approximately 150 each); and 3/16" (2), with pliers
8. Electric or pneumatic drill motor, with #40, #30, #19, #10, 3/32" and 1/4" bits
9. Center punch
10. Hole deburring tool
11. Dimple dies, #40, and rivet squeezer or C-frame riveting tool
12. Assorted Cleco side-grip clamps (with pliers) or small C-clamps, 6-10
13. Long #40 bit
14. Phillips screwdriver
15. Small, rubber-padded spring clamps, 6-10 (recommended)
16. Smart Level (recommended)
17. 90° drill motor or adapter, with #40 bit
18. Rivet gun, air compressor and bucking bars
19. Flush head rivet set
20. Universal head rivet sets, 3/32" and 1/8"
21. Blind rivet puller
22. Rivet squeezer (recommended)
23. Rotary cutting tool (optional)

ADDITIONAL MATERIALS

1. Two 1/4" bolts, 2" long (hardware-store quality)
2. Masking tape
3. Two pieces of 2" X 2" metal angle, approximately 2" long
4. Sheetrock screws
5. Scrap wood blocks
6. 1/4"-thick board, at least 69" long, any width
7. Corrosion protection materials

WORKSPACE

Like the tail surfaces, the ailerons are built on a flat table without jigs. Each aileron is approximately 69" X 15". For assembly steps in which aluminum skins are lying flat on the bench, it's a good idea to pad your bench surface with cardboard to avoid unnecessary scratching of the finish. Also, you might consider leaving the plastic protective film on the outside of the skin through the positioning and drilling stages; remove it for hole deburring and riveting.

ASSEMBLY SEQUENCE

Construction of the ailerons is very straightforward, consisting of two phases: **positioning and drilling** and **riveting**. In the first phase, the structural components are clamped into place and rivet holes are drilled. In the second phase, the basic structure is riveted together.

> **Note** The ailerons are not identical, but they are mirror images of one another, and construction procedures are identical left and right. For clarity, therefore, the text and illustrations that follow refer to the **left aileron only**. Note, however, that each step in the assembly process is followed by a check box for both left and right ailerons. The Sportsman has incorporated an anti-servo in the left aileron, which has given the controls an extremely well balance feel. The right aileron is reserved for an optional electric trim. If you wish to install the Aileron Electric Trim Kit P/N 921-06200-01, contact the order desk at Glasair Aviation.

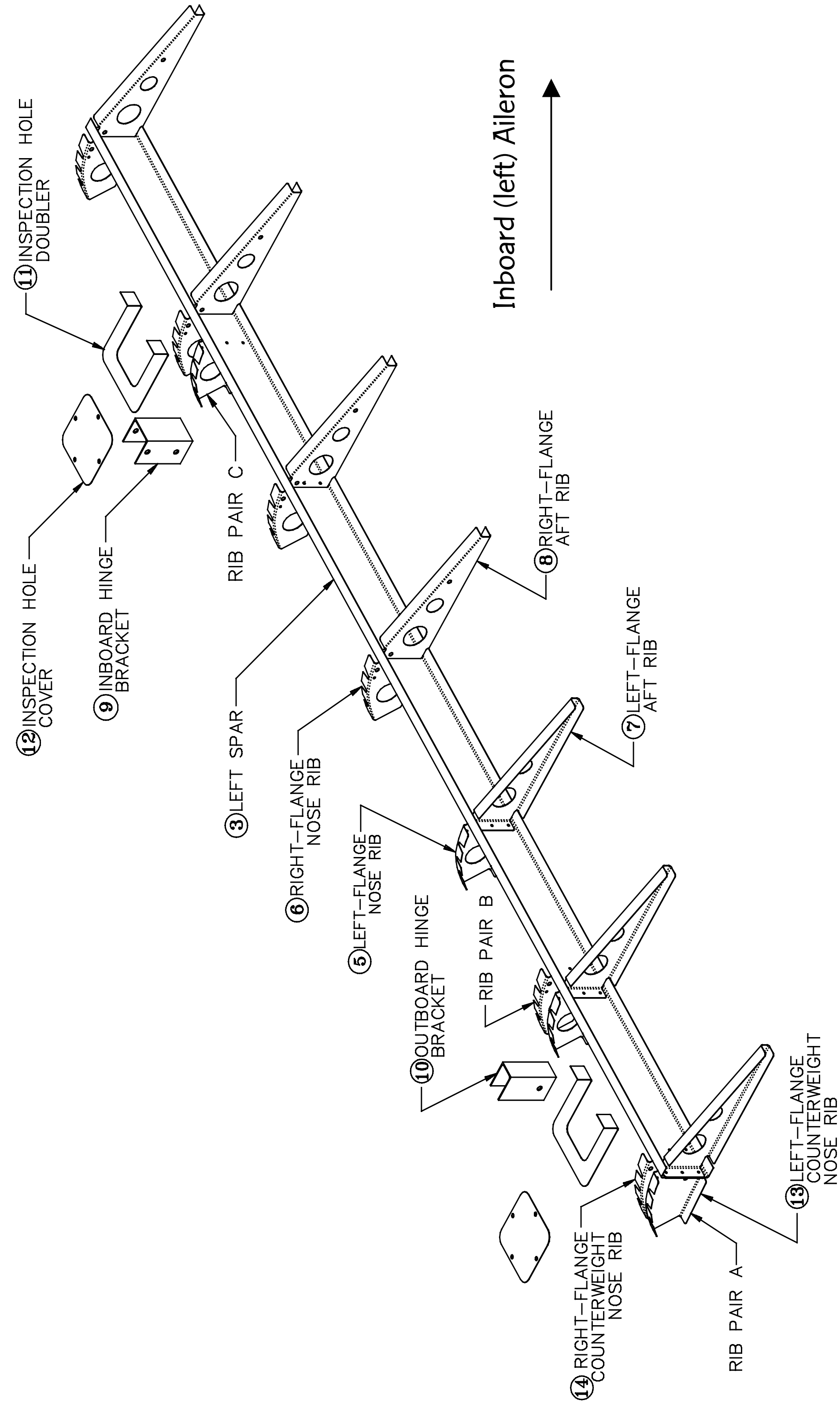


Figure 1: Aileron Assembly (Left-Hand Shown)

POSITIONING AND DRILLING

Step 1: Straighten and Deburr the Parts

Using a square, check the flanges on all the **left-flange** [5] and **right-flange nose ribs** [6], **left-flange** [7] and **right-flange aft ribs** [8], and **left-flange** [13] and **right-flange counterweight nose ribs** [14] for squareness, straightening as necessary with a pair of padded duck bill pliers.

Deburr the edges and lightening holes of all parts as necessary.

Completed: Left [ ] Right [ ]

Step 2: Mark Rivet Lines on the Flanges of the Ribs and Spar

Using a marking pen, mark a centerline on the upper and lower flanges of all the ribs. Rivet lines must also be marked on both the upper and lower flanges of the **spar** [3], but these are not strictly centerlines: as shown in Figure 2, mark these rivet lines parallel to and **11/32"** in from the edge of the **upper** flange and **9/32"** in from the edge of the **lower** flange.

Note The upper flange of the spar is the one that is bent more acutely to the spar web, as shown in Figure 2. To distinguish the left spar from the right, hold a spar right-side up with the flanges pointing toward you. If the double column of rivet holes in the spar web is on the left end, then you're holding the left-hand spar. In other words, the double column of holes is at the **outboard** end of each spar.

Completed: Left [ ] Right [ ]

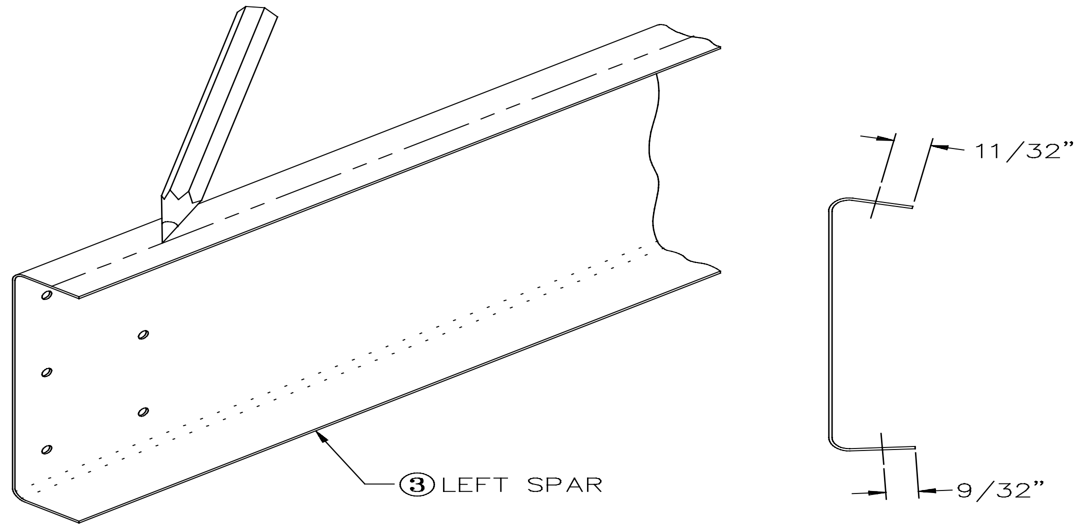


Figure 2: Marking the Spar Rivet Lines

Step 3: Drill the Hinge and Actuator Bolt Holes in Rib Pairs B and C

A pair of nose ribs with opposite flanges is located web-to-web at each hinge location on the spar. These are labeled Rib Pairs B and C in Figure 1. Quarter-inch bolts running between these ribs serve as the hinge points for the aileron, and a similar bolt running between the ribs of Pair C anchors the actuator rod end.

Pilot holes exist for all these holes, but they must be drilled up to final size. First, choose a pair of nose ribs—one left-flange and one right-flange—to be the inboard hinge pair (Pair C). Clamp these together web-to-web as shown in Figure 3 with a pair of Clecos through two of the three small, pre-punched rivet holes in the webs. Use a **1/4"** bit to drill the two 3/16" holes to final size. Take care to keep your drill perpendicular to the webs while drilling these holes. After the holes are drilled, label these ribs as Pair C.

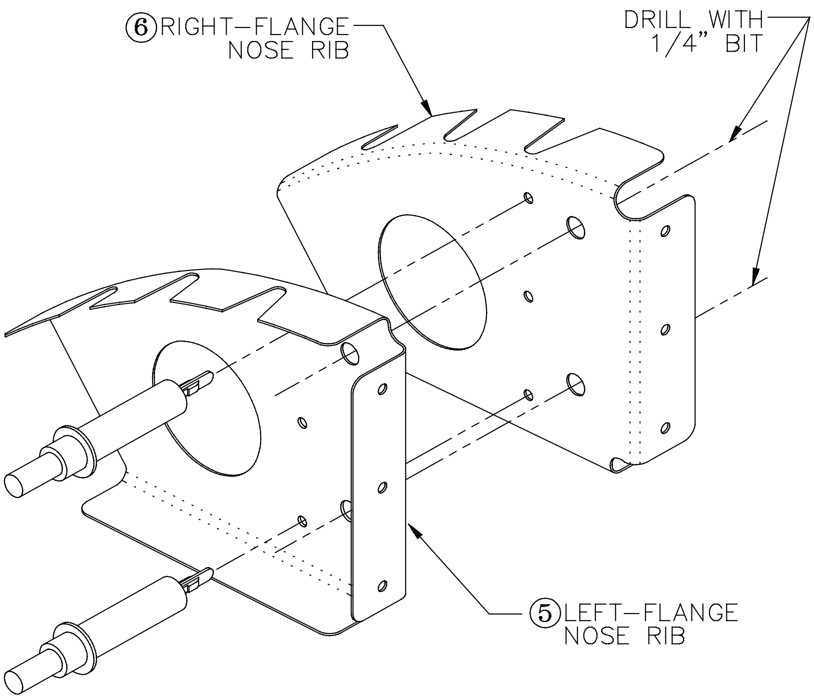


Figure 3: Drilling the Hinge and Actuator Bolt Holes

Repeat the process for a second, outboard pair of nose ribs (Pair B). The only difference is that you only need to drill the lower pair of holes up to **1/4"** size (one hole per rib). Label these ribs as Pair B.

After drilling, remove all the Clecos and deburr the holes.

Completed:
Left [ ]
Right [ ]

Step 4: Mark and Drill the Counterweight Bolt Holes

Two 3/16" bolts are used to secure the counterweight assembly to the outermost pair of nose ribs (labeled Pair A in Figure 1). Pilot holes do not exist for these holes, so the first step is to mark their locations.

Choose a left-flange counterweight nose rib; this is one of the nose ribs **without** a lightening hole. Figure 4 shows where the centers of the two bolt holes should be located. Mark them as accurately as possible on the outboard web and lightly center punch them.

Then clamp the rib together web-to-web with one of its right-flange counterparts using two 3/16" Clecos through the large holes in each rib. Drill the marked bolt holes with a **#10** bit, and then remove the Clecos and deburr the holes.

Completed:
Left [ ]
Right [ ]

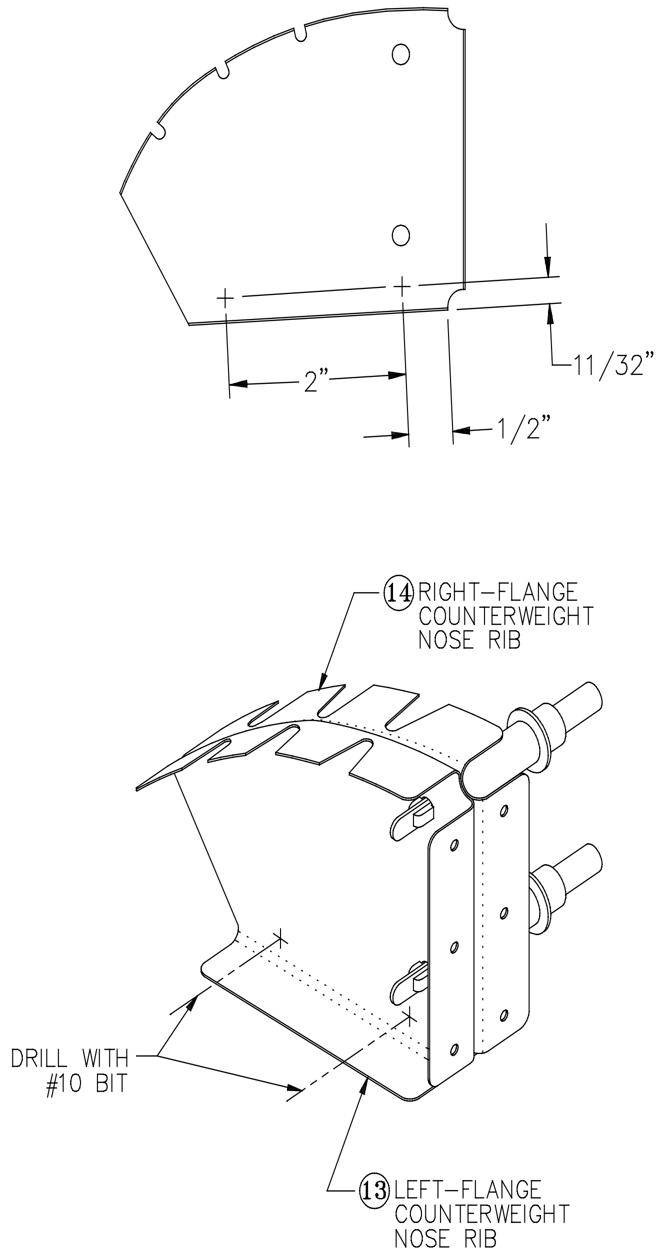


Figure 4: Marking and Drilling the Counterweight Bolt Holes

Step 5: Position and Drill the Bolt Nutplates

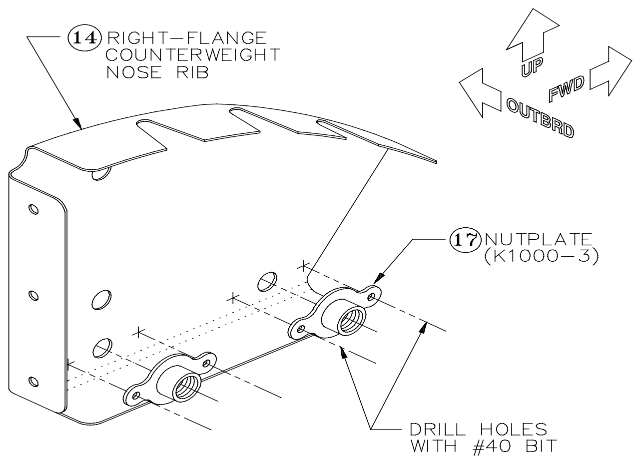


Figure 5: Positioning and Drilling the Counterweight Nutplates

Nutplates of various types are used to secure the blind ends of the hinge, actuator and counterweight bolts. Standard, two-lugged K1000-3 **nutplates** [17] are used with the counterweight bolts. Using the usual procedures outlined in "SECTION II: TOOLS AND TECHNIQUES," position and drill a nutplate at each of the two 3/16" holes **you drilled** along the lower flange of the **inboard** counterweight nose rib, as shown in Figure 5. Use a **#40** bit to drill the rivet holes.

Note The counterweight nutplates should be positioned on the **right-flange** counterweight nose rib on the **left-hand** aileron and on the **left-flange** counterweight nose rib on the **right-hand** aileron.

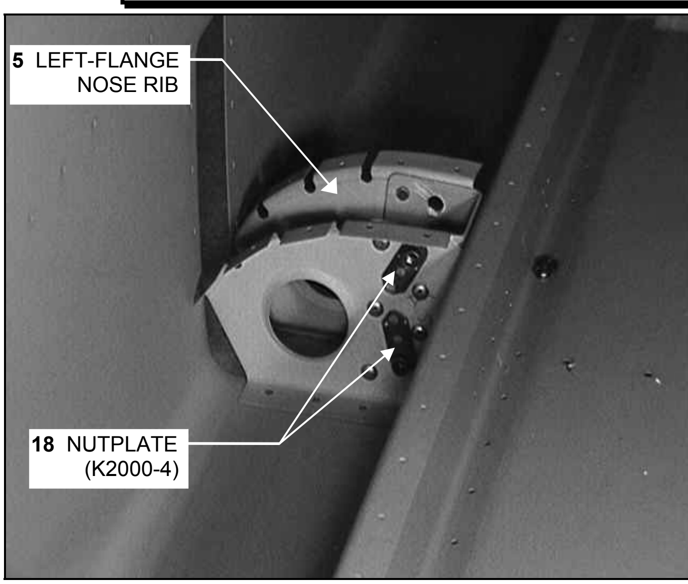


Figure 6: Positioning and Drilling the Hinge and Actuator Bolt Nutplates (Rib Pair C Shown)

Due to clearance problems, the hinge and actuator bolts are secured with single-lugged K2000-4 **nutplates** [18]. Position these at an angle, as shown in Figure 6, and drill them as usual with a **#40** bit. They should be positioned inside the flanges of the **outboard** rib of the **inboard hinge rib pair** (Pair C) and the **inboard** rib of the **outboard hinge rib pair** (Pair B). Remember that Pair B accommodates only one bolt and, therefore, one nutplate.

Note Figure 6 and many of the subsequent photos are provided to illustrate the basic relationships among parts. However, because these photos show the prototype aircraft, there are many minor differences, especially in things like rivet counts and construction sequences. In the event you note any discrepancies between the text or line illustrations and the photos, the text and illustrations should always be taken as definitive.

Note Remember that the main text of the *Assembly Manual* applies to the **left aileron**. For the **right aileron**, the nutplates should be positioned on the **right-flange** rib of the **inboard** pair and the **left-flange** rib of the **outboard** pair.

Hint To help keep straight where the nutplates go, remember that the hinge and actuator bolts are inserted through the inspection holes in the skin. The nutplates must therefore always be on the opposite side of the rib pairs from the holes. Similarly, the counterweight bolts are inserted from the open, outboard end, so their nutplates must be on the inboard side.

After drilling, deburr all the rivet holes.

Completed: Left [ ] Right [ ]

Step 6: Dimple the Ribs and Nutplates

All five of the nutplates you just positioned and drilled will be installed with 3/32" AN426AD3 flush-head rivets. Dimple the ribs and the nutplates themselves to accommodate these rivets. The male die should be on the **outboard** side of the Pair A rib, the **outboard** side of the Pair B rib and the **inboard** side of the Pair C rib.

Note As in portions of the elevator assembly, you'll need to use a ground-down female dimple die in order to clear the lower rib flange.

Completed: Left [ ] Right [ ]

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14:

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

Step 7: Cleco Nose Rib Pairs B and C to the Spar

Use two Clecos per rib through the pre-punched holes to clamp the four nose ribs of Pairs B and C to the spar. Refer to Figure 1 to ensure that the rib flanges are all properly oriented.

Completed: Left [ ] Right [ ]

Step 8: Mark and Drill the Hinge Brackets

The **inboard** [9] and **outboard hinge brackets** [10] are situated between the pairs of nose ribs you just Clecoed to the spar. As shown in Figures 7 (inboard) and 8 (outboard), the "bottom" of each U-shaped bracket sits tightly against the spar web, while the "sides" of the 'U' are tight against the rib webs on either side.

> **Note** Figures 7 and 8 depict the brackets already riveted to the adjacent nose ribs. This operation will not be performed until much later in the assembly sequence, and so these photographs are intended **only** to show how the hinge brackets are positioned.

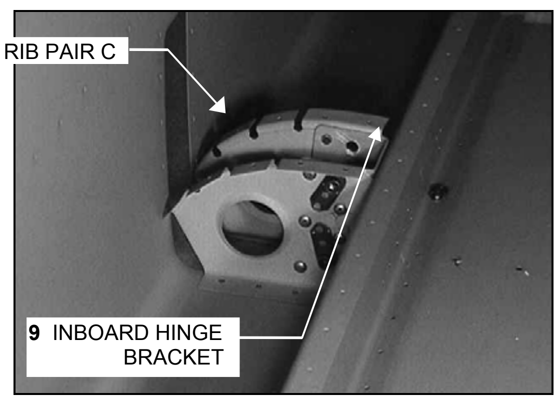


Figure 7: Inboard Hinge Bracket

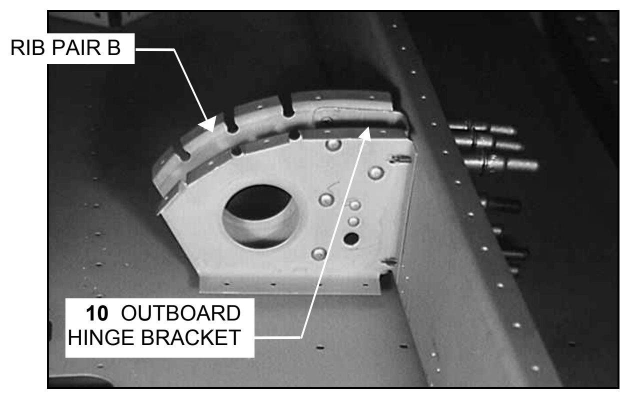


Figure 8: Outboard Hinge Bracket

Each bracket is riveted to the spar web through six holes; the locations of these holes must be marked on each bracket. Figure 9 shows the dimensions of the four corner hole locations on each bracket. Mark and center punch these holes on the outside of both brackets, and then mark and punch two additional holes midway between each corner pair. The location of these holes is not overly critical, but be sure to observe the edge margin specified in the figure between the bracket flanges and the holes. Once all the holes are marked and punched, pilot drill them with a **3/32"** bit.

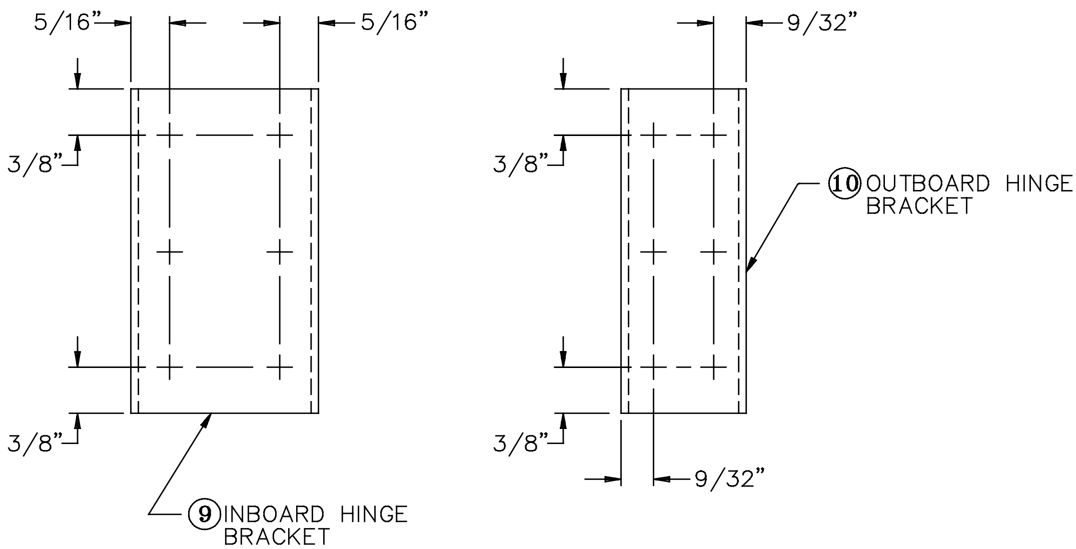


Figure 9: Hinge Bracket Rivet Hole Locations

With both brackets pilot drilled, begin with the inboard bracket, which is the wider of the two. Note that there are two 1/4" holes in each side of the bracket corresponding to the hinge and actuator bolt holes in the ribs of Pair C. Slide the bracket between these ribs and align it vertically by sliding a 1/4" bolt or drill bit through one set of these holes in the bracket and rib webs, as shown in Figure 10. Then, holding the bracket tightly in position, drill through the bracket and spar web from the forward side at the six pilot drilled locations. Use a long **#40** bit and Cleco as you go. After two Clecos are in place, you can remove the alignment bolt.

With the bracket Clecoed to the spar web, slide two 1/4" alignment bolts or drill bits through the holes in the bracket and the rib webs, as shown in Figure 11. Then use a **#30** bit to drill the three rivet holes through each rib web and the sides of the bracket. Cleco two holes on each side after drilling.

After drilling all the holes in the inboard bracket, repeat the process for the outboard bracket. The procedures are identical.

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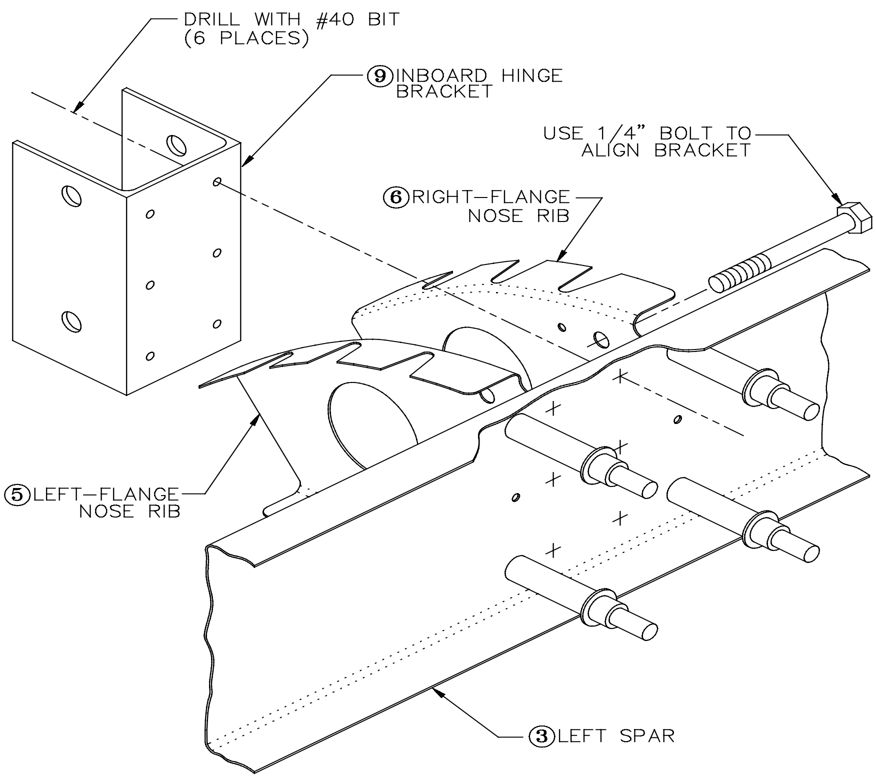

Figure 10: Drilling the Hinge Bracket/Spar Web Rivet Holes

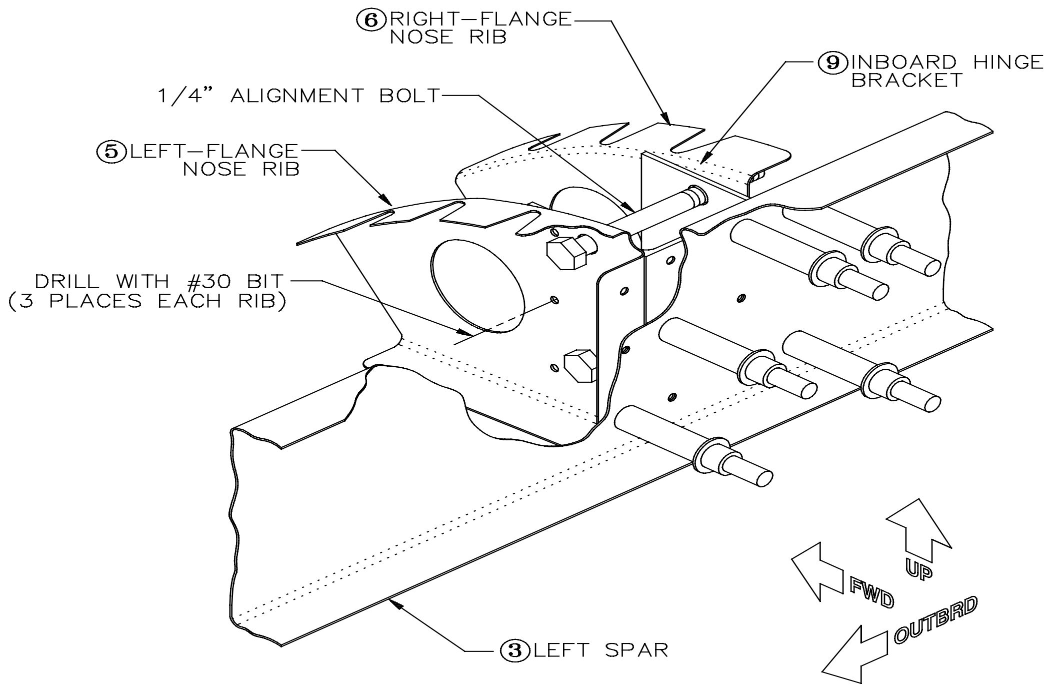

Figure 11: Drilling the Hinge Bracket/Rib Web Rivet Holes

Step 9: Cleco the Remaining Ribs to the Spar and Drill All the Rib/Spar Rivet Holes to Final Size

Cleco all the remaining nose, aft and counterweight nose ribs to the spar. Pay careful attention to the orientation of the rib flanges, as shown in Figure 1, and note that in most cases the same Clecos will secure a nose rib and an aft rib. Make any adjustments necessary in the up and down direction for the ribs to get the optimum match-up of the upper and lower surface contours.

The two counterweight nose ribs of Pair A require some special attention. In a subsequent step, a 1/2"-square steel tube that bears the aileron counterweight will be mounted between these two ribs. For this reason, it's imperative that the facing webs of these ribs be held **at least** 1/2" apart. This spacing is too important to entrust to the marked rivet lines on the rib flanges. Instead, use a temporary spacer inserted between the Pair A ribs. A small square of 1/2" plywood attached to one rib web with a loop of masking tape will work fine. This will hold the ribs the requisite distance apart while the skin-to-rib rivet holes are drilled.

Note To be absolutely certain that the ribs are held the required distance apart, carefully measure the 1/2" plywood spacer to ensure that it's not undersize. We recommend applying a couple layers of masking tape on the 1/2" spacer to produce a gap 5–10 thousandths over 1/2".

When all the ribs are in position, number them so they can be returned to the spar in the same order after disassembly. Finally, juggling the Clecos as necessary, drill all the holes in the flanges of each nose and aft rib and the corresponding holes in the spar web up to **#40** size. Leave two Clecos in each rib pair and the temporary spacer between the ribs of Pair A when finished.

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Step 10: Clamp the Spar/Rib Assembly to the Bench

Two pieces of metal angle mounted on the edge of the bench provide a convenient way to clamp the spar/rib assembly to the bench while positioning and drilling the skin. The dimensions and material specifications of these angles are not at all critical. Two-inch-long pieces of 2" X 2" aluminum angle are ideal, but angle of smaller dimensions would also work, and steel is fine as well.

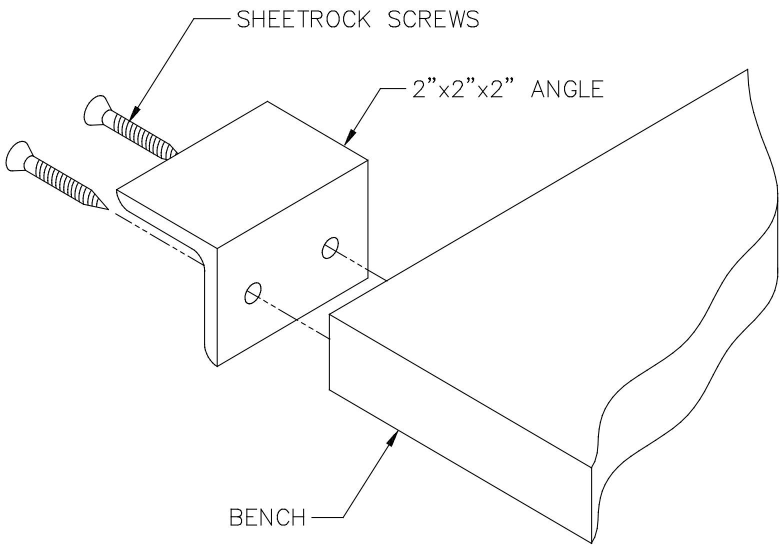

Figure 12: Mounting the Clamping Angle

As shown in Figure 12, drill two holes in one flange of each angle to accommodate mounting screws. Sheetrock screws are easiest, but any wood screw will do. Once the holes are drilled, mount one of the angles on the edge of your bench near one end with the upper flange flush with the bench surface.

Next, as shown in Figure 13, use a C-clamp to clamp the spar/rib assembly to the angle. The assembly should initially be clamped **upside down** and the nose ribs should hang over the edge of the bench.

Once the spar/rib assembly is clamped at one end, mount the second clamping angle under the opposite end of the spar and use a second clamp to secure the spar to the second angle. Finally, as shown in Figure 13, slide a 1/4"-thick strip of wood under the aft ribs to support them against the bench top

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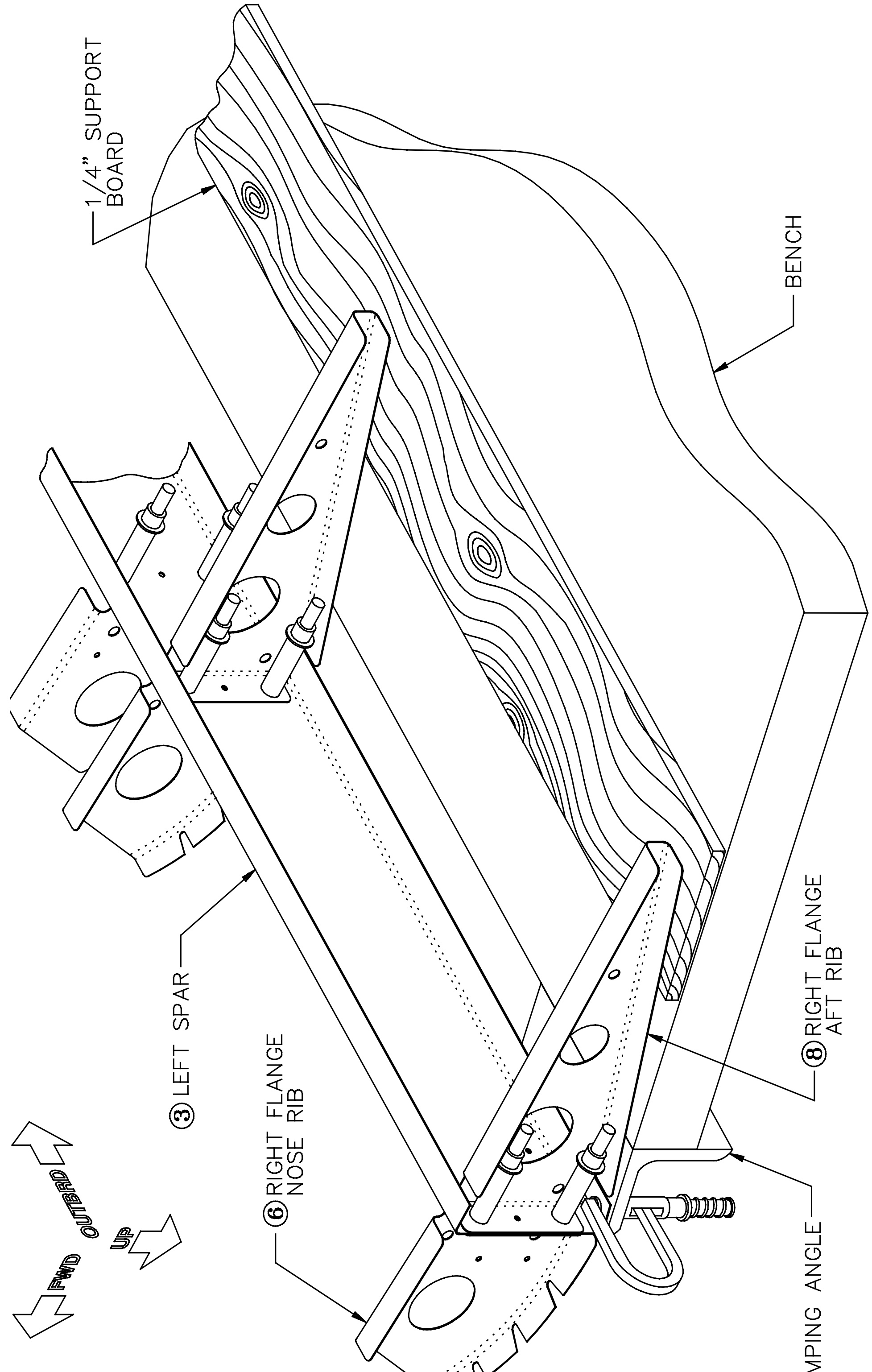

Figure 13: Clamping the Spar/Rib Assembly to the Bench

Step 11: Position the Skin and Drill the Lower-Surface Rivet Holes

With the spar/rib assembly clamped upside-down to the bench top, open the **left skin** [1] and slide it over the assembly. As shown in Figure 14, the upper surface of the skin will hang down toward the floor.

> **Hint** The left and right skins can be distinguished most easily by observing that, with the inspection holes **down**, the **double row** of pre-punched nose rib pilot holes are always on the **outboard end**—that is, on the **left end** of the **left aileron** and the **right end** of the **right aileron**. .

Pull the skin back until the rivet line on the lower spar flange is centered under the pre-punched rivet holes in the lower surface and align the inboard and outboard edges of the skin on the ends of the spar. When it's positioned properly, clamp the skin to the spar flange at each end with a pair of side-grips, as shown in the figure.

With the skin clamped in place, adjust the spar as necessary to keep the marked rivet line centered under the holes, and then drill several **#40** holes along the spar flange. Cleco these holes, remove the side-grips and then drill (**#40**) and Cleco all the remaining holes along the lower spar flange.

> **Note** Some of the pre-punched skin holes over the spar flanges lie almost directly beneath (relative to the aircraft) the web of an aft rib. For this reason, it may be virtually impossible to properly buck a hard rivet in some of these holes. Check your spar holes as you drill; if they appear to be too close to the underlying rib web to enable bucking—say, within 1/8"—drill them up to **#30** size for later installation of blind rivets. Use a drill stop set at **3/16"** when drilling these holes to avoid the possibility of damaging the underlying rib web.

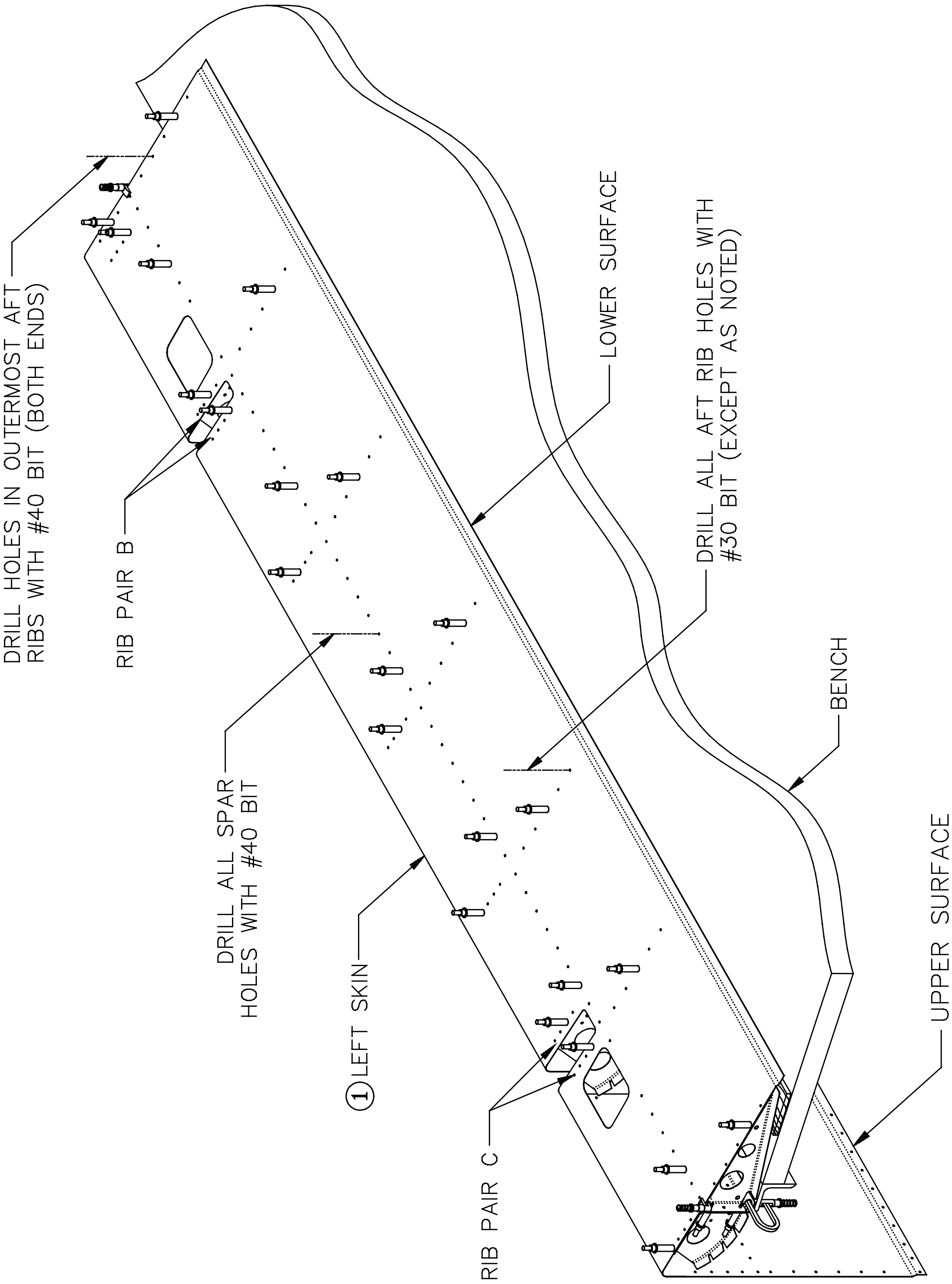

Figure 14: Positioning the Skin and Drilling the Lower Surface

Next, bring the aft ribs into alignment by centering the lines you marked under the pre-punched skin holes. You can simply raise the trailing edge of the skin slightly to adjust these ribs. When the rivet lines are centered, drill all the rib holes, starting at the spar and moving aft. **Do not drill the aft most hole in the two inboard aft ribs. These will be trimmed for the anti-servo tab.** Cleco periodically as you go.

Caution Be very careful to use the proper drill bits for the various aft ribs. As noted in Figure 14, all the aft rib holes are drilled with a **#30** bit **except** the holes in the **outermost** aft ribs at each end, which are drilled with a **#40** bit. The reason for this difference is that the latter two ribs are accessible for bucking or squeezing, whereas blind rivets must be used for the remaining aft ribs.

Finally, repeat the above procedure on all the nose ribs. You can easily adjust them left or right as necessary simply be reaching under the hanging upper skin surface. **Don't forget about a 1/2" spacer between the counterweight nose ribs**. When they are properly aligned, drill them beginning at the spar and working forward; Cleco periodically as you go.

Caution Be very careful to use the proper drill bits for the various nose ribs. As noted in Figure 15, all the nose rib holes are drilled with a **#30** bit **except** the holes in the **outermost** nose ribs at both ends and the **ribs immediately to the left and right of the inspection holes in the skin**; these are drilled with a **#40** bit. As with the aft ribs, the reason for this difference is that the latter four ribs are all accessible for bucking or squeezing, whereas blind rivets must be used for the remaining nose ribs.

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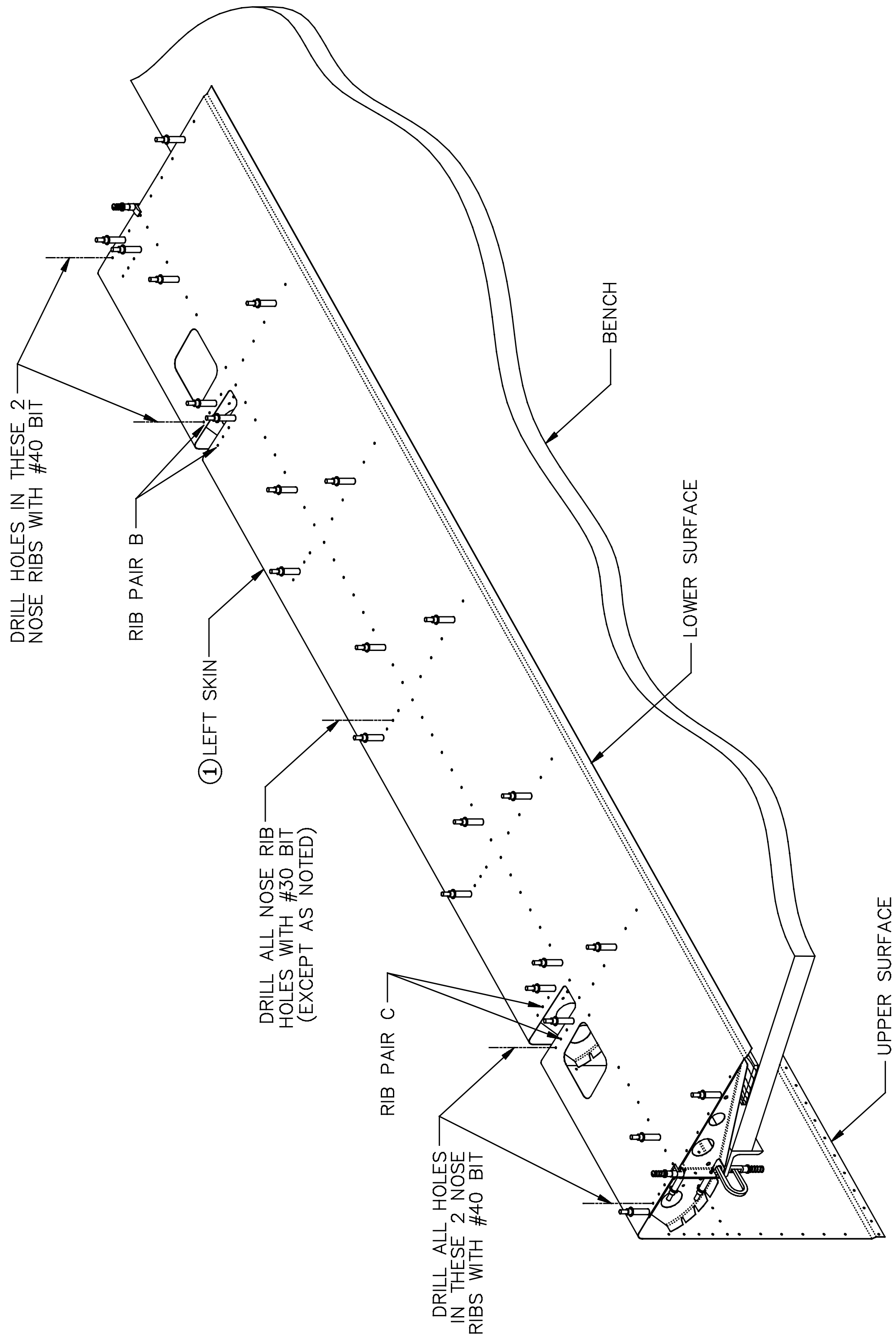

Figure 15: Drilling the Lower-Surface Nose Rib Holes

Step 12: Mark Locations for the Inspection Hole Doubler Rivet Holes

The two inspection holes in the skin allow access to the aileron hinge and actuator bolts. An **inspection hole doubler** [11] is installed inside the skin around each hole to provide anchor points for the nutplates that secure the **inspection hole covers** [12]. Before positioning the doublers under the skin for drilling, you need to mark hole locations for the rivets that will hold them in place, as there are no pre-punched pilot holes for this purpose.

As shown in Figure 16, the eleven necessary holes are arranged around the forward, inboard and outboard edges of the inspection holes. The placement of the holes is not overly critical except that you must maintain an edge margin to the hole centerpoints of **3/16"**. If you index the aftmost holes on the inboard and outboard edges to the aftmost rivet hole in the adjacent nose rib, then a spacing of **7/8"** all the way around results in a good pattern.

Mark and lightly center punch these locations.

> **Note** Figure 16 shows the **inboard** inspection hole. The **outboard** inspection hole is exactly the same size, but the hole locations are mirror image.

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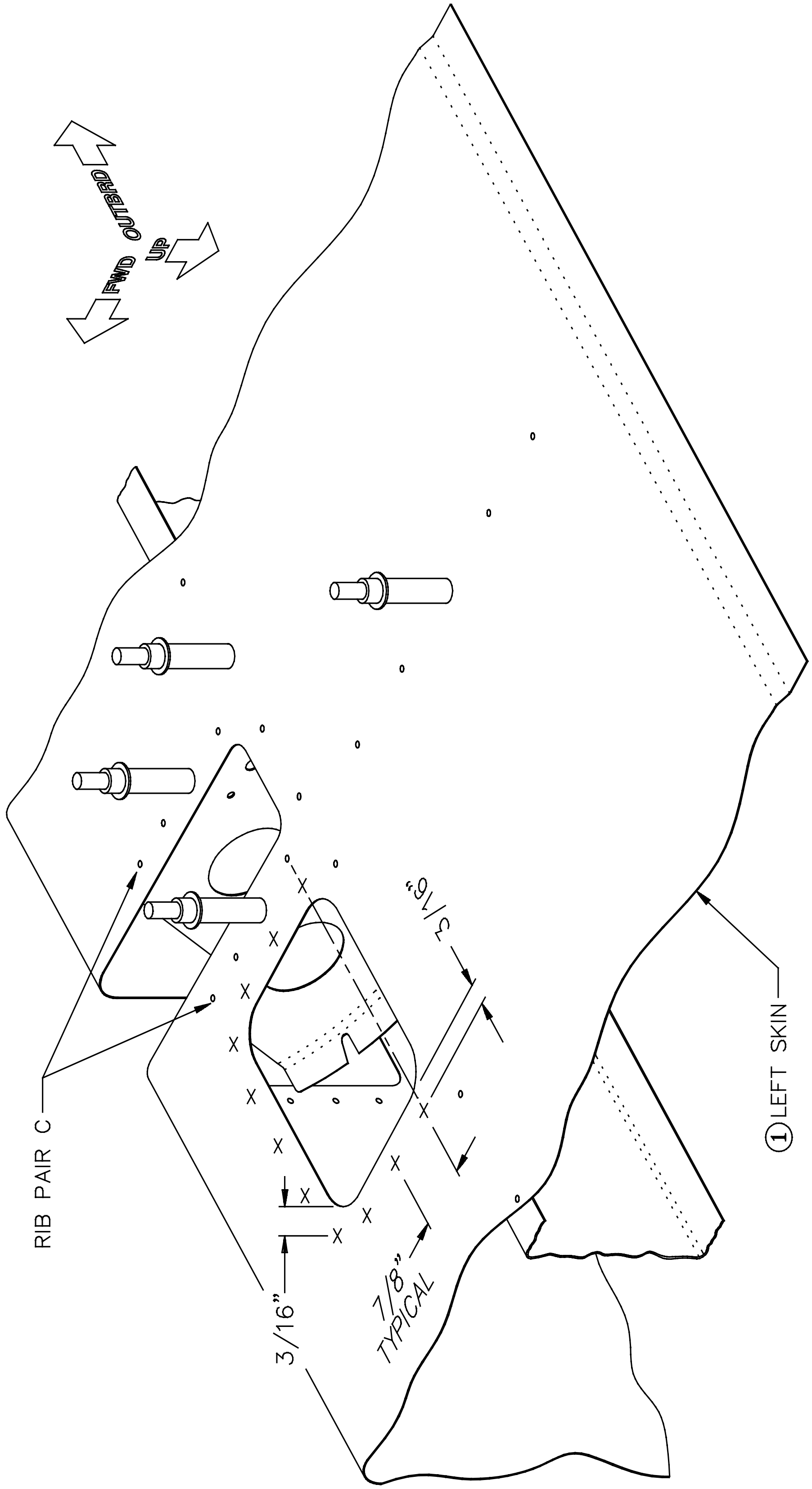

Figure 16: Marking the Inspection Hole Doubler Rivet Holes

Step 13: Position and Drill the Inspection Hole Doublers

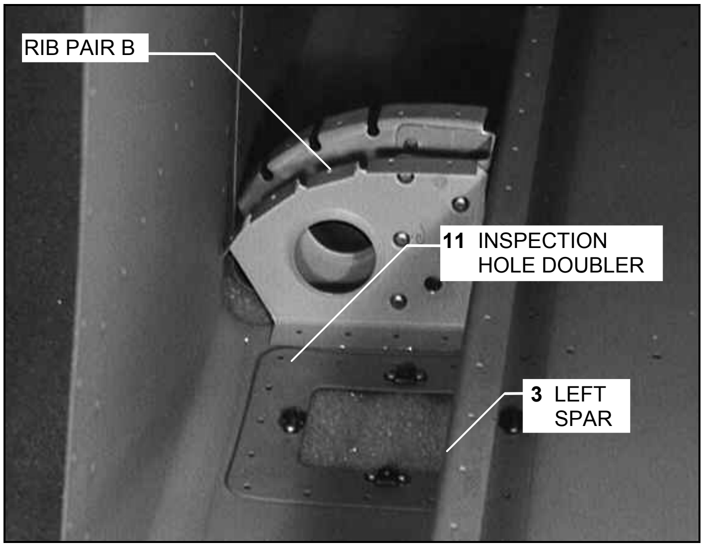

Figure 17: Inspection Hole Doubler

Figure 17 shows the basic orientation of the inspection hole doubler for the **outboard** inspection hole: the closed end of the U-shaped doubler is forward of the spar, and the bent end-tabs are tight against the spar web.

With the spar/rib assembly still clamped to the bench and the lower surface of the skin Clecoed in place, position the doublers and clamp them in place to the skin with side-grips or small C-clamps, as shown in Figure 18. The doubler should be centered on the inspection hole, which means that approximately **1/2"** of the doubler should extend inward beyond each edge of the hole, creating a recessed flange for the cover plate.

Note As with Figures 8 and 9, Figure 17 shows the inspection hole doubler at a more advanced stage of construction. Its presentation here is intended solely to indicate how the doubler is positioned relative to the skin and spar.

With the doublers clamped in position, use a **#40** bit to drill through the skin and doubler at each of the eleven marked locations. Drill your first holes near the clamps and then insert Clecos. Drill subsequent holes adjacent to the Clecos and move outward, Clecoing as you go.

Hint Because the doubler is made of very thin, flexible stock, you may find it helpful to hold it tightly against the skin from underneath with a block of scrap wood while drilling.

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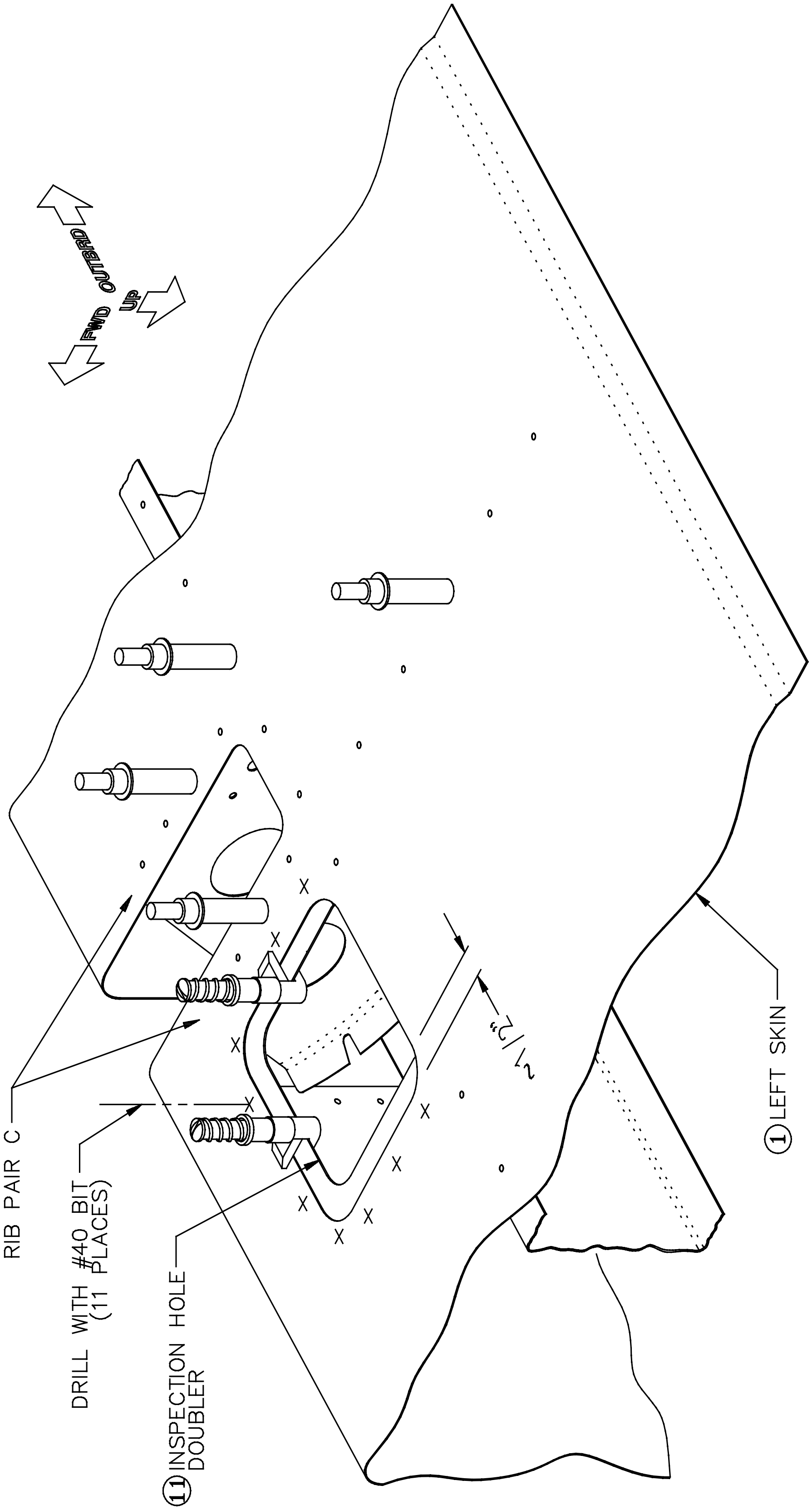

Figure 18: Drilling the Inspection Hole Doubler Rivet Holes

Step 14: Drill the Inspection Hole Cover Mounting Screw Holes

After drilling all the rivet holes around the perimeter of both doublers, leave Clecos in at least the three middle holes along each edge of the inspection hole, as shown in Figure 19.

Press the cover plate into the inset formed by the skin and one of the doublers and drill through each of the four pilot holes for the AN526-8R6 mounting **screws** [15] with a **#19** bit.

Note The cover plates are identical. As Figure 19 shows, each plate is slightly longer than the inspection hole, so when the forward edge of the plate is seated in the cutout, the aft edge will overlap the lower surface of the skin. This is perfectly proper. For this reason, the two side holes and the forward hole will be drilled through the cover plate and the doubler; the aft hole will be drilled through the cover plate, the lower surface of the skin and the lower spar flange.

Deburr the holes in the cover plate and set it aside. Repeat the process on the remaining cover plate and doubler.

Caution You may be tempted to extend the inspection holes aft of the spar so that the covers will fit flushly. We **strongly** discourage such a modification. The aileron is a stressed-skin structure in which the skin must be riveted to the spar along its entire length to provide the necessary torsional strength. Rivet holes to tie the skin to the spar aft of the inspection holes will be drilled in a subsequent step.

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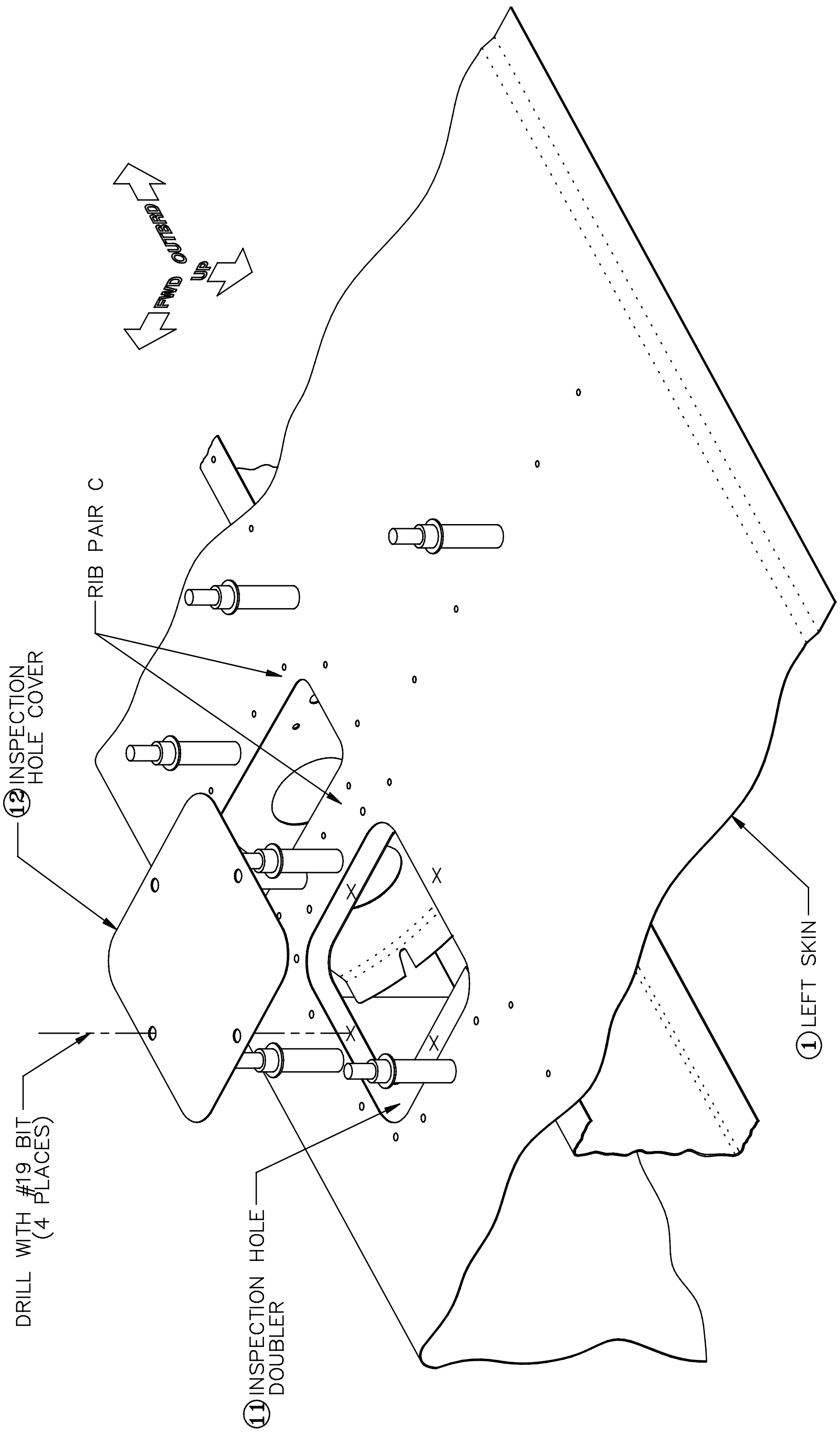

Figure 19: Drilling the Inspection Hole Cover Mounting Screw Holes

Step 15: Mark and Drill the Spar Web/Inspection Hole Doubler Rivet Holes

With the lower surface of the skin still Clecoed to the spar/rib assembly, remove the C-clamps holding the spar to the bench and turn the entire assembly over so that it's sitting right-side up on the bench, supported on the Clecos.

As shown in Figure 20, mark two hole locations on each tab of both doublers. These holes need not be too precise, but be sure to maintain at least **1/4"** edge margin between the hole locations and the edges of the tabs. Drill all marked holes with a **#40** bit.

After drilling, mark the doublers so they can be returned to their original locations after disassembly. Then remove the Clecos securing the doublers and thoroughly deburr all the holes. Set the doublers aside.

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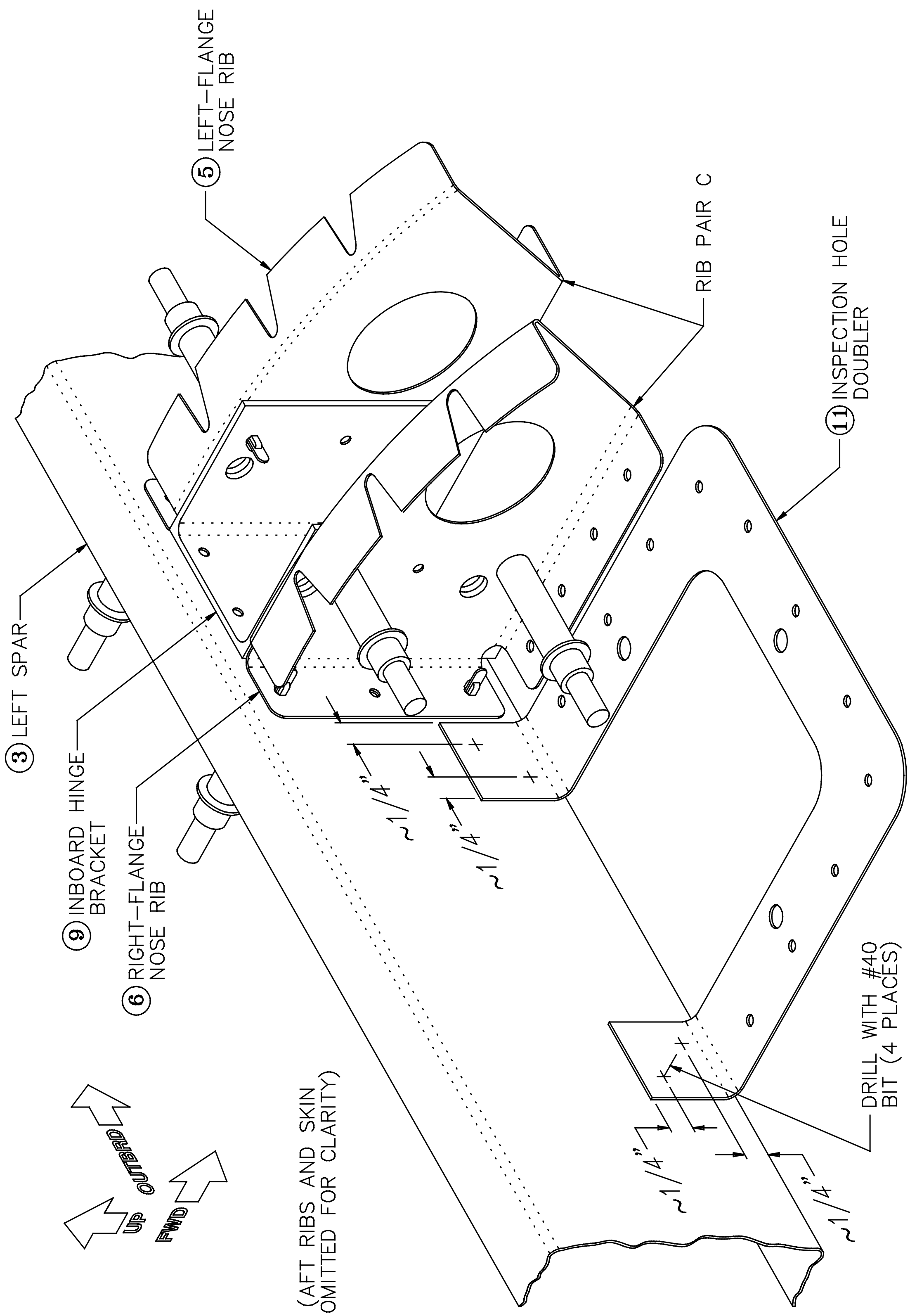

Figure 20: Drilling the Spar Web/Inspection Hole Doubler Rivet Holes

Step 16: Position and Drill the Upper Surface of the Skin

With the lower surface of the skin Clecoed to the spar/rib assembly and the entire assembly sitting right-side up on the Clecos, pull the upper surface of the skin back tightly against the ribs. Use side-grips or small, rubber-padded spring clamps along the trailing edge joggle to clamp the upper surface of the skin to the lower along the entire length of the aileron.

> **Hint** Extra clamps—either side-grips or spring clamps—used to clamp the skin to the rib flanges at each end may make the final positioning easier.

Ideally, the rivet line you marked on the upper spar flange and the centerlines you marked on the ribs will all be centered under their respective lines of pre-punched skin holes. As a practical matter, however, the more important thing is to keep the skin tight against the rib and spar flanges and to bring the trailing edge joggles of the upper and lower surfaces together as flushly as possible. Because the upper camber of the aileron airfoil is so pronounced, it may take some effort and numerous readjustments of the clamps to achieve this.

When you are satisfied with the alignment of the trailing edge joggles and the skin is lying flat against the rib and spar flanges, you may want to make a final check to ensure that no twist has been introduced into the structure. As described in "SECTION IV: HORIZONTAL STABILIZER ASSEMBLY," you can use a level supported on two blocks to check this precisely. Readjust the trailing edge clamps as necessary to true up the aileron.

Beginning with the spar and then moving aft along the aft ribs and forward along the nose ribs, drill through all the pre-punched pilot holes with a **#40** bit **with the following exception**: as shown in Figure 21, drill the **forward-most hole** in each nose rib with a **#30** bit, except for the **outermost** nose ribs at each end, which should both be drilled entirely with a **#40**. **Do not drill the aft most hole on the two inboard aft ribs. This rib will be trimmed for the antiservo tab.** Cleco as you go.

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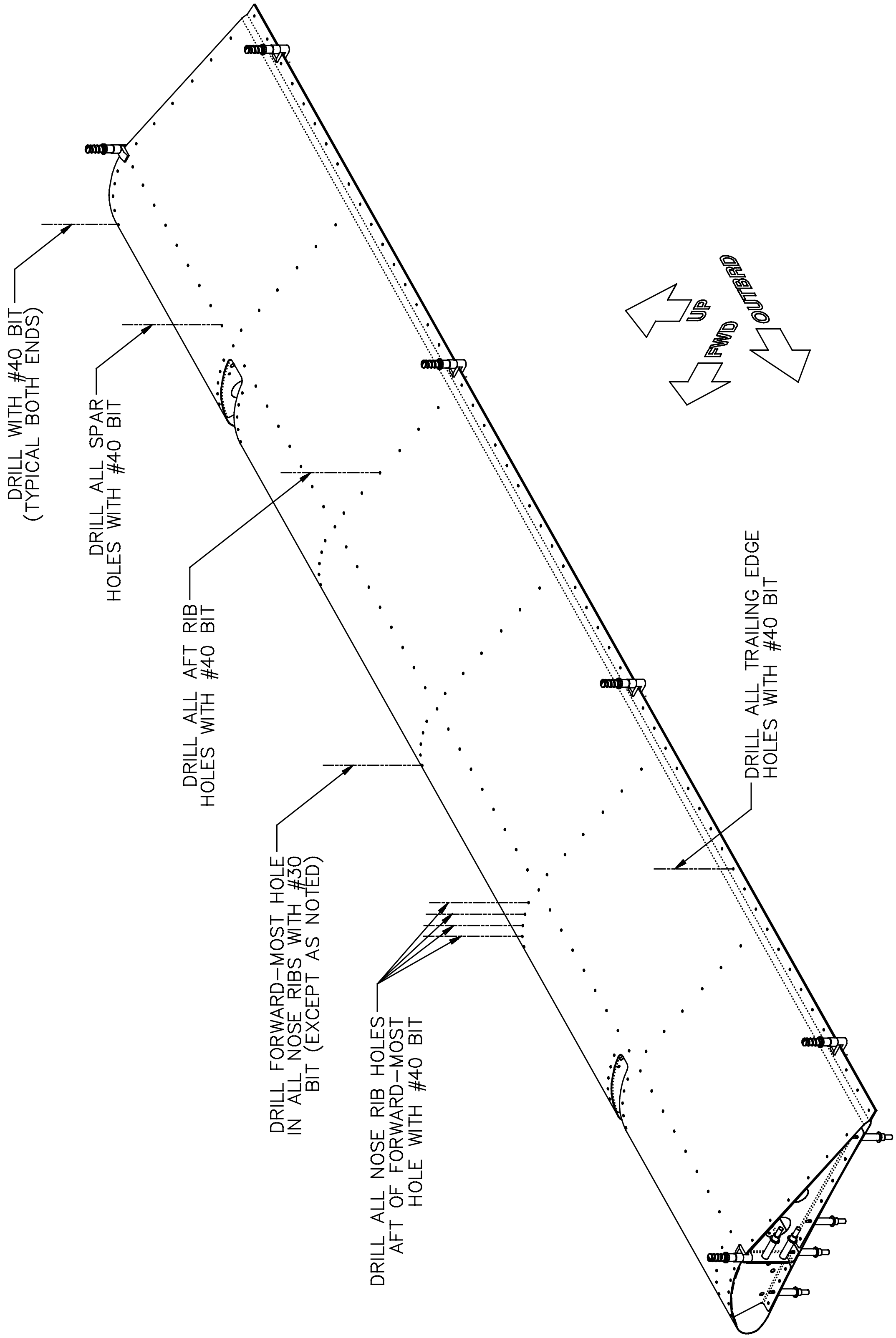

Figure 21: Positioning and Drilling the Upper Surface of the Skin

Step 17: Position and Drill the Inspection Hole Cover Nutplates

As Figure 22 shows, the inspection hole covers are secured with four K1000-08 **nutplates** [16], one on each edge of each cover. The nutplates on the inboard, outboard and forward edges of the plate are riveted to the inspection hole doubler, while the aft nutplate is riveted **through the lower surface of the skin** to the lower flange of the spar. Using standard procedures, position these nutplates and drill the necessary **#40** rivet holes.

Additionally, you should drill **two more #40 holes** through the lower surface of the skin and the lower spar flange, one on either side of the aft nutplate. Drill these holes on the spar rivet line and halfway between each nutplate rivet hole and its adjacent pre-punched skin hole, as shown in Figure 22.

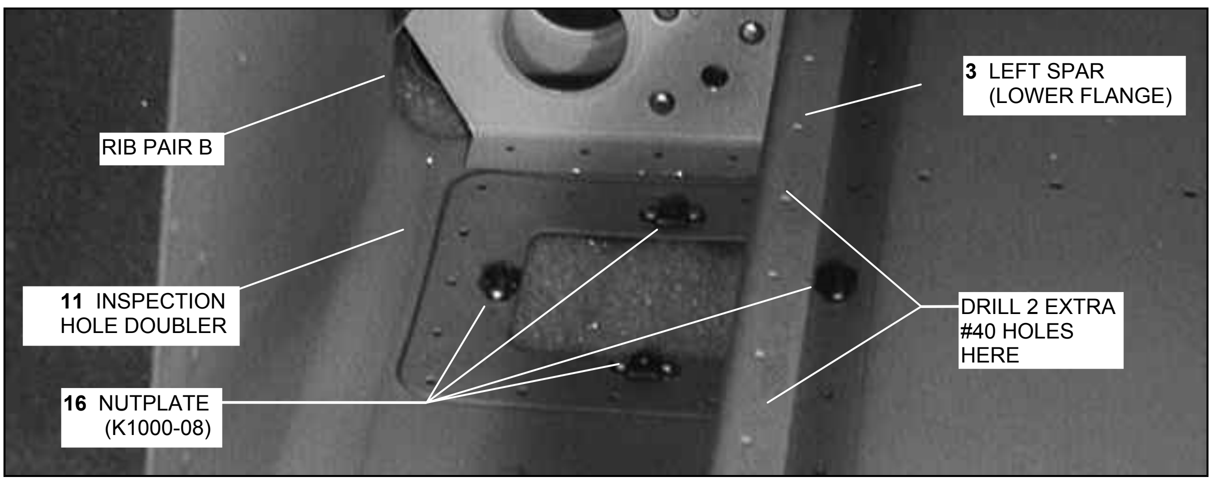

Figure 22: Positioning the Cover Plate Nutplates

After all the drilling is complete, remove all the Clecos holding the skin to the spar/rib assembly and thoroughly deburr all the holes in the skin, spar flanges and rib flanges.

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Step 18: Layout and Mark the Servo Tab on the Left Skin

The servo tab is positioned on the inboard 23" of the left aileron. It is hinged on top along its length by a rolled piano hinge centered 2.86" forward of the trailing edge as shown in Figure 23. Begin by marking a line, on the inboard side of the upper surface, 2-15/16" forward of the trailing edge and 23" long. Mark a similar line on the lower surface 2-13/16 forward of the trailing edge. Mark an end line at the 23" dimension on both the upper and lower surfaces and radius the corners 1/8".

With a pair of snips, trim along these lines (or do a final trim with a file later) being careful to get a good edge on the wing side. When cutting across the joggle, you might have better success with a cutoff wheel. The skin removed will be replaced with the servo skin provided. Reference Figure 23 for additional information.

Step 19: Trim the Ribs and Install the Forward Spar

Remove the two inboard aft ribs and mark a line on the aft end of the outboard rib 6.5" aft of the forward spar flange and then trim that rib to the 6.5" length. **You should trim the rib right up to the point of safe edge margin for the last rivet in this rib.** Mark the inboard rib flush with the upper and lower skins and then trim that rib accordingly. Re-install these ribs in their respective positions on the spar. Insert the **Forward Servo Spar [19]** between the two aileron skins with the 97-degree flange on the lower surface and the end of the spar flush to end ribs. The lower corner of the spar should match the 2-13/16" edge of the lower skin. Reference Figure 24. If the spar is interfering with the center rib, trim the spar on the upper and lower flanges as required. Tape the spar to the skins for now.

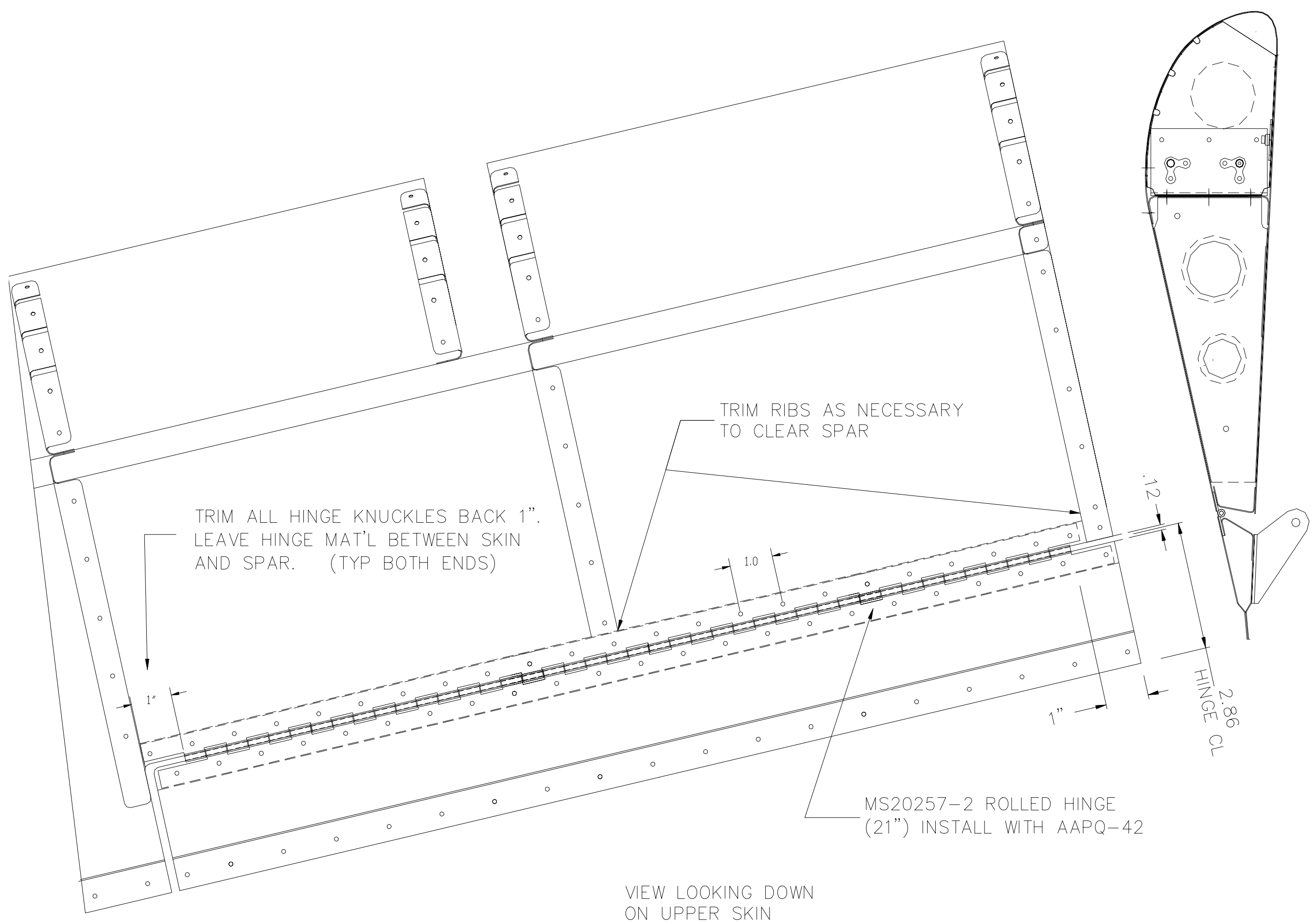

Figure 23: Aileron Servo Tab Layout

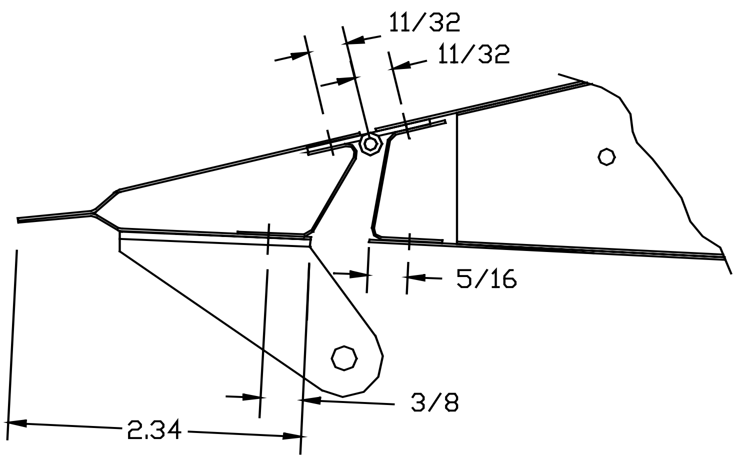

Figure 24: Detail View of the Servo Hinge

Step 20: Drill and Assemble the Servo Tab

Your kit came with two S**ervo Skins [21],** which are identical and are the correct size for the upper skin. The bottom skin will have to be trimmed to the 2.34" dimension shown in Figure 24. After you have trimmed and deburred the skin, position the **Aft Spar [20]** so the lower corner matches lower skin edge. Tape these two parts together for now. Next position the upper skin over the spar/lower skin assembly and insert the hinge between the two as shown in Figure 24. The hinge centerline is approximately 1/16" forward of the upper skin edge. The cutout for the hinge knuckles should be flush with the edge of the skin. Position the hinge so the inboard and outboard edges are flush to the rib but the first knuckles are 1.0" from the edge of the tab. Mark the rivet pattern on the upper skin approximately as shown in Figure 23. The rivet spacing along the hinge itself is 1" and should be centered 11/32" aft of the hinge centerline. After these are marked and the assembly is straight, drill the upper hinge line with a **#30** drill and cleco as you go. Next mark the lower rivet pattern approximately as shown in Figure 23. The spacing on the lower surface is 1.25". Drill these with a **#40** drill since these will be AN470AD3 rivets. **Do not drill the two rivets that are common to the horn.** Drill the trailing edge rivet pattern with a **#40** drill as shown in Figure 23. Dimensions are not critical.

The **servo horn [22]** is installed on the lower surface of the tab at the 12-15/16" dimension from the inboard end as shown in Figures 23 and 24. It should be centered on the horn installed on the aileron hinge. Drill the four #40 holes shown, two common to the spar and two on the far aft end. Make sure the horn is perpendicular to the span of the aileron.

Finally, disassemble all the parts and deburr, then reassemble the parts again for joining to the aileron.

Completed: [ ]

Step 21: Install the Tab on the Aileron

Insert the forward edge of the hinge between the upper skin and the spar on the aileron. Position the tab assembly per the dimensions shown in Figure 23 aligning the trailing edges and the inboard end. The gap between the main aileron skin and that of the tab should be approximately 3/32". If you need to trim some skin from the aileron you can, or you can take some off the trailing edge.

When you are satisfied with the fit of the two, clamp them into position. Deflect the tab surface. It should deflect approximately 18 degrees in the upward direction and 23 degrees down. If you need more deflection, pull the hinge out slightly from the upper skin. When you are satisfied with everything, mark the approximate rivet spacing on the upper hinge line and drill those with a **#30** drill. Mark the lower skin spar line with a similar 1.25" spacing as on the lower surface of the tab and drill those also with a #30 drill.

One again disassemble everything, deburr and corrosion proof the parts. See also Step 24.

Completed: [ ]

Step 22: Dimple the Inspection Hole Doublers, Spar Flange, Skin and Nutplates

All the nutplates you positioned and drilled will be mounted with 3/32" flush head rivets (AN426AD3). These rivets will also be used in the two extra skin-to-spar holes you drilled in a previous step. Dimple all the relevant holes in the doublers, the spar flange and the skin, as well as in the nutplates themselves.

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Step 23: Smooth and Deburr the Parts

Carefully smooth and deburr all cut edges and holes. Brush away any chips or shavings that might be clinging to the parts away from drilled holes or cut edges.

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Step 24: Corrosion-Proof the Aileron Interior

Take whatever cleaning, surface preparation and priming measures you deem necessary to protect the interior parts of your aileron from corrosion. At a minimum, you should thoroughly clean and alodine-treat the skins, ribs, spar and brackets. See "SECTION II: TOOLS AND TECHNIQUES" for a more complete discussion of corrosion-proofing options.

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RIVETING

Step 25: Rivet the Hinge and Actuator Bolt Nutplates to the Nose Ribs of Pairs B and C

Using 3/32" flush head rivets (AN426AD3), rivet the K2000-4 hinge and actuator bolt nutplates to their respective ribs—one to the **inboard** rib of Pair B and two to the **outboard** rib of Pair C. In all cases, the manufactured head should be on the rib web, with the shop head formed on the nutplate.

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Step 26: Rivet the Counterweight Bolt Nutplates to the Inboard Counterweight Nose Rib

Rivet the two K1000-3 nutplates to the web of the **inboard** counterweight nose rib to accommodate the counterweight bolts. Use 3/32" flush head rivets (AN426AD3).

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Step 27: Rivet the Inspection Hole Cover Nutplates to the Doublers

Use 3/32" flush head rivets (AN426AD3) to rivet the six K1000-08 nutplates that are located on the inspection hole doublers. Rivet three nutplates to each doubler with the manufactured heads on the outside.

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Step 28: Rivet Rib Pairs B and C to Their Respective Hinge Brackets

Use 1/8" AN470AD4 universal-head rivets to rivet the left- and right-flange nose ribs of Rib Pairs B and C to the outboard and inboard hinge brackets, respectively. The manufactured heads should be on the outside (i.e., on the rib webs), as shown in Figure 25.

> **Note:** Make sure that the shop heads of these rivets are no greater than 3/32" tall. This is necessary to provide sufficient clearance for the hinge spacers, which you will install in "SECTION IX: SYSTEMS INSTALLATION." If you have the means to counter-sink the inside holes on the hinge (or a heavy deburr), the shop heads will fill in the countersink and provide good clearance for the spacers.

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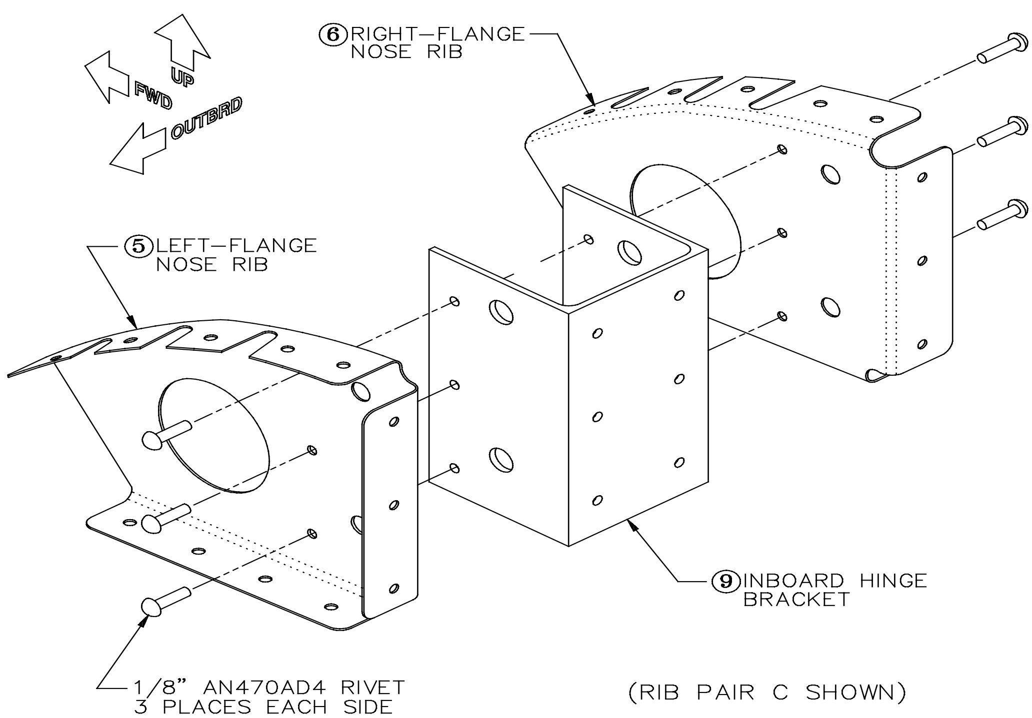

Figure 25: Riveting the Nose Ribs to the Hinge Brackets

Step 29: Rivet the Hinge Brackets to the Spar

Use 3/32" AN470AD3 universal-head rivets to rivet the hinge brackets to the spar web. As shown in Figure 26, the manufactured heads should be on the **aft** side of the spar web.

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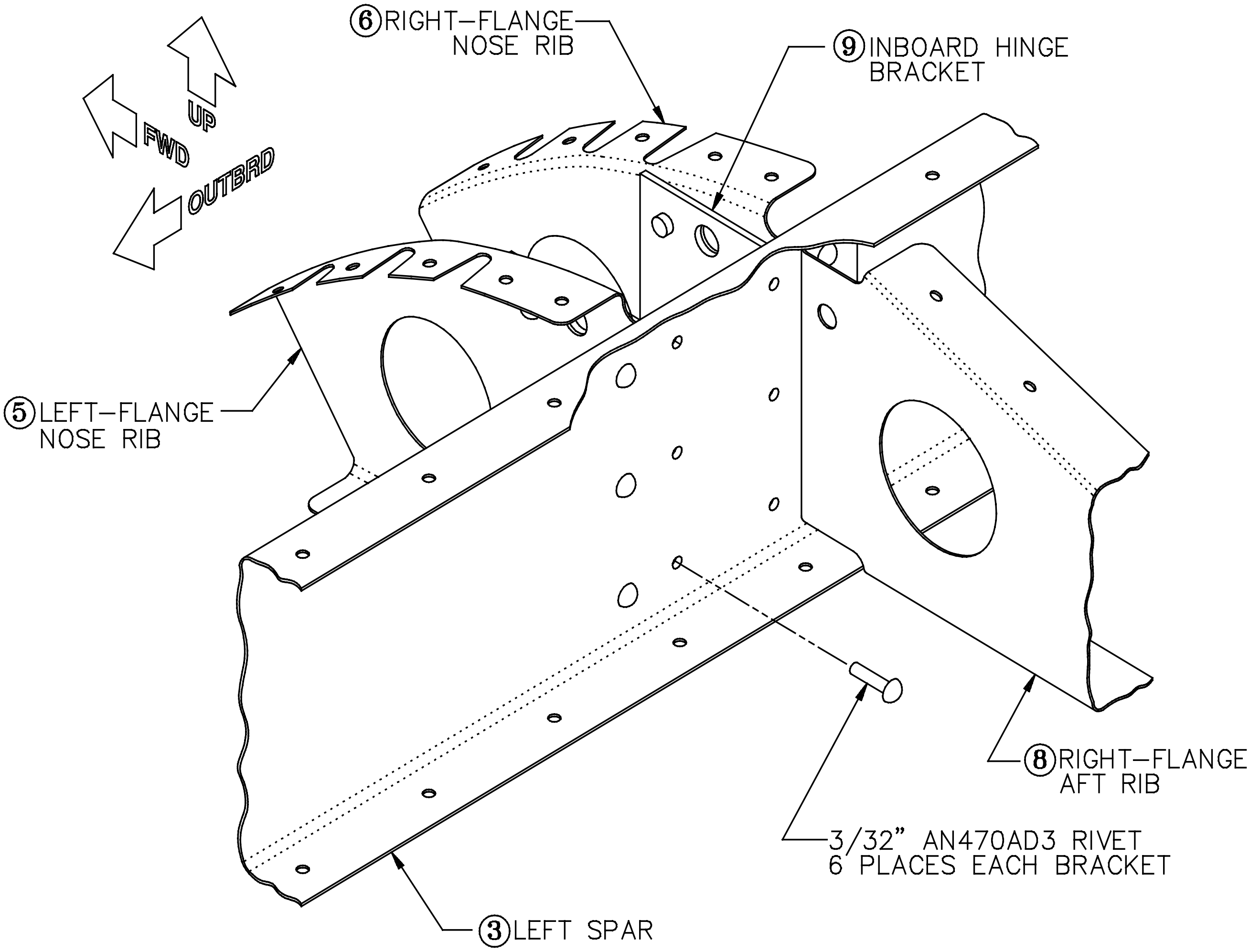

Figure 26: Riveting the Hinge Brackets to the Spar

Step 30: Rivet the Skin to the Upper Flanges of the Spar and Aft Ribs

Slide the skin over the spar/rib assembly, Cleco the upper surface in place and clamp the assembly **right-side up** to the clamping angles on the edge of your bench, as shown in Figure 28. Then use 3/32" AN470AD3 universal-head rivets to rivet the skin to the upper flange of the spar, as shown in the figure. Refer back to "SECTION II: TOOLS AND TECHNIQUES" for a discussion of the proper sequence for driving a line of rivets. Then, starting at the spar and moving aft, use the same type and size of rivets to rivet the skin to the upper flanges of the aft ribs.

Completed: Left [ ] Right [ ]

Step 31: Rivet the Skin to the Upper Flanges of the Nose Ribs

Begin at the spar and rivet forward along each nose rib's upper flange using 3/32" AN470AD3 universal-head rivets. You will find it increasingly difficult to hold the skin tightly against the rib flange as you move forward due to the curve being imposed on the skin. For this reason—as well as an awkward angle for bucking—it is impractical to drive a hard rivet into the forward-most hole in each nose rib. As shown in Figure 28, use a 1/8" AAPQ-42 blind rivet for this location on each rib, **except on the outermost ribs**. Because there is access there for a rivet squeezer, use 3/32" AN470AD3 universal-head rivets for **all** holes in these two ribs.

> **Note** The forward-most hole in each nose rib should have been drilled with a **#30** bit to accommodate the larger blind rivet. If this has not been done at this point, drive all the hard rivets aft of these holes. Then insert a Cleco in each of the forward-most holes and, removing one Cleco at a time, drill the holes up to #30 size. After drilling one hole, insert a larger Cleco before drilling the next hole. After all have been drilled, remove all the Clecos, deburr all the holes (both in the skin and the ribs) and install the blind rivets.

Completed: Left [ ] Right [ ]

Step 32: Rivet the Ribs and Inspection Hole Doublers to the Spar

Rivet all the nose, counterweight nose and aft ribs to the spar with 3/32" AN470AD3 universal-head rivets. The manufactured heads should be aft, as shown in Figure 27.

> **Note** Be sure to remove the temporary spacer from the counterweight nose rib if you haven't already done so.

Also, using the same rivets with the manufactured heads aft, rivet the inspection hole doublers to the spar. Refer back to Figure 20 to ensure proper orientation.

Completed: Left [ ] Right [ ]

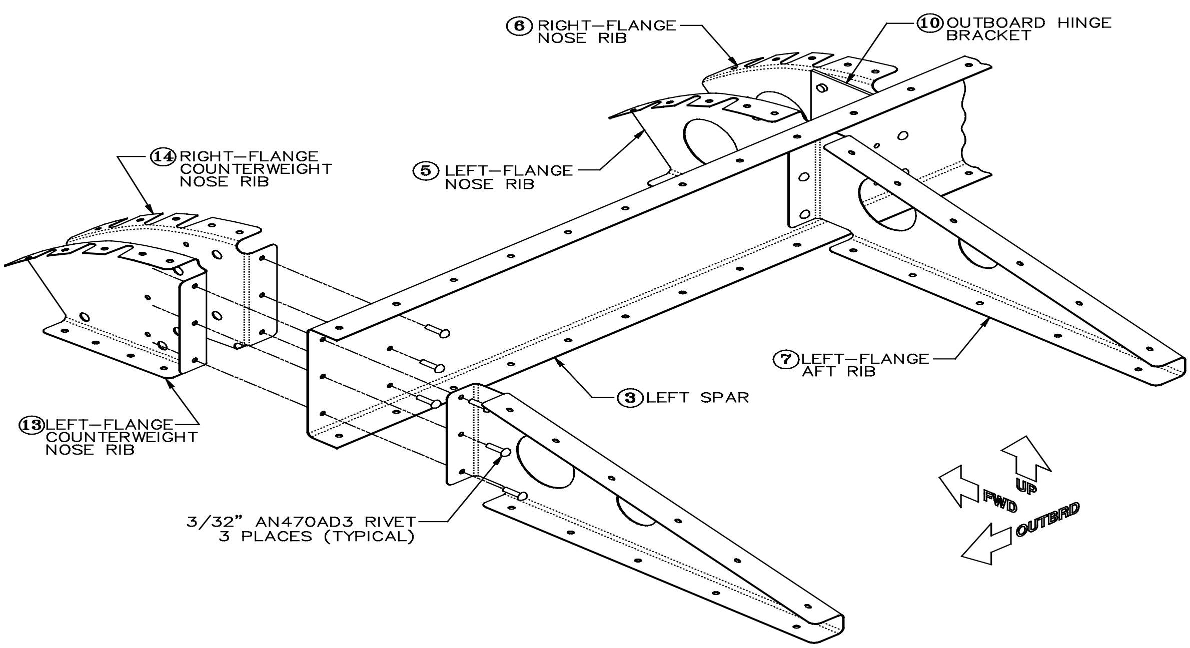

Figure 27: Riveting the Ribs to the Spar

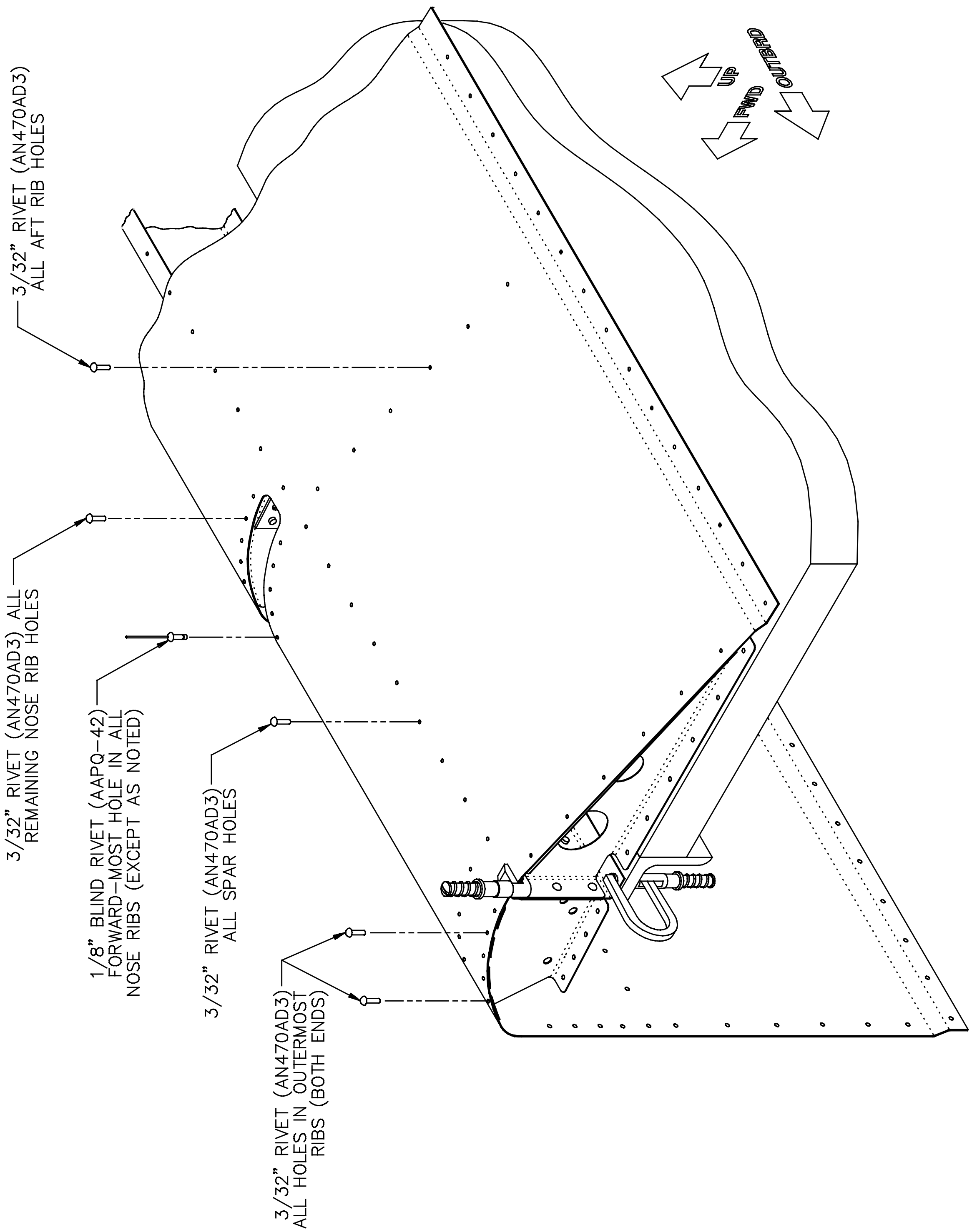

Figure 28: Riveting the Upper Surface of the Skin to the Spar/Rib Assembly

Step 33: Rivet the Skin to the Lower Flanges of the Nose Ribs

After the upper surface of the skin has been riveted to the spar/rib assembly, turn the assembly over and rivet the lower surface to the nose ribs, starting forward and moving aft to the spar. As shown in Figure 29, use 3/32" universal head rivets (AN470AD3) wherever the flange is accessible to a rivet squeezer or bucking bar—that is, all holes in both outermost ribs and all holes in the two ribs adjacent to the access holes in the skin. Rivet all the other nose ribs with 1/8" blind rivets (AAPQ-42).

Completed: Left [ ] Right [ ]

Step 34: Drill the Trailing Edge Joggles

Use a **#40** bit to drill through both skin surfaces at each pre-punched pilot hole, being careful to keep the trailing edge as straight as possible. Replace the clamps with Clecos as you go. **Do not drill the inboard 23" of the trailing edge. This will be trimmed for the anti-servo tab.** When all the drilling is complete, un-Cleco the upper surface of the skin.

Completed: Left [ ] Right [ ]

Step 35: Rivet the Inspection Hole Doublers to the Skin

Using 3/32" universal head rivets (AN470AD3), rivet the inspection hole doublers to the skin. The manufactured heads should be on the outside. Be careful not to over-drive or -squeeze these rivets, as the thin material of the skins and rings can easily buckle.

Completed: Left [ ] Right [ ]

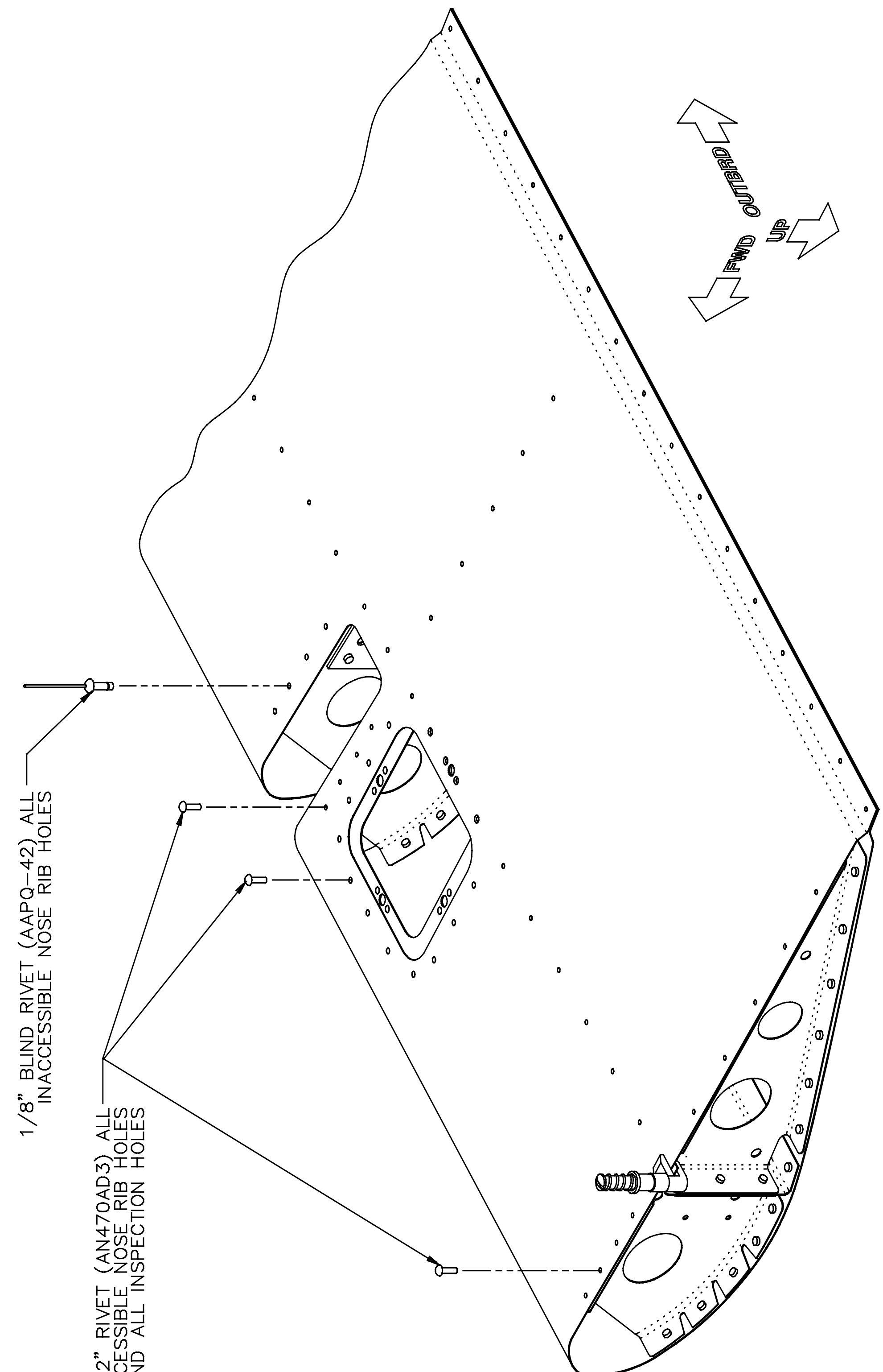

Figure 29: Riveting the Skin to the Lower Flanges of the Nose Ribs

Step 36: Rivet the Skin and the Aft Inspection Cover Nutplates to the Lower Spar Flange

Use 3/32" universal head rivets to rivet the skin to the lower flange of the spar, as shown in Figure 31. Refer back to "SECTION II: TOOLS AND TECHNIQUES" for a discussion of the proper sequence for driving a line of rivets. In order to drive these rivets, you will have to lift the trailing edge of the skin and reach inside the aileron to position the bucking bar. Figure 30 depicts this technique.

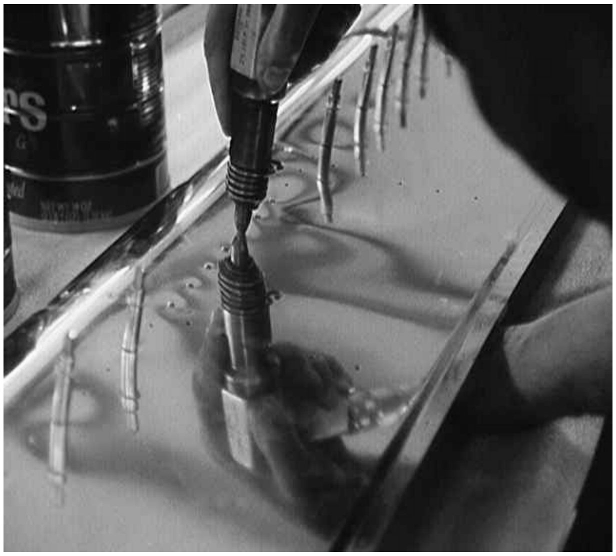

Figure 30: Riveting the Skin to the Lower Flange of the Spar

In the course of riveting the spar line, also rivet the aft nutplates for each inspection hole cover to the spar using 3/32" flush head rivets (AN426AD3). These rivets should also be used in the holes immediately to the left and right of each nutplate.

Finally, recall that a handful of holes along the lower spar flange may have been drilled up to #30 size because of their proximity to underlying rib webs. Rivet these holes with blind rivets (AAPQ-42) **after** all the other spar rivets have been driven.

Completed: Left [ ] Right [ ]

Step 37: Rivet the Skin to the Lower Flanges of the Aft Ribs

Beginning at the spar and moving aft, rivet the skin to the lower flanges of the aft ribs. As shown in Figure 31, use 1/8" blind rivets (AAPQ-42) for all the aft ribs **except the outermost pair**; because these are accessible for squeezing, use 3/32" universal head rivets (AN470AD3) on the outermost ribs.

Completed: Left [ ] Right [ ]

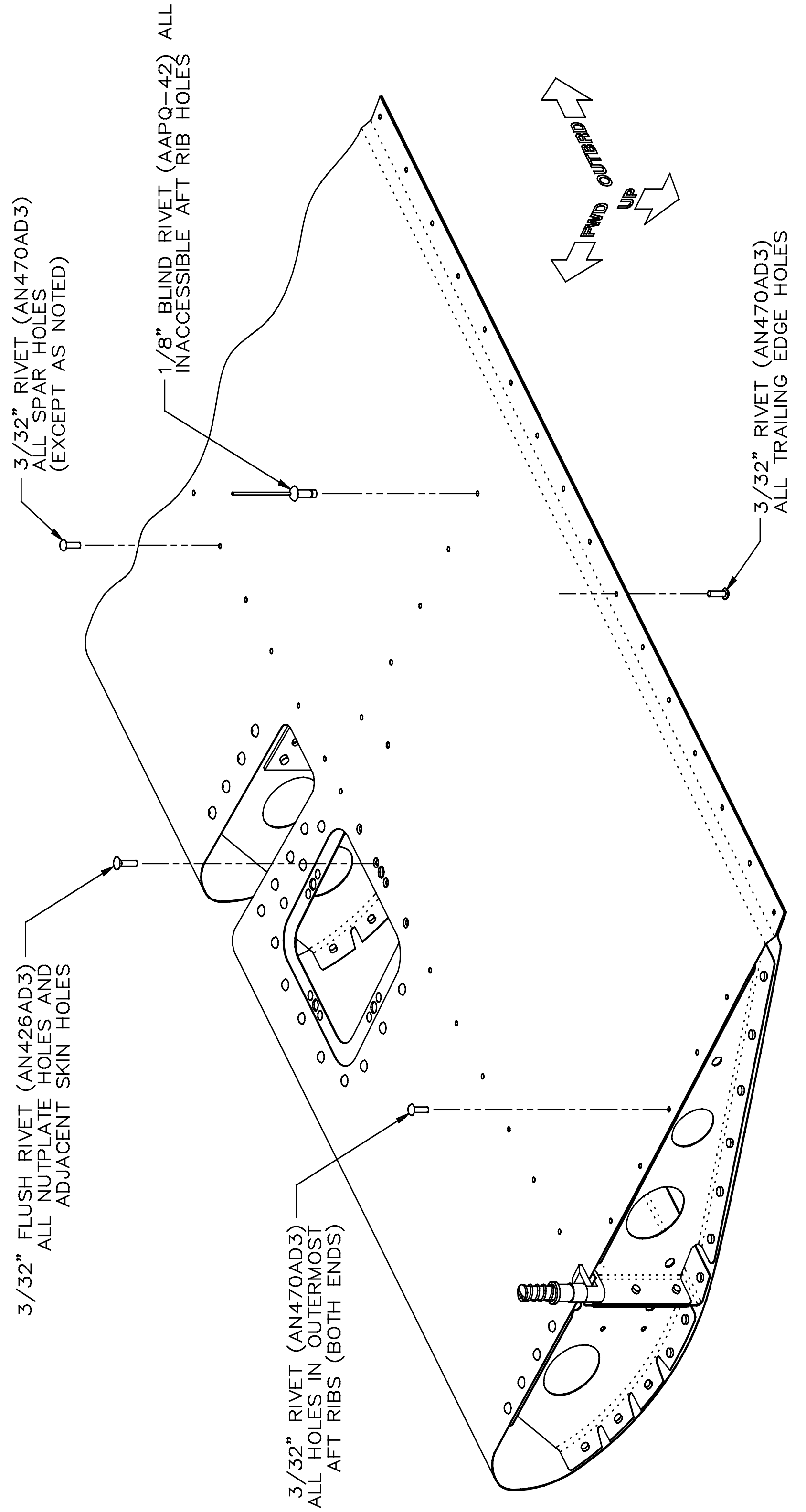

Figure 31: Riveting the Skin to the Lower Flanges of the Spar and Aft Ribs

Step 38: Rivet the Servo Tab

Assemble the lower servo tab skin to the spar and the horn. Rivet all these surfaces together using 3/32" universal head rivets (AN470AD3). IF you chose to flush rivet the servo tab, dimple the spar and skin for 3/32" flush head rivets (AN426AD3).

Next install the upper skin and the hinge on the assembly. On a flat surface, rivet the upper spar line with 1/8" blind rivets (AAPQ-42).

Finally, rivet the trailing edge joggle of the tab using 3/32" universal head rivets (AN470AD3) with the manufactured heads on the upper surface. Again, use the techniques previously discussed in the rudder and other tail sections for keeping the trailing edges straight.

Completed: [ ]

Step 39: Rivet the Forward Servo Tab Spar to the Aileron.

Install the antiservo tab on the aileron and clamp the trailing edges of the two surfaces together making sure the two surfaces are straight and not twisted. Rivet the upper and lower spar lines with 1/8" blind rivets (AAPQ-42).

Completed: [ ]

Step 40: Rivet the Trailing Edge Joggles

Using 3/32" universal head rivets (AN470AD3), rivet the upper and lower trailing edge joggles together, as shown in Figure 31. Observe proper sequencing as discussed in "SECTION II: TOOLS AND TECHNIQUES" and avoid over-squeezing or -driving these rivets, as the thin skin material will be prone to buckling between rivets that are too tight. The manufactured heads should be on the **upper** surface.

Completed: Left [ ] Right [ ]

Step 41: Mark and Cut the Counterweight Arm Slot

As alluded to earlier, the counterweight assembly (which will be installed in "SECTION X: FINAL ASSEMBLY,") consists of a lead casting around an arm made of square steel tubing. As shown in the top panel of Figure 32, the arm slides between the two counterweight nose ribs at the outboard end of the aileron, where it is secured with two 3/16" bolts. In order to provide access to the channel between these ribs, a square slot must be cut in the skin right at the leading edge.

Make the slot by drilling a **#30** hole at each corner, then drilling a larger hole in the center, and finally cutting and filing out the remaining material. As shown in the lower left-hand panel of Figure 32, locate the hole positions by, first, drawing two chordwise lines around the leading edge. The first of these lines should be **11/16"** in from the outboard edge of the skin, and the second should be **1/2"** beyond the first.

Once these lines are established, mark the two lower hole locations **1/16"** above the flat-bottomed portion of the lower surface of the skin. The two upper hole locations should be marked **9/16"** above the flat bottom.

> **Note** The 1/2" distance from the lower holes to the upper ones must be measured **vertically**. The linear distance along the surface of the skin will be considerably greater than 1/2".

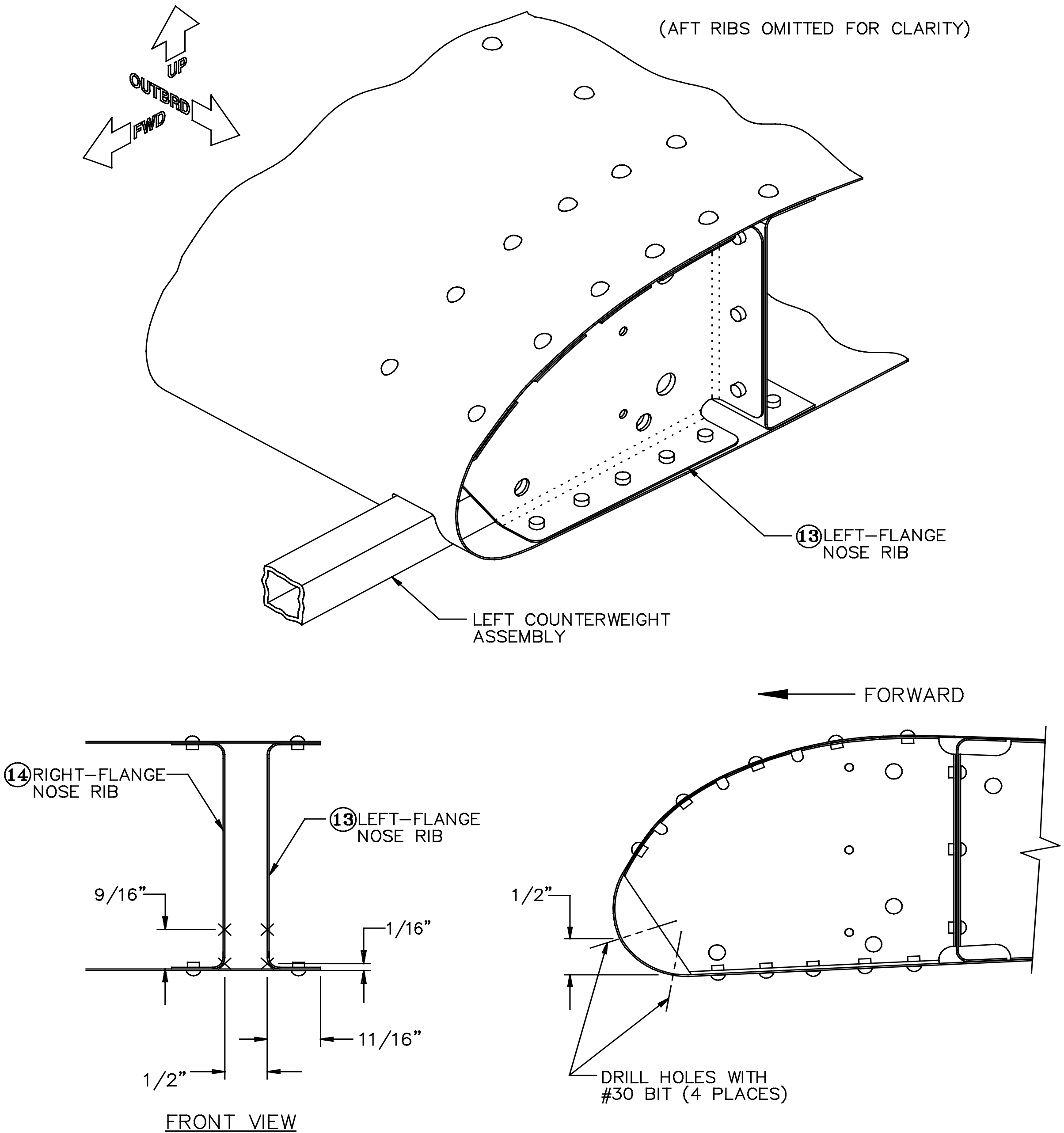

Figure 32: Marking and Cutting the Counterweight Arm Slot

Once the four corner hole locations are marked, drill each with a **#30** bit. As indicated in the cross-sectional view of Figure 32, drill the holes perpendicular to the skin surface.

Note As you may already have realized, drilling four #30 corner holes on 1/2" centers will result in a cutout that is larger than 1/2" square. This is intentional, since the aluminum aileron skins should **not** directly contact the steel counterweight arm.

Next, use a **3/8"** hole cutter or Unibit to drill out the majority of the material inside the corner holes. Use files or a rotary cutter as necessary to remove whatever is left and smooth the cut edges.

Caution Be careful **not** to square the radii left in the corners of the cutout by the #30 holes. Square corners act as stress risers, from which cracks can arise.

Completed: Left [ ] Right [ ]

Note The ailerons are now complete. They won't be needed again until Step 38 of "SECTION IX: SYSTEMS INSTALLATION" when they will be mounted to the wings to finish the control system installation. Until then, store the ailerons in a safe place to protect them from damage and corrosion.

FLAP ASSEMBLY PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Skin	2	201-10051-01
2	Spar	2	201-10052-01
3	Left-flange nose rib	10	201-10053-01
4	Right-flange nose rib	10	201-10053-02
5	Left-flange aft rib	6	201-10054-01
6	Right-flange aft rib	8	201-10054-02
7	Flap-track guide arm	8	201-10055-01
8	Aft Spar	2	201-10056-01
9	Trailing Edge	2	201-10057-01
10	Deployment Arm	4	201-10058-01
11	Rib Doubler .05 x .63 x 2 1/2" x 26"	1	201-10060-01

Tools and Additional Materials

Construction of the flaps requires most of the same tools and additional materials as the ailerons, plus the following :

1. Hacksaw (acceptable) or bandsaw or scroll saw (preferable)
2. Belt sander (recommended)
3. Small C-clamps, 2–4
4. Chip chaser
5. Sand or shot bags, 3–4
6. Microstop countersink cage with #30 piloted cutters of 100° and 120°
7. Three 10'-long 1 X 4s
8. 6"-length of steel pipe, 2–3" in diameter
9. Lead body hammer or rubber mallet

Workspace

Like the ailerons, the flaps are built on a flat table without jigs. Each flap is approximately 110" X 13". For assembly steps in which aluminum skins are lying flat on the bench, it's a good idea to pad your bench surface with cardboard to avoid unnecessary scratching of the finish. Also, you might consider leaving the plastic protective film on the outside of the skin through the positioning and drilling stages; remove it for hole deburring and riveting.

Assembly Sequence

Construction of the flaps consists of four phases: **component preparation**, **flap-track and deployment arm installation**, **skin positioning and drilling** and **main structure riveting**.

Unlike the ailerons, the left and right flaps **are identical**; construction procedures for both flaps are exactly the same. For clarity, the text and illustrations that follow refer to **one flap only**, but the instructions for each step are followed by a check box for both left and right flaps.

Figure 31 shows the configuration of the flap.

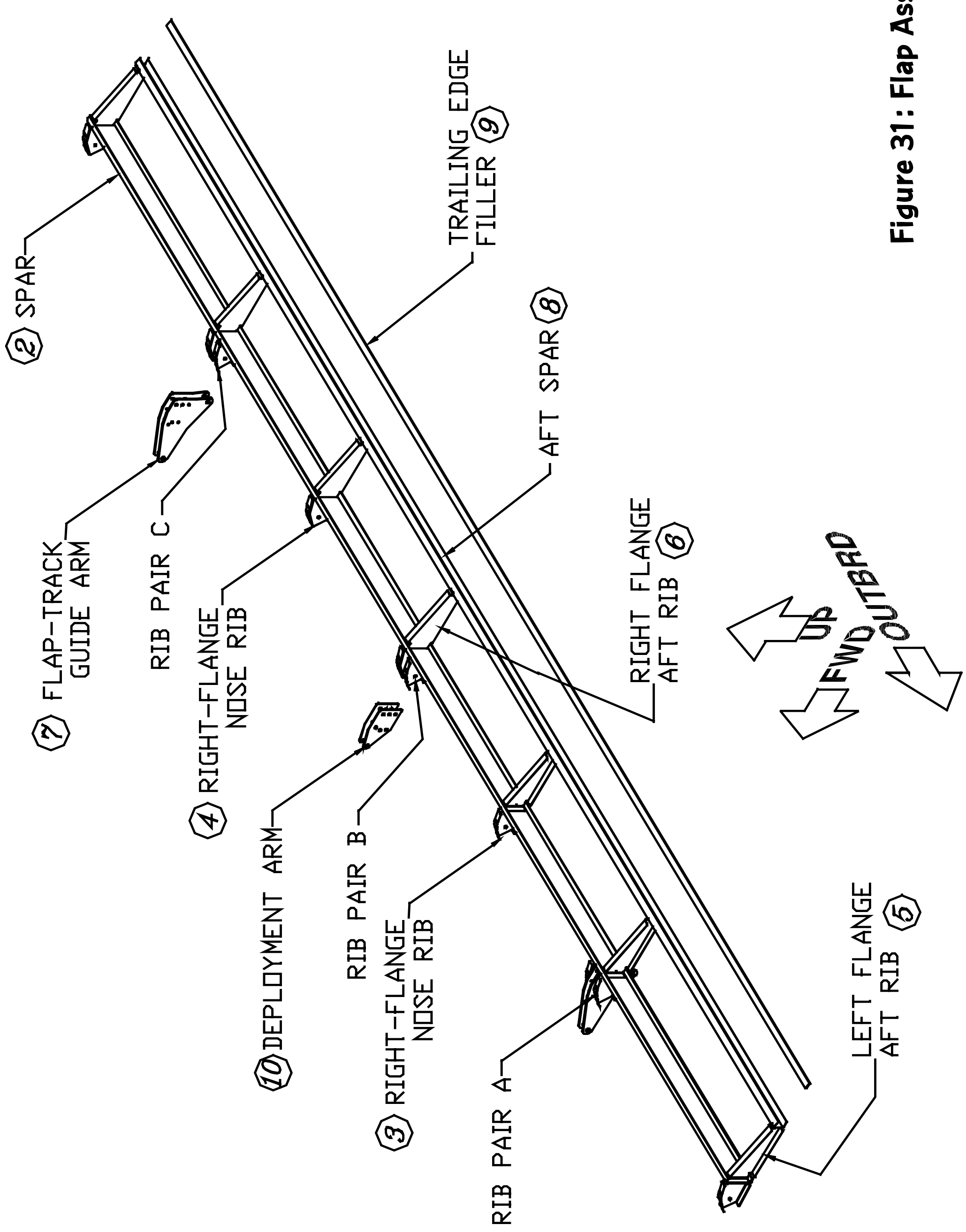

Figure 31: Flap Assembly

Component Preparation

Step 42: Straighten and Deburr the Parts

Using a square, check the flanges on all the ribs (**left-flange** [3] and **right-flange nose ribs** [4], and **left-flange** [5] and **right-flange aft ribs** [6]) for squareness, straightening as necessary with a pair of padded duck bill pliers.

Deburr the edges and lightening holes of all the parts as necessary.

Completed: Left [ ] Right [ ]

Step 43: Mark Rivet Lines on the Flanges of the Ribs and Spar

Using a fine-point marking pen, mark a centerline on the flanges of all the ribs. Rivet lines must also be marked on both spar flanges, as shown in Figure 32. Mark these lines parallel to and **7/32"** in from the edge of the **upper** flange and **9/32"** in from the edge of the **lower** flange.

Note The lower flange is the one that is perpendicular to the spar web.

Completed: Left [ ] Right [ ]

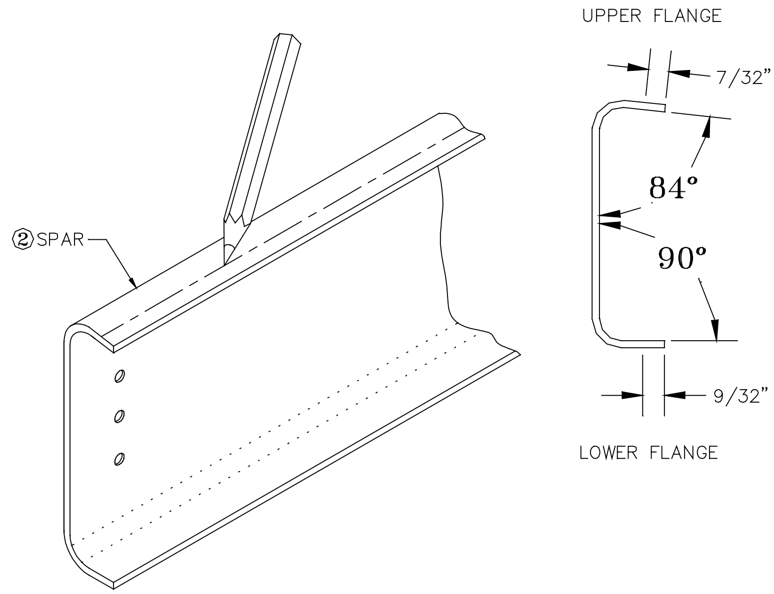

Figure 32: Marking the Spar Rivet Lines

Step 44: Cut and Trim the Nose Rib Reinforcement Angles

Each nose rib that supports either a **flap-track guide arm** [7] or a **deployment arm** [8] is reinforced with a small aluminum angle. Each angle sits inside the nose rib with one flange against the rib web and the other against the aft flange of the rib. These six angles must be cut from the supplied **.05 x .63 x 2-1/2" x 26" rib doubler [11];** there should be approximately 26" of this stock.

Begin, as shown in Figures 33 & 34, by cutting the angle stock to **the 2" length.** However, because of the shape of the nose ribs into which the angles must fit, the angles must be trimmed to fit inside the radius of the upper flange of the nose rib. Furthermore, because left- and right-flange nose ribs are involved, the angles must be cut in mirror-imaged pairs. Figure 33 shows the dimensions for the nose rib reinforcement angles, and Figure 34 shows them nested inside a nose rib. **Make three of each type for each flap**.

Finally, smooth the cut edges and slightly round the corners of each piece.

Completed: Left [ ] Right [ ]

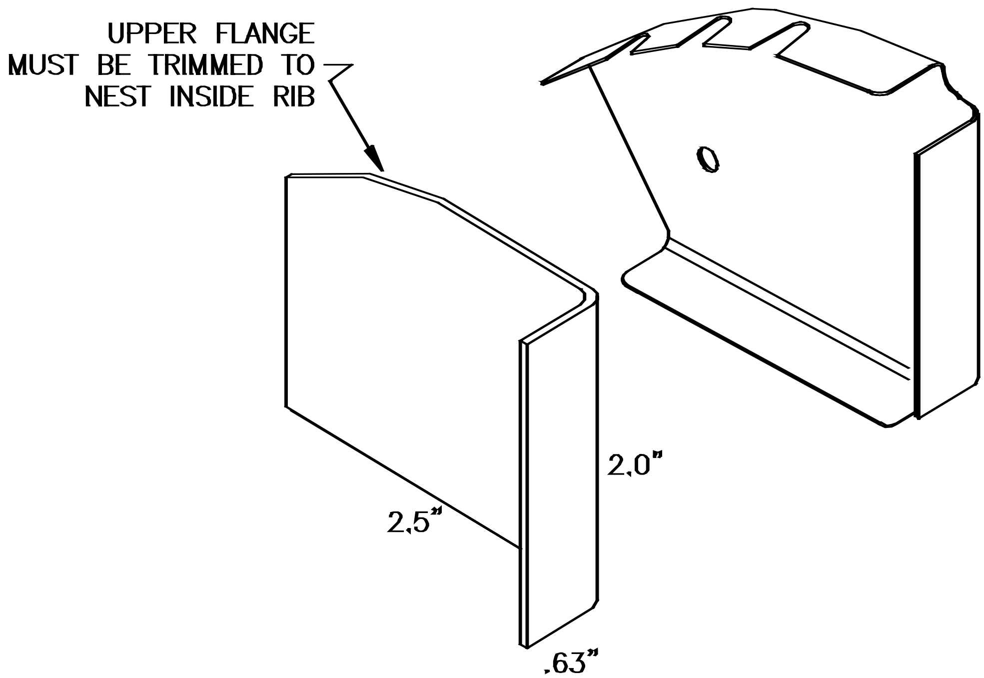

FIGURE 33

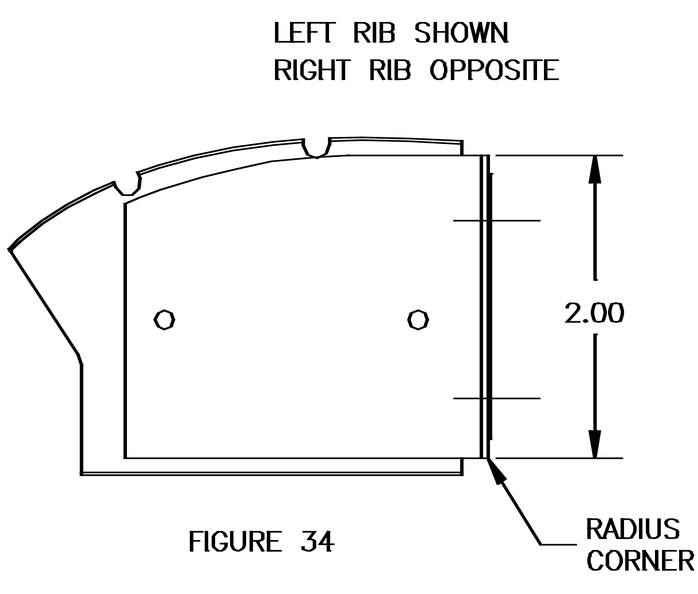

FIGURE 34

Figure 33 & 34: Cutting the Nose Rib Reinforcement Angles

FLAP-TRACK AND DEPLOYMENT ARM INSTALLATION

Step 45: Drill the Nose Rib Reinforcement Angles

The nose rib reinforcement angles must be drilled to match the hole patterns in the corresponding nose ribs so that they can be Clecoed together. Begin by choosing one left-flange and one right-flange nose rib and labeling them "Pair A." Choose a second and third pair and label them "Pair B" and "Pair C."

As shown in Figure 35, use a small C-clamp and Cleco side-grips to clamp an angle inside each of the six chosen nose ribs. Make sure the 5/8" flanges nest inside one another without any gaps and without distorting the thin flange of the rib. This will help keep the guide arms better aligned in subsequent steps.

Note Figure 35 shows an angle clamped inside a left-flange nose rib for illustration; the three right-flange ribs should be handled identically. The angles will only fit inside ribs of the same flange direction, so if you have trouble fitting one, simply switch it to an opposite-flanged rib.

With the angles clamped in place, use a **1/8"** bit to drill through each rib web and its reinforcement angle at the aft-most of the two 1/8" pre-punched rib web holes, as shown in the figure. After drilling, mark each angle so that it can be matched with its rib later.

Completed: Left [ ] Right [ ]

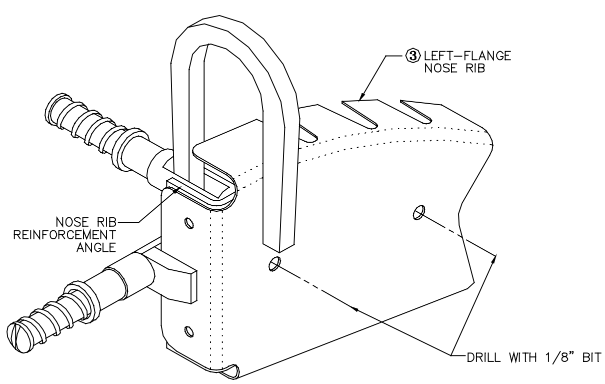

Figure 35: Drilling the Nose Rib Reinforcement Angles

Step 46: Drill the Flap-Track and the Deployment Arm Nose Ribs

As shown in Figure 31, each flap-track guide arm is matched with a nose rib. At each flap track location, one arm is paired with a left-flange rib and one with a right-flange rib.

Begin with Pair A. Using the two 1/8" holes near the middle of the ribs, Cleco a flap-track guide arm and a reinforcement angle to the web of each rib. As Figures 36 and 37 show, the arms should extend forward and downward from the ribs. Drill through the rib web, arm and angle at each of the six un-Clecoed pilot holes in the arm with a **#30** bit, as shown in Figure 36.

After drilling, insert Clecos in two of the newly drilled holes, remove the original Clecos, and ream the two 1/8" holes up to final size with a **#30** bit. Mark each arm and its rib so they can be matched up again later.

Note Figure 36 shows the drilling of a right-flange nose rib for illustration; the two left-flange ribs are handled identically. It is important that when an opposite pair of guide arms are placed back to back, the holes through the arms (for the track roller bearings) be aligned and parallel to each other. When assembled to the spar later the arms should all be aligned with each other.

Repeat the process with two more guide arms and the ribs of Pair C. When all the holes have been drilled, remove the guide arms. Countersink all eight of the #30 holes in each arm on the side of the arm **opposite** the rib, as shown in Figure 37. Set your microstop to accommodate 1/8" AN426AD4 flush-head rivets. The countersunk rivets are required to clear the flap track during deployment.

Completed: Left [ ] Right [ ]

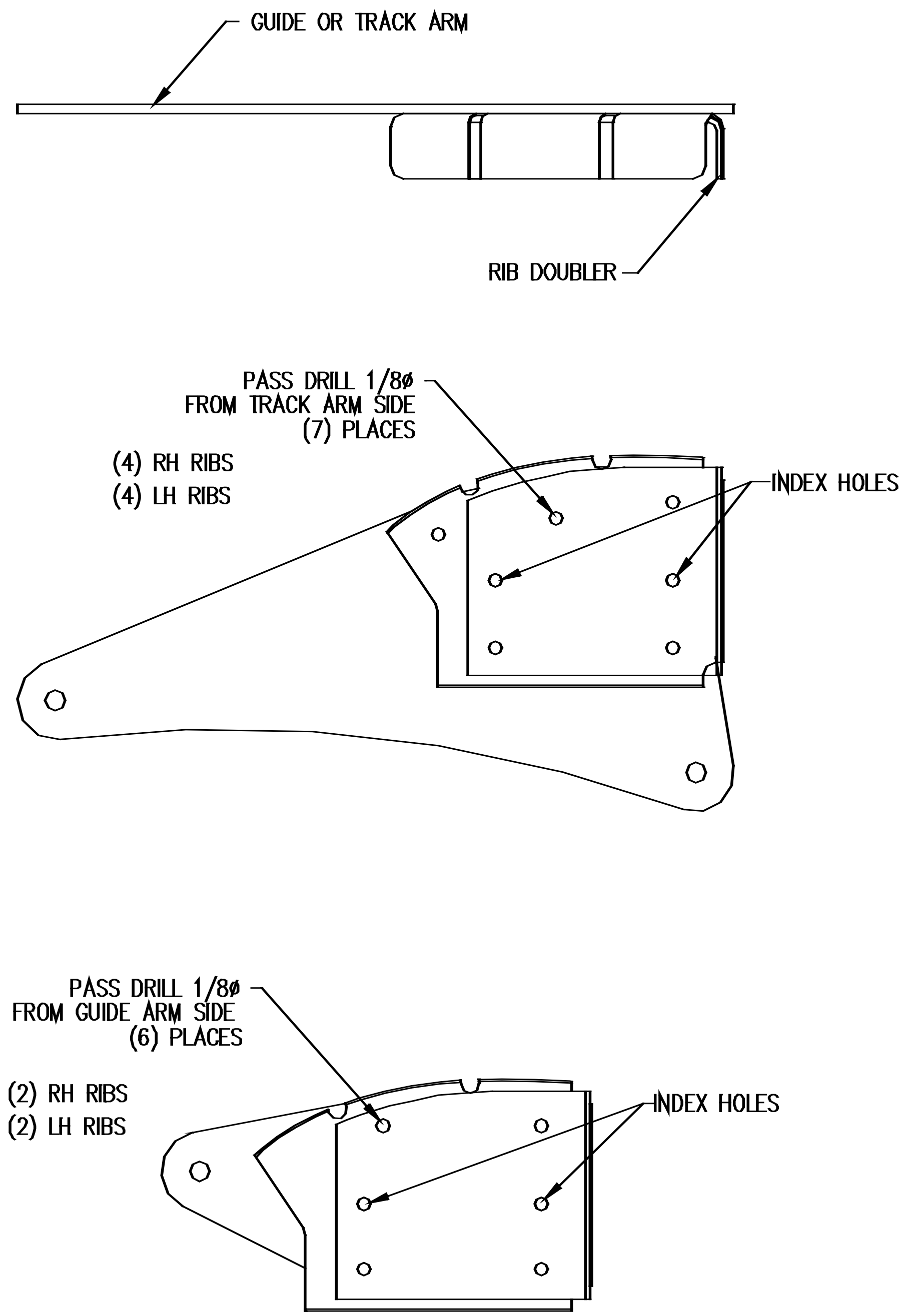

Figure 36: Assembling the Deployment Arm and Flap-Track Nose Ribs

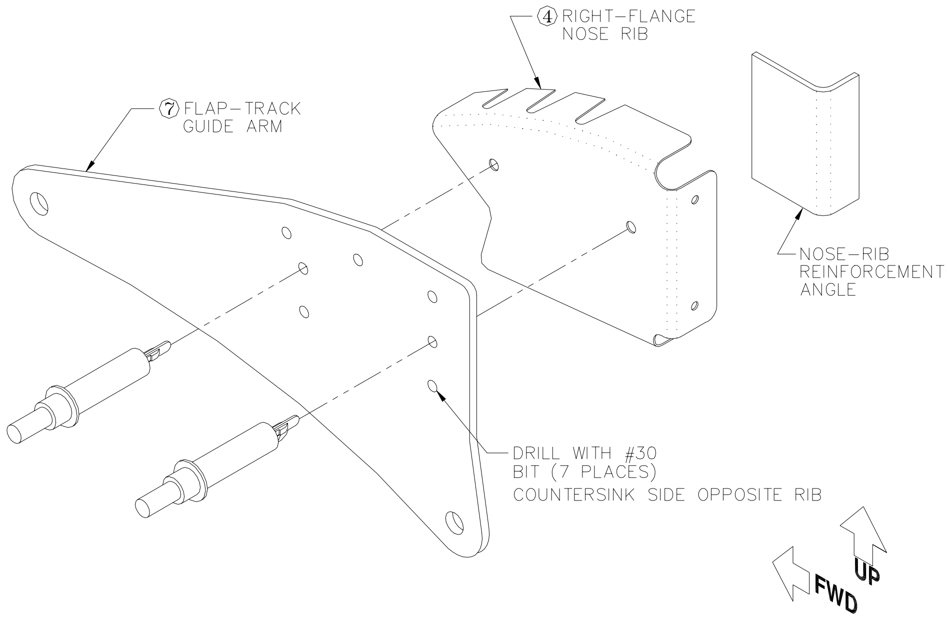

Figure 37: Drilling the Deployment and Flap-Track Nose Ribs

In similar fashion to the guide arms, using the two 1/8" holes near the center of the ribs, Cleco a deployment arm to the web of each rib and to a reinforcement angle. The arms should extend forward and upward from the ribs, as shown in the Figure 37.

With the arms Clecoed to the ribs, drill through the rib web, arm and angle at each of the six un-Clecoed pilot holes in the arm with a #30 bit. After these holes have been drilled, insert a pair of Clecos in two of the newly drilled holes, remove the original Clecos, and ream the two 1/8" holes up to final size with a #30 bit. Mark each arm and its rib so that they can be matched again later.

> **Note** Figure 37 shows the drilling of a right-flange nose rib for illustration; the two left-flange ribs are handled identically.

When all the holes have been drilled, remove the deployment arms and deburr all the holes. None of the holes in the deployment arms requires countersinking.

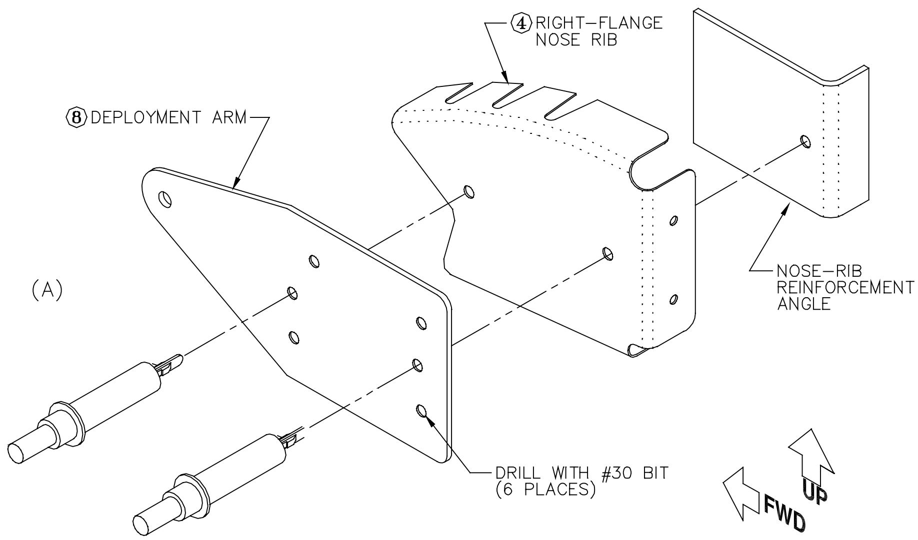

Figure 38: Drilling the Deployment Arm and Nose Ribs

Completed: Left [ ] Right [ ]

Step 47: Corrosion-Proof the Flap-Track and Deployment Arm Parts

Apply the anti-corrosion protection of your choice to the flap-track and deployment arms and their respective nose ribs and reinforcement angles.

Completed: Left [ ] Right [ ]

Step 48: Rivet the Reinforcement Angles and Flap-Track Guide Arms to the Ribs of Pairs A and C

Clamp the nose rib reinforcement angles and the flap-track guide arms to the ribs of Pairs A and C with three Clecos, as shown in Figure 39. Use 1/8" AN426AD4 flush-head rivets to rivet the angles and arms to the nose ribs through the five un-Clecoed holes. Then remove the Clecos and rivet the remaining three holes. Pay careful attention to the marks you made earlier to ensure that each angle and arm gets reunited with its proper rib.

Completed: Left [ ] Right [ ]

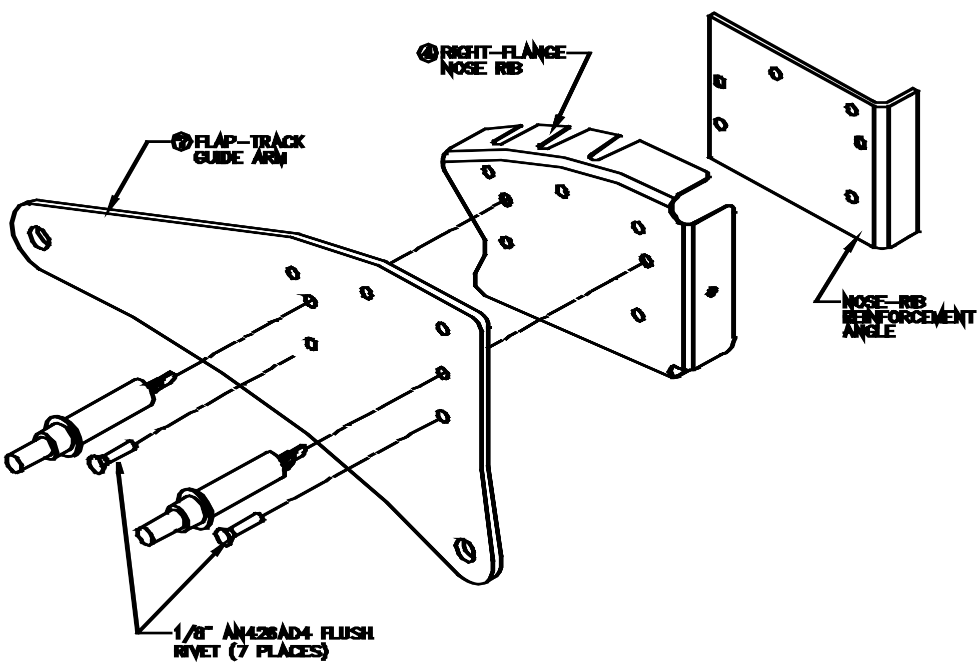

Figure 39: Riveting the Reinforcement Angles and Flap-Track Guide Arms to Rib Pairs A and C

Step 49: Rivet the Reinforcement Angles and Deployment Arms to the Ribs of Pair B

Clamp the remaining two nose rib reinforcement angles and the deployment arms to the ribs of Pair B. Then rivet the angles and arms to the nose ribs using 1/8" AN470AD4 universal-head rivets. Pay careful attention to the marks you made earlier to ensure that each angle and arm gets reunited with its proper rib. As shown in Figure 40, the manufactured heads of all rivets should be on the rib side.

Completed: Left [ ] Right [ ]

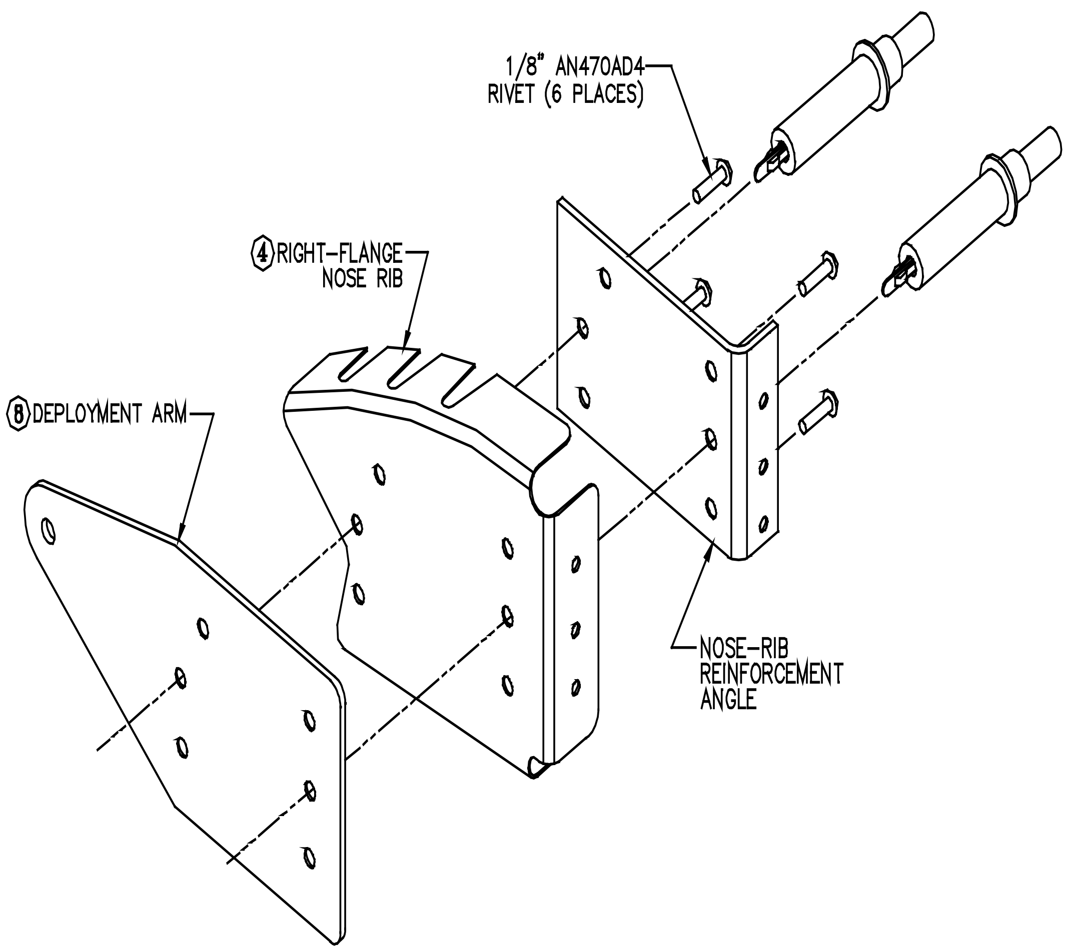

Figure 40: Riveting the Reinforcement Angles and Deployment Arms to Rib Pair B

Step 50: Drill the Rib/Spar Rivet Holes in the Reinforcement Angles

With the flap-track and deployment arms riveted to their respective nose ribs and reinforcement angles, you can now use the holes in the aft flange of each nose rib as guides to drill through the aft flanges of the reinforcement angles, as shown in Figure 41. Use a **#40** bit, and deburr all the holes after drilling. Also, use a chip chaser to ensure that no shavings are trapped between the reinforcement angles and the aft rib flanges.

Completed: Left [ ] Right [ ]

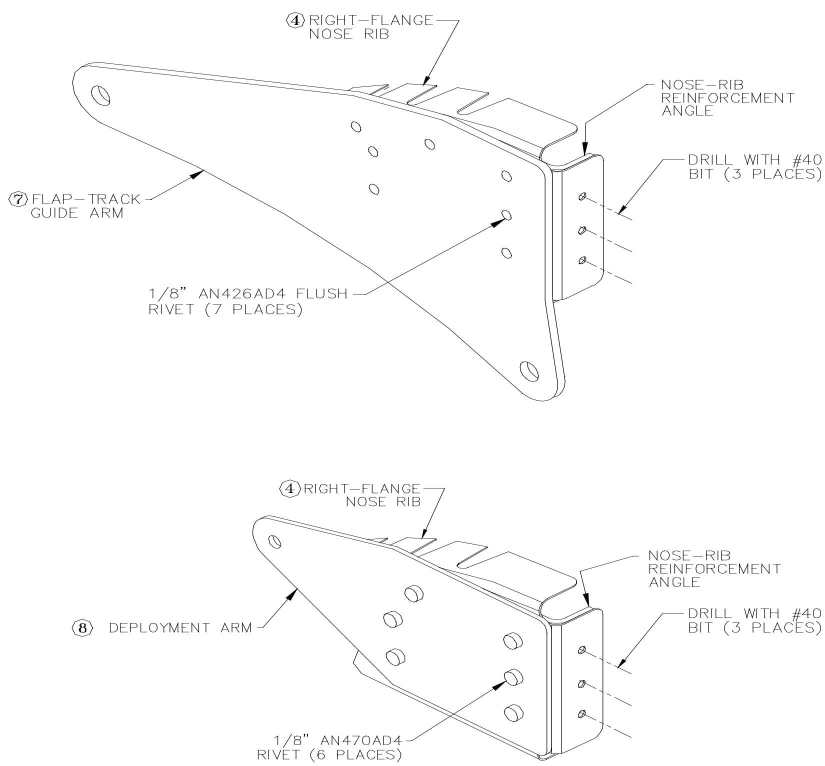

Figure 41: Drilling the Rib/Spar Rivet Holes in the Reinforcement Angles

SKIN POSITIONING AND DRILLING

Step 51: Cleco the Ribs to the Spars and Drill All the Rib/Spar Rivet Holes to Final Size

Cleco **all the nose and aft ribs** to the spar. Use two Clecos for each pair of ribs. In addition to referring back to Figure 31 to ensure that you orient the flanges properly, be sure also that you position the ribs of Pairs A, B and C together with their mates and at their proper stations.

> **Note** It is important that you check the alignment of the rib flanges to the spar flange. Due to manufacturing tolerances, it is possible for the ribs to ride high or low on the spar resulting in a high spot or low spot when the skins are installed. Use a six-inch scale or a piece of scrap material to double-check the fit. If necessary, shift the rib either up or down and pass drill the rib to the spar. Drill up to #30 if necessary.

Once all the ribs are in place, juggle the Clecos as necessary to drill all the rib/spar rivet holes up to **#40** size **with the following exceptions**: all the ribs of Pairs A, B and C (as well as their reinforcement angles) should be drilled with a **#30** bit. Label each rib so that it can be returned to its original position on the spar after disassembly. When finished, leave all the ribs attached to the spar with only two Clecos each.

Completed: Left [ ] Right [ ]

Step 52: Clamp the Spar/Rib Assembly to the Bench and Position the Skin

It will be easiest to work the lower flat surface of the flap first. Fabricate some blocks approximately 1-5/16" tall , the length is not critical. Clamp the spar/rib assembly **upside down** to the bench at one end. As shown in Figure 42, the nose ribs should hang over the edge of the bench. Move the second clamping angle to the other end of the spar, secure it to the bench and clamp that end of the assembly .

Double check with a level that there is not any twist on the frame. Also make sure the spars are aligned on either the inboard or outboard end and that the ribs are perpendicular to the spars.

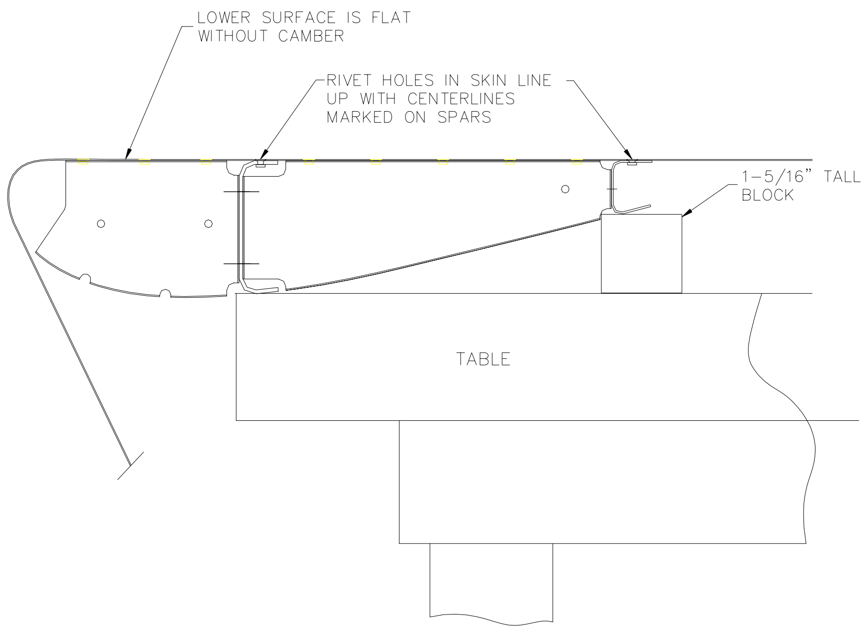

Figure 42: Clamping the Spar/Rib Assembly to the Bench

With the spar/rib assembly clamped upside-down to the bench top, open the **skin** [1] and slide it over the assembly. The flap-track and deployment arms will protrude through their respective slots in the skin. As shown in Figure 42, the upper surface of the skin will hang down toward the floor.

> **Note** You shouldn't have any trouble distinguishing the upper from the lower surface of the skin, because the skin will only fit over the deployment arms if it is right-side up relative to the spar/rib assembly. The upper surface has also been bump-formed.

Align the inboard and outboard edges of the skin on the ends of the spar. Then pull the skin back until the rivet line on the lower spar flange is centered under the pre-punched rivet holes in the skin. When the skin is positioned properly, clamp it to the spar flange at each end with a side-grip clamp, as shown in the figure. The aft spar center-line should also be visible through the skin holes. If you need to trim any skin around the deployment or guide arms in order to get the skin to fit do so now but be careful not to remove any more material than is necessary.

Completed: Left [ ] Right [ ]

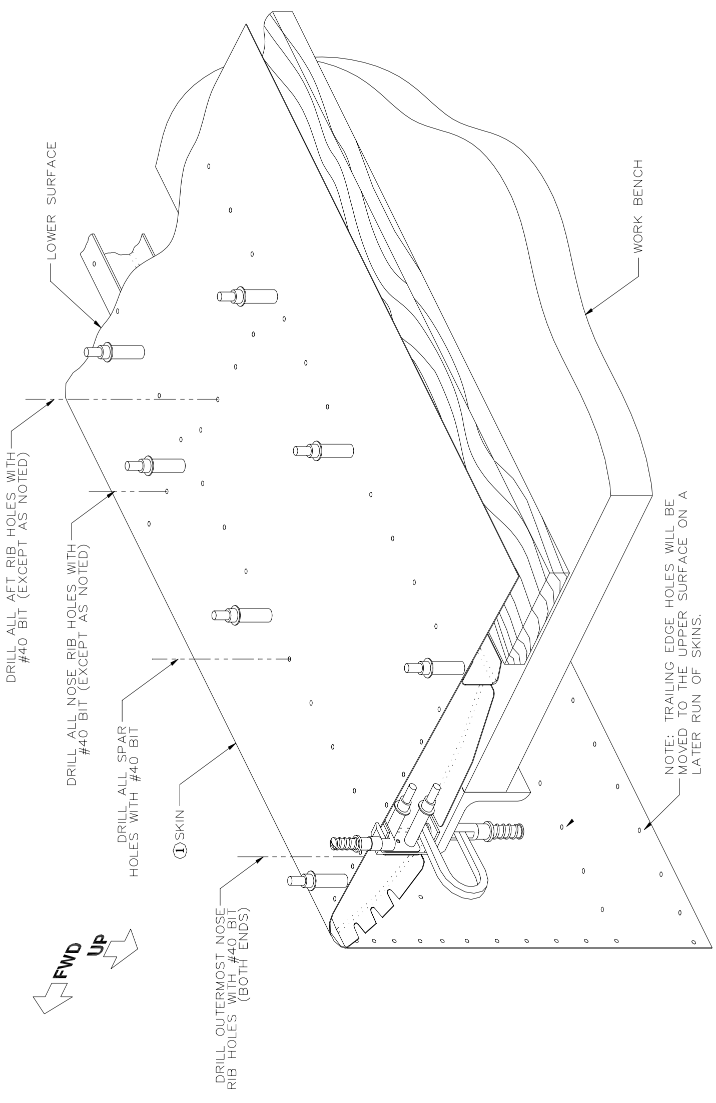

Figure 43: Positioning the skin

Step 53: Bolt Spacers Between the Flap-Track and Deployment Arms

Because the flaps ultimately will travel in their tracks on bolts between the flap-track guide arms, **it's very important to maintain the alignment of these arms while drilling and riveting the flap. All four arms should be in alignment.** The alignment of the deployment arms is slightly less critical, but it's still worthwhile to take some care in keeping them properly positioned.

The way to maintain the alignment is to bolt temporary spacers between each pair of arms, as shown in Figure 44. The spacers can be made of any metal or hard wood or plastic. Their dimensions are not critical, except for their thicknesses; to hold the arms the proper distance apart, the flap-track guide arm spacers must be **5/8"** thick, and the deployment arm spacer must be **1/2"** thick.

Drill **#10** holes through each of the spacers and bolt them in place between the arms with an AN3 or equivalent bolt of the proper length, a washer and a nut. Hardware-store quality fasteners are fine for this application.

Hint For the spacers to do their job, it's very important that the holes through them be drilled **perpendicular** to the surface. Use a drill press for this if you have one.

Note You may find that interference between the skin and the arms results when you try to insert the spacers between the arms. If so, use a fine-toothed file to enlarge the skin slots as necessary to get a clean fit. However, be sure to leave smoothly radiused corners. The flap track travels back and nearly contacts the spar. You can assemble the track in the guide arms with rollers bearings and spacers and move it back and forth to inspect for any potential interference between rivet heads, skins and the track.

Completed: Left [ ] Right [ ]

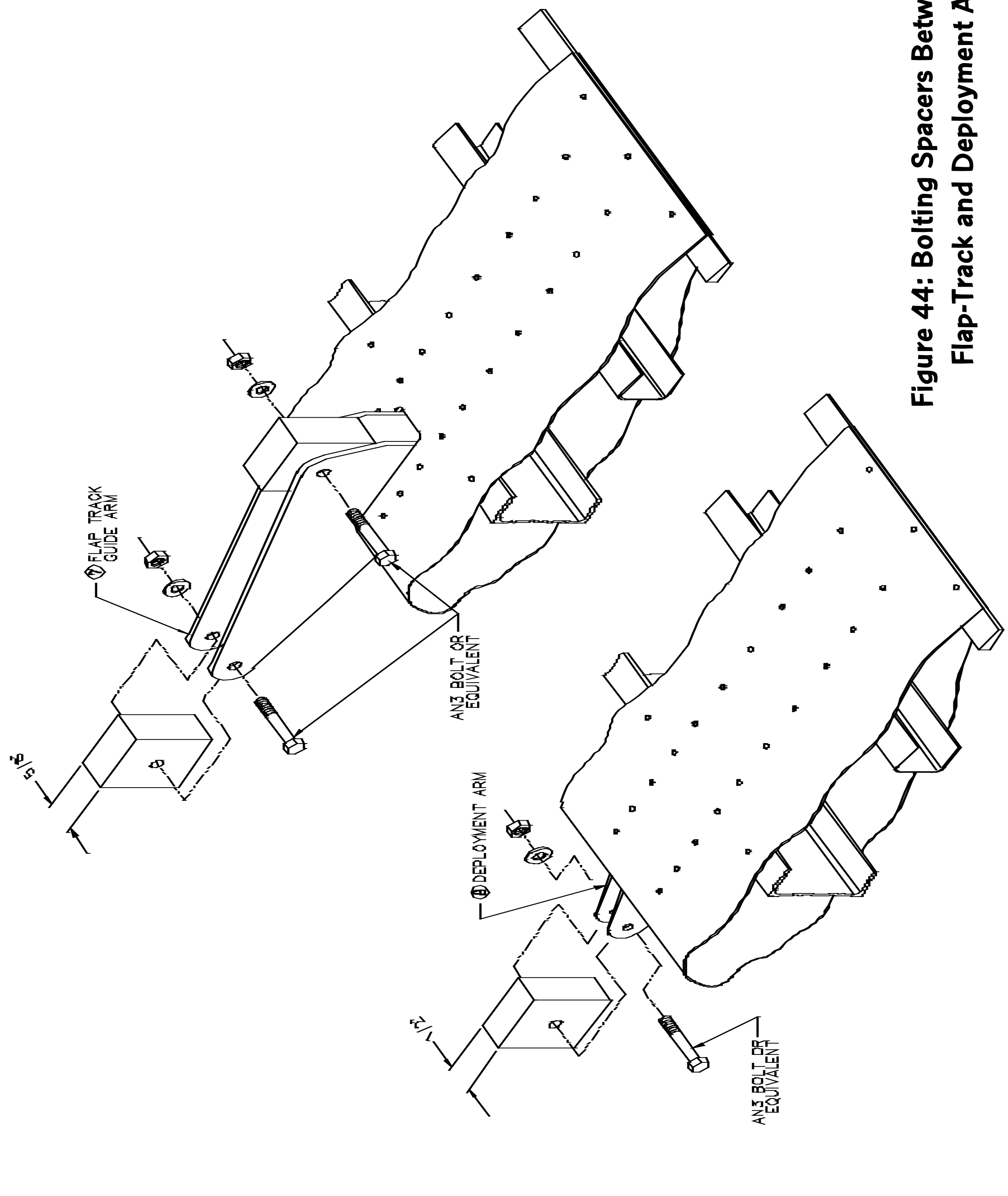

Figure 44: Bolting Spacers Between the Flap-Track and Deployment Arms

Step 54: Drill the Lower Surface of the Skin

With the skin clamped in place on the spar/rib assembly and the flap-track and deployment arms properly spaced, drill as follows:

A) Drill several **#40** holes along the forward spar flange, checking before drilling each time that the marked rivet line is centered under the pre-punched pilot holes. If the spar is bowed at all, you may need to reach under the assembly or push on the rear spar and adjust it manually to bring it back into alignment with the row of pre-punched skin holes. Check the aft spar for alignment as you go as well. Cleco each of these holes after it is drilled. Then remove the side-grips at the ends of the spar and drill (**#40**) and Cleco all the remaining holes along the lower spar flange.

B) Bring the aft ribs and rear spar into alignment by centering the lines you marked on their flanges under the pre-punched skin holes. Lift the trailing edge of the skin slightly to reach underneath to move the ribs left or right as necessary. When the rivet lines are centered, start drilling at the forward spar and move aft to the rear spar, Clecoing every hole as you go. Use a **#40** bit for all the holes.

C) Align the nose ribs and drill all those holes with a **#40** bit Again, start at the spar and work forward, Clecoing every hole.

Figure 43 illustrates these drilling instructions.

Completed: Left [ ] Right [ ]

Step 55: Position and Drill the Upper Surface of the Skin

Unclamp the spar/rib assembly from the bench and set it right-side up on a pair of 10'-long 2 X 4 supports, as shown in Figure 45. These strips help prevent the introduction of twist into the flap while drilling the upper surface of the skin.

Hint You may want to tack-glue or screw the support strips to your bench top so they don't tip over when you put pressure on the flap during drilling.

Pull the upper surface of the skin back against the ribs, and use side-grips or rubber-padded spring clamps along the trailing edge to clamp the upper surface to the lower along the entire length of the flap. Also, use a pair of side-grips to clamp the skin at each end of the spar. Ideally, the spar and rib rivet lines will be centered under the pre-punched skin holes, and the upper and lower trailing edge joggles will be aligned flushly with one another. **More important**, however, is **(A)** that you **retain adequate edge margin** between the spar holes and the forward and aft edges of the upper spar flange, and **(B)** that **the skin be kept tight against the ribs and spar**. This may require you to tolerate some misalignment at the trailing edge for now; if necessary, the trailing edge can be trued with a body file after riveting.

Hint We strongly recommended a helper or two for folding the upper surface of the skin back against the spar/rib assembly. Because the flap is so long, it's very difficult for a single pair of hands to accomplish this task without kinking the skin. Initially, it may seem that the skin simply isn't going to fit, but be patient; once you Cleco a few spar holes, it will fall into place.

Note When the skin is pulled back tightly against the spar/rib assembly, the forward ends of the nose ribs may dimple the skin slightly, interrupting the curvature of the flap airfoil. This is mostly a cosmetic problem, although it also does introduce a high-stress point into the skin. For both these reasons, you should eliminate such dimpling either by pulling the skin back less tightly (if doing so will not violate the conditions in A and B above) or by **very slightly** rounding the forward ends of the nose rib flanges where the dimple appears.

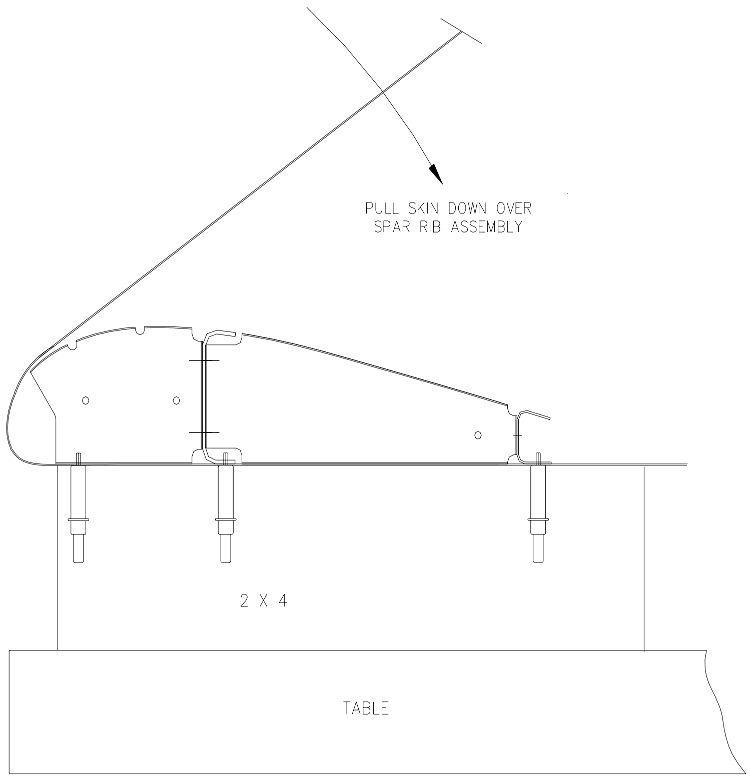

Figure 45: Pulling the Upper Skin Over the Assembly

When you are satisfied that the skin is flat against the rib and spar flanges, weight the flap with three or four sand or shot bags placed over ribs and spars near or at the 2 x 4 supports. These will hold the flap tightly against the support strips under the flap and, assuming these are flat, will remove any twist. Readjust the trailing edge clamps if necessary to true up the flap.
With the skin in final position, drill as follows (see Figure 46):

A) Drill (**#40**) and Cleco all the holes along the forward spar flange. Use the standard procedure of drilling and Clecoing first the two holes at each end, then several intervening holes, and finally the remaining holes.

Begin at the spar and move aft along the aft ribs to the aft spar with a **#40** bit. Both spars are drilled with a **#40.** Cleco as you go. The nose ribs need to be drilled with a **#30** for pull rivets. If you are bending the thin flanges on the nose rib with the #30, start first with a #40 and then pass drill later with a #30.

> **Note** As on the ailerons, some of the pre-punched skin holes along the spar may lie almost directly above a rib web, making bucking impractical. Check as you go and drill suspect holes up to **#30** size for later installation of blind rivets. Use a drill stop set at **3/16"** to avoid damaging the rib webs.

Completed: Left [ ] Right [ ]

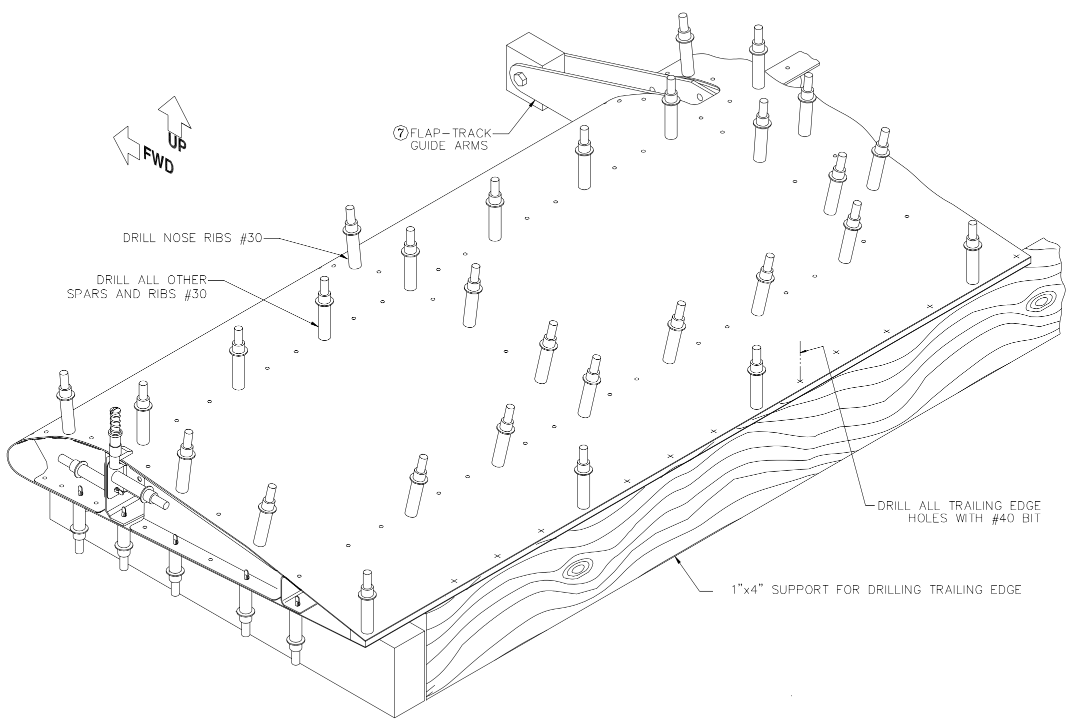

Figure 46: Drilling the Upper Skin

Step 56: Drill the Trailing Edge

Now that the flap assembly has two closed sections, it is fairly rigid against twist. However, it is important that you make sure the assembly remains flat and free of twist.

Add an additional 2x4 or 1x4 along the trailing edge. Make sure it is the same height as the others. Insert the trailing edge shim between the two skins until the thin end lines up with the shortest edge of the skin. Because it is a wedge, it does not clamp well without sliding forward. You may want to use double back tape to assist you here.

Using the holes provided in the upper surface of the skin, drill normal to the upper surface through the shim and the other side. Double check your first hole and adjust the angle of the drill or the position of the shim. **(NOTE: Early run skins had the predrilled holes in the lower surface. The assembly will have to be laid upside down and drilled, but the exit hole through the upper surface should still be perpendicular to the upper surface so the head of the rivet can sit flat.)**

Completed: Left [ ] Right [ ]

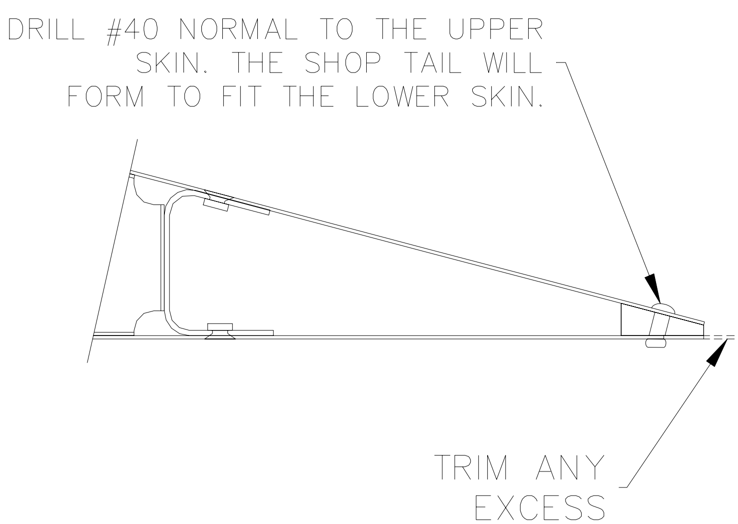

Figure 47: Drilling the Trailing Edge

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Step 57: Deburr and Corrosion-Proof the flap

Thoroughly deburr, clean, prep and prime the flap components as you deem necessary. At a minimum you should give the skins, ribs, spars and other parts a thorough cleaning and alodine treatment.

> **Note** If you chose to flush rivet the flap assemblies, the forward spar can be countersunk. But the thinner aft spar must be dimpled. Be careful, as dimpling a small thin spar may tend to stretch or shrink the flanges and distort the spar rather significantly. The trailing edge shim or wedge may be countersunk on both the upper and lower surface. The shop tails will fill in the dimpled skin fairly well. Also, go ahead and drill 1/4 "

MAIN STRUCTURE RIVETING

Step 58: Rivet the Ribs to the Forward Spar

Rivet all the nose and aft ribs to the forward spar with universal-head rivets. Use 1/8" AN470AD4s on all the ribs of Pairs A, B and C; on all other ribs, use 3/32" AN470AD3s. As shown in Figure 48, the manufactured heads should be aft. The aft spar will just remain clecoed at this time.

> **Note** Be aware that you will need to use longer rivets on those nose ribs that have reinforcement angles riveted to them.

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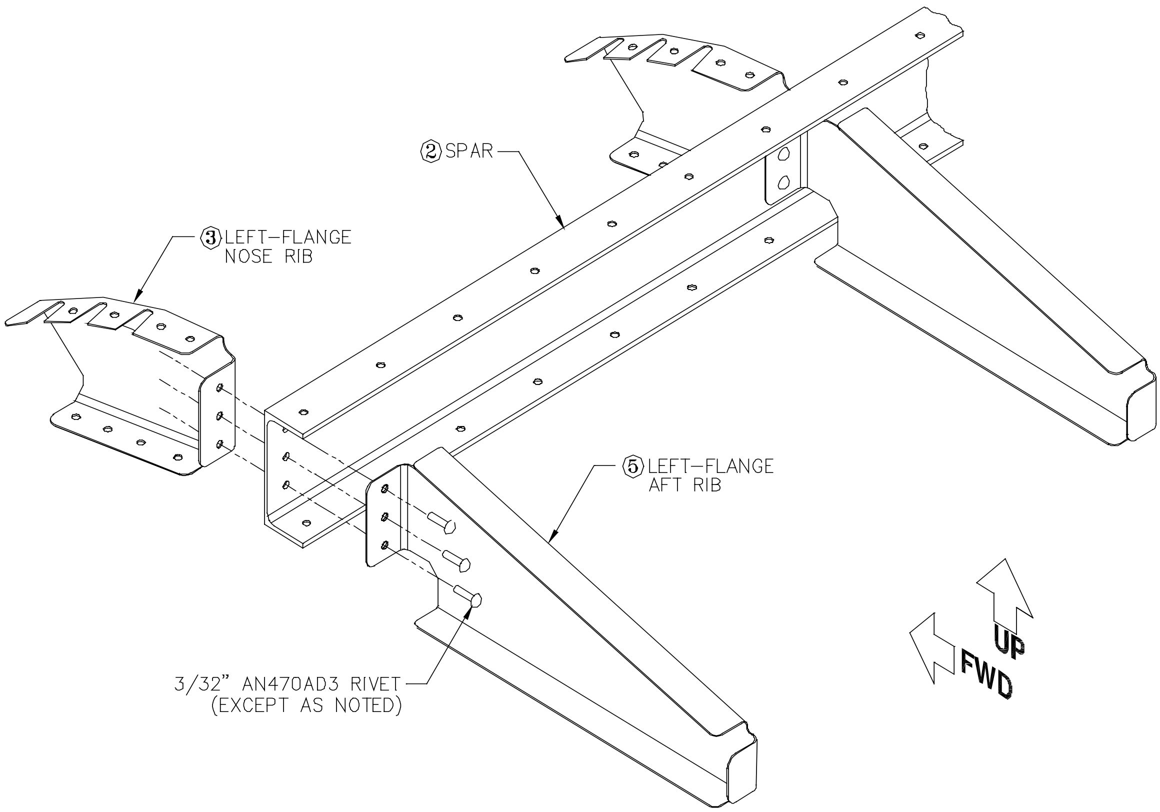

Figure 48: Riveting the Ribs to the Spar

Step 59: Rivet the Lower Skin to the Nose Ribs and Spar Assembly

Now comes the real importance of keeping the assembly supported flat and free of twist. Using your table and supports from before, with the lower surface up, begin at the spar and rivet forward along each nose rib's lower flange to the leading edge accessing the rivets between the skin and the table. As shown in Figure 49, use AN470AD3 universal-head rivets for all the lower skin. Then work your way aft to the rear spar, but do not rivet the rear spar at this time.

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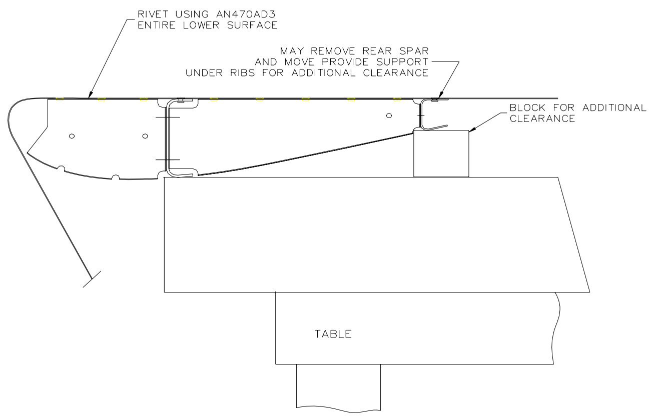

Figure 49: Riveting the Lower Surface of the Skin

Completed: Left [ ] Right [ ]

Step 60: Rivet the Skin to the Upper Flanges of the Nose Ribs

Flip the flap assembly over so it is supported flat and free of twist on the lower surface. Beginning at the spar and moving forward, use 1/8" AAPQ-42 blind rivets to rivet the skin to the upper flanges of all the nose ribs, **with the following exceptions**: first, since the outermost nose ribs at both ends are accessible for bucking or squeezing, use 3/32" AN470AD3 universal-head rivets in these locations.

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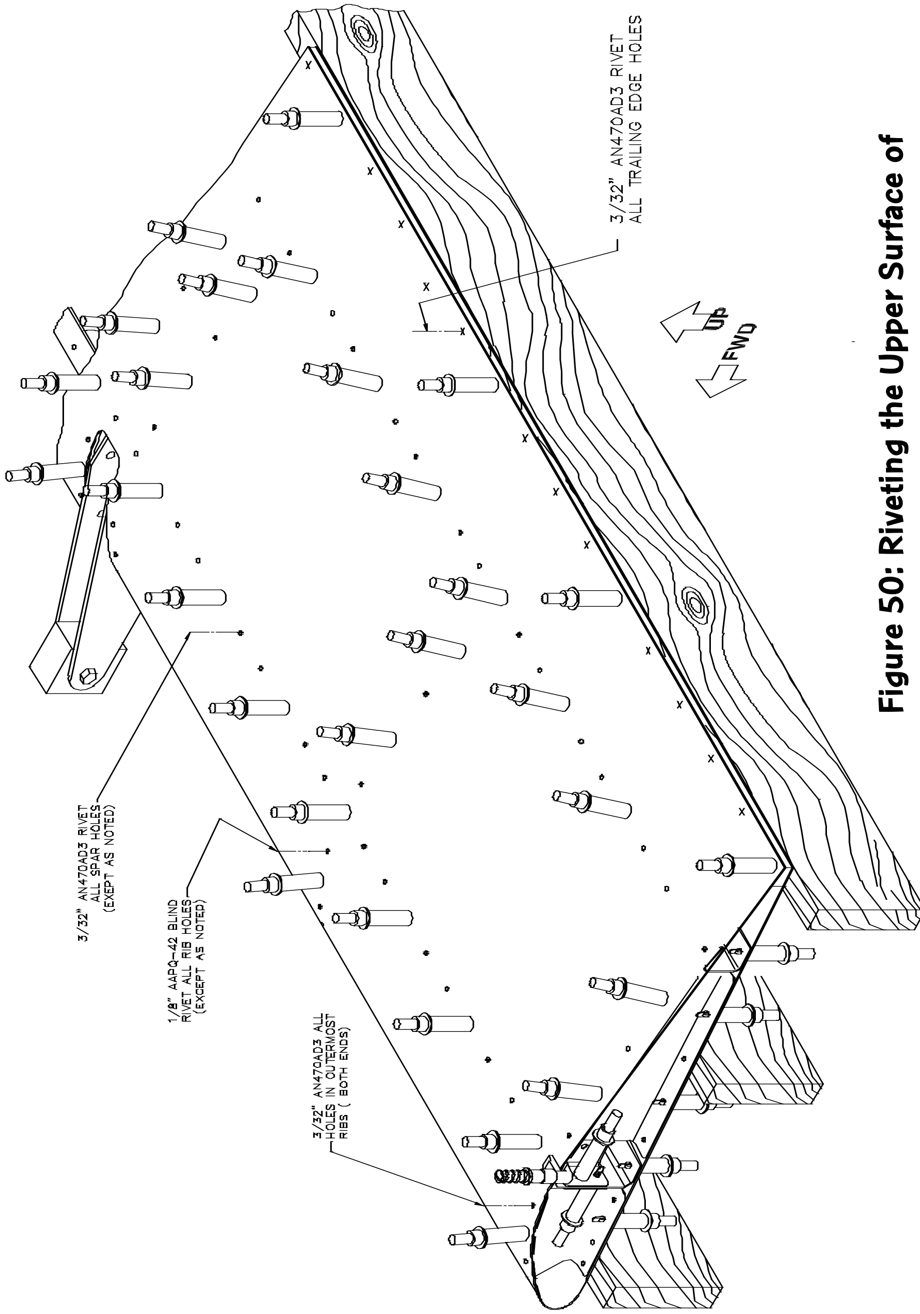


Figure 50: Riveting the Upper Surface of the Skin to the Spar/Rib Assembly

Step 61: Rivet the Skin and the Upper Flanges of the Forward Spar and Aft Ribs

Rivet the skin to the upper flanges of the forward spar and aft ribs by working your way aft. Carefully lift the skin for access as needed. As shown in Figure 50, use AN470AD3 universal-head rivets for the rest of your riveting sequence.

Completed: Left [ ] Right [ ]

Step 62: Rivet the Aft Spar to the Aft Ribs and Skin

Using AAPQ-42 blind rivets, rivet the aft spar to the main ribs. Then using AN470AD3 universal-head rivets, rivet the upper and lower spar flanges to the skin.

Completed: Left [ ] Right [ ]

Step 63: Rivet the Trailing Edge

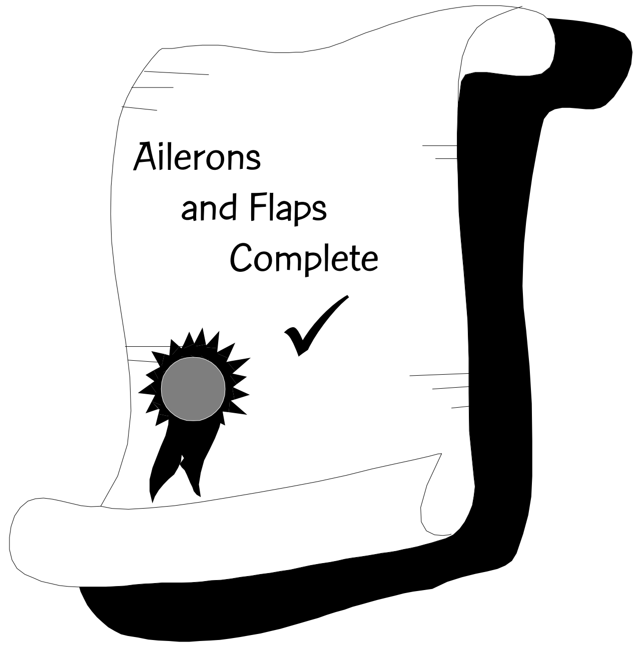
Using 3/32" AN470AD3 universal-head rivets, rivet the upper and lower trailing edge together. Remember to keep the rivet head normal to the upper surface and let the shop tail form to the lower skin. Over driving these will tend to pucker the skin, as the thin material will be prone to buckling between rivets that are too tight.

Completed: Left [ ] Right [ ]

It starts to get *very* tight when getting a bucking bar into position on these rivets. It can be done with caution and care. If you feel that it is beyond your abilities, then the entire surface can be drilled up at this time and AAPQ-42 blind rivets can be used instead.

CONGRATULATIONS!

You've completed the aileron and flap assemblies. On to the fuselage, where your project will very quickly begin to look like an airplane!!



SECTION VIII: FUSELAGE ASSEMBLY

PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Lower rudder hinge	1	101-00010-01
2	Vertical fin spar	1	101-00011-03
3	Upper rudder hinge	1	101-00013-01
4	Lower elevator bellcrank bracket	1	101-00014-01
5	Upper elevator bellcrank bracket	1	101-00014-02
6	Left fuselage shell	1	101-01051-01
7	Right fuselage shell	1	101-01051-02
8	Tailcone	1	101-01055-01
9	Wing pivot	2	101-02500-01
9.1	Forward spar attach pin	2	101-03000-01
10	Cage	1	101-05000-03
11	Left fuselage strut	1	101-07000-03
12	Right fuselage strut	1	101-07000-04
13	Horizontal stabilizer forward attach bracket [from Sec. IV]	1	300-01000-01
14	Lower elevator bellcrank half	1	602-05001-01
15	Upper elevator bellcrank half	1	602-05001-02
15.1	UHMW Polyethylene, 1/8" X 2" X 2"	1	620-0420-001
16	DBM cloth, 3" width	60 ft.	027-00002-01
17	Foam sheet, 20-lb., 3/16" X 24" X 24"	1	027-20316-01
18	Bulkhead A template	1	040-00201-01
19	Bulkheads B & C template sheet	1	040-00202-01
20	Bulkheads D & E template sheet	1	040-00203-01
22	Inter-bulkhead shearweb template	1	040-00205-01
23	Vertical Fin, RH	1	101-01056-01
24	Top deck	1	101-01052-01
25	Aluminum sheet, .050" X 12" X 12"	1	075-01050-01
25.1	Aluminum sheet, .125" X 3" X 10"	1	075-01253-01
26	Nylon washer, .032"	60	085-00003-01
27	Nylon washer, .064"	80	085-00004-01

28	Aluminum angle, .125" X 1" X 1-1/2"	84 in.	100-0640-009
30	Aluminum angle, .063" X 1" X 1"	1.5 ft.	100-0640-003
31	Bellcrank bearing	1	170-0134-001
32	MEKP catalyst	8 oz.	270-0105-001
33	Bi-directional cloth, 50" width	18 ft.	270-0110-002
34	Foam sheet, 5-lb., 1/4" X 24" X 30"	1	270-0123-108
35	Mill fiber	250g	270-0130-001
36	Cobalt promoter	4 oz.	270-0135-001
37	DMA accelerator	4 oz.	270-0135-002
38	Q-cell	100g	270-0140-001
39	Vinyl ester resin	2 gal.	270-0155-001
40	Aluminum sheet, .063" X 12" X 12"	2	075-01011-01
40.1	Aluminum blind rivet, 1/8"	4	700-0045-001
41	Bolt	4	AN3-4A
41.1	Bolt	8	AN3-6A
42	Bolt	8	AN3-7A
43	Castle nut	3	AN310-4
44	Castle nut	2	AN310-7
45	Jam nut	2	AN316-4R
46	Nylon self-locking nut	120	AN364-1032A
47	Nylon self-locking nut	11	AN364-428A
48	Nylon self-locking nut	3	AN364-524A
49	Nylon self-locking nut	4	AN365-1032A
51	Cotter pin	3	AN380-2-2
52	Cotter pin	2	AN380-3-3
54	Drilled-shank bolt	2	AN4-10
55	Bolt	8	AN4-11A
56	Drilled-shank bolt	1	AN4-25
57	Bolt	2	AN4-5A
58	Bolt	3	AN4-6A
61	Bolt	4	AN5-6A
62	Flush-head machine screw	40	AN507-10R16
63	Flush-head machine screw	10	AN507-10R20
64	Flush-head machine screw	10	AN509-10R10
65	Flush-head machine screw	30	AN509-10R11

66	Flush-head machine screw	5	AN509-10R12
67	Flush-head machine screw	5	AN509-10R13
68	Flush-head machine screw	40	AN509-10R14
68.1	Drilled-shank bolt	2	AN8-15
69	Drilled-shank bolt	2	AN7-44
70	Washer	60	AN960-10
71	Thin washer	70	AN960-10L
72	(Reserved)		
73	(Reserved)		
74	Washer	2	AN960-516
75	Washer	4	AN960-716
76	Aluminum washer	66	AN960D10
78	Aluminum washer	15	AN960D416
79	Thin aluminum washer	9	AN960D416L
80	Aluminum washer	4	AN960D516
81	Large washer	16	AN970-3
82	Large washer	8	AN970-4
83	Floating nutplate	4	F5000-4
84	Nutplate	2	K1000-4
84.1	Nutplate	15	MF5000-3
85.1	Aluminum spacer	1	NAS43DD4-32
85.2	Aluminum spacer	1	NAS43DD4-50
87	Flanged steel bushing	2	NAS77-7-019
88	Flanged steel bushing	2	NAS77-7-025
89	Flanged bronze bushing	1	NAS77A4-025
90	Flanged bronze bushing	2	NAS77A5-062

Parts List for Taildragger Landing Gear

Note The following item is unique to the taildragger landing gear installation.

Key No.:	Part Name:	Qty:	Part No.:
91	Flanged steel bushing	2	NAS77-3-014

Hint Your cage is stamped with a serial number and all your fiberglass parts are stamped with part numbers. These numbers are also recorded on your shipping invoice. The Serial Number identifies your part uniquely based on its place in our production run. We recommend that you either save your shipping invoice or record Serial Numbers elsewhere, such as in your permanent airframe log. If, in the future, we ever issue an advisory publication that applies only to the parts of a particular run, this information will help you determine whether your Sportsman is affected.

Suggested Tool List

1. Fine-point marking pen
2. Sanding block (at least 12" long)
3. Respirator or dust mask (highly recommended for use while sanding or grinding fiberglass)
4. Electric or pneumatic drill motor, with #40, #30, #10, letter “F”, 3/16", 1/4", 5/16", 3/8", 13/32" and 1/2" bits
5. Assorted flat and round files
6. Single-ended hacksaw
7. Die grinder with rotary files, 3” disc sander and drums (recommended)
8. Heavy-duty scissors and/or rotary cloth cutter
9. Safety goggles (highly recommended for use while catalyzing resin and grinding fiberglass laminates)
10. Bench grinder with non-metallic abrasive wheel (recommended)
11. Rule, 12", graduated in 1/32nds of an inch
12. Bandsaw (highly recommended) or hacksaw (acceptable)
13. Belt sander (recommended)
14. Center punch
15. Hammer
16. Large C-clamps or adjustable squeeze clamps
17. Assorted Cleco side-grip clamps (with pliers), rubber-padded spring clamps and/or small C-clamps, approximately 5
18. Bench vise
19. Shop vacuum
20. Digital level (highly recommended) or spirit level (acceptable)
21. Microstop countersink cage with #40, #30 and #10 piloted cutters (carbide-tipped #30 cutter recommended for fiberglass work)
22. 1/4 and 3/8” drive ratchet and socket sets with assorted sizes, 3/8"—3/4"
23. Plumb bob
24. 90° drill motor or adapter
25. .4375" straight reamer
26. Hole deburring tool
27. Assorted box or open-end wrenches, 3/8"—3/4"
28. Carpenter's level (6'-long recommended)
29. Utility knife

30. Saber saw with carbide grit blade for cutting fiberglass (recommended)
31. Hot-melt glue gun (recommended)
32. Small electric fan (6-8") with clamp mount (recommended)
33. Decimal rule, graduated in tenths of an inch
34. Clecos, 3/32" (4) and 1/8" (approximately 40), with pliers
35. Rivet squeezer (recommended) or rivet gun, air compressor and bucking bars (acceptable) with flush-head rivet sets
36. Small needle-nose pliers, forceps or pick-up tool
37. Protractor
38. Bevel gauge (recommended)
39. Hole saw, 3-5/8", 1-3/8 diameter
40. Try square or combination square
41. Small inspection mirror (recommended)
42. Scroll saw (recommended)

Additional Materials

1. One 8-foot 2 X 6
2. Four 8-foot 2 X 4s
3. Two 1 X 4s, approximately 4-1/2' long
4. Two 1 X 4s, approximately 2-1/2' long
5. Scrap plywood, approximately 2 square feet
6. Sheetrock screws, approximately 75
7. Two rubber-padded bicycle hanging hooks
8. Sandpaper, various grits 80—400
9. Several sand or shot bags
10. Unwaxed resin mixing cups
11. Resin mixing sticks
12. Latex surgical gloves
13. 2" varnish-type paint brushes (one attached to the end of a 2'—3' dowel or length of tubing)
14. Acetone
15. Coarse Scotch Brite pads
16. Prep Sol or lacquer thinner
17. Corrosion-proofing materials. Acid etch primer best used on bare metal parts. Marhyde brand available in some auto paint stores.

18. Loctite Low Viscosity or Medium Viscosity Bearing Retaining Compound or equivalent
19. Duct tape or wide masking tape
20. Padded sawhorse or stool, approximately 36" tall (depending on the height of your hanging framework; see below)
21. Assorted foam or cloth padding material
22. Non-styrene based plastic sheeting (Visqueen, polyethylene or equivalent)
23. Step ladder
24. Hardware-store quality 1" X 1" aluminum angle stock, 6—8' long, (used in various clamping and laminating procedures but **not** to be mistaken for the aircraft-grade angle stock supplied with the kit **nor** to be used in any structural application. We recommend marking this stock with a red marker to distinguish it from the good stuff!)
25. Thumbtacks or push pins
26. Spray adhesive or rubber cement
27. Hot-melt glue sticks
28. Mold-release wax (NGA P/N 270-0205-001) or equivalent
29. Two wooden shims, approximately 1/8" X 1" X 4", or equivalent (Four tongue depressors or popsicle sticks stacked in pairs will work fine.)
30. Four yardsticks or equivalent wooden slats
31. Assorted scrap wood blocks
32. Piece of stiff cardboard, 12" X 12"
33. Piece of sheet metal, Formica, Masonite or other hard, smooth material, 30" X 30"
34. Piece of 3/16"—1/2" plywood (any grade), chipboard, particle board or paneling, etc., 30" X 30"
35. A three to four foot tall sawhorse with padding covering the cross beam

WORKSPACE

The fuselage from the firewall to the tailcone is approximately 20' long and 4' wide.

For wrapping the fuselage around the cage, it's useful to suspend the steel-tube **cage** [10] from an overhead framework such as the one illustrated in Figure 1. The hooks shown in the figure are the rubber-padded, screw-in type used to hang bicycles. They are widely available at hardware stores and cycling shops.

All the dimensions shown can be altered to suit the individual builder with the exception of the distance between the two hooks—this should remain approximately **32"** as shown. The other dimensions given in the figure keep the bottom of the fuselage about 3' off the ground. This working height is a compromise: it keeps much of the work in the fuselage (both in this section of the assembly process and in "SECTION IX: SYSTEMS INSTALLATION") at a comfortable working height, and it allows relatively easy access to the bottom of the fuselage, where you will have to drill and countersink a number of holes. However, it also raises the top of the vertical fin to slightly higher than 9' above the floor (almost 10' when the rudder is hung). This not only exceeds some builders' available ceiling height, but also means that a lot of the work in the aft fuselage must be done at about shoulder height, which some may find quite inconvenient. The bottom line is that you must make your own best compromise, taking account of your workspace and your work habits.

Once the fuselage halves have been wrapped around the cage it is a good idea to lower the cage/fuselage assembly onto two sets of blocks where the strut attachments protrude from the shell. These blocks may be any height to accommodate work, but experience has shown that a height of about 2 1/2 feet is appropriate. The tail can then be supported by sawhorse. The sawhorse should have some kind of soft covering to protect the fiberglass from damage. An old piece of rug wrapped around the sawhorse cross-beam seems to work well.

A final workspace consideration has to do with ventilation. Although the fuselage is entirely pre-molded, you will still be doing a considerable amount of fiberglass work on this assembly. No extraordinary measures need to be taken on account of this work, but use simple common sense: open doors or windows when working with resin, don't ventilate your shop into your living space, and use a fan if natural cross-ventilation is inadequate.

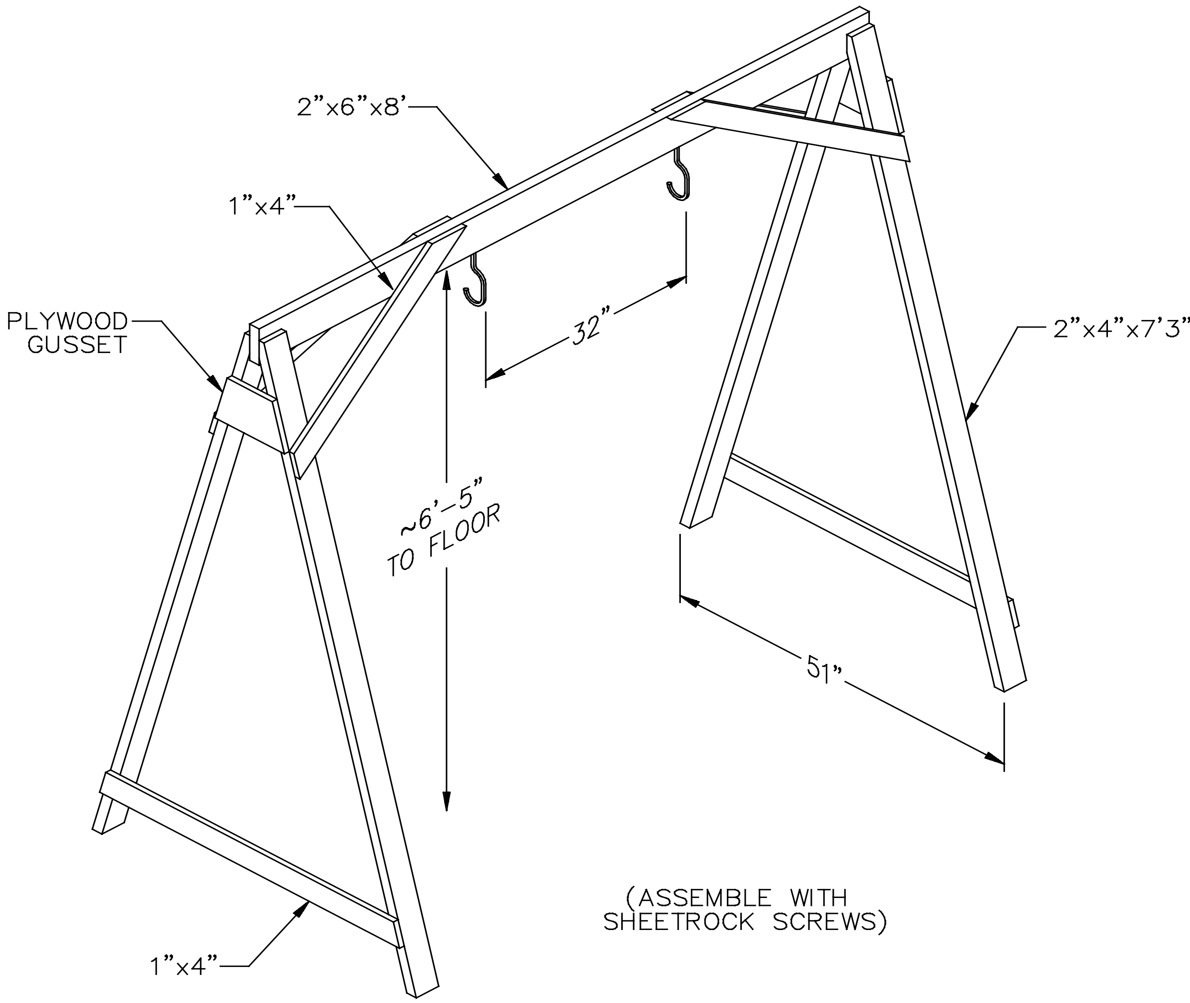


Figure 1: Suggested Design for the Fuselage Hanging Framework. May also be hung from an overhead beam in a shop.

Assembly Sequence

The fuselage assembly process consists of the following four main phases:

1) **Component Preparation**: surface finishing the fuselage shells, cage and other steel parts.
2) **Fitting Fabrication**: cutting and finishing the attach brackets that secure the shells to the cage.
3) **External Structure**: mounting the shells on the cage and joining them together.
4) **Internal Structure**: installing the aft fuselage bulkheads, vertical fin spar and rib, inter-bulkhead shearweb, tail surface attach points, baggage compartment bulkhead and fuselage struts.

Component Preparation

Note An inherent quality of the resins used in composite construction is their tendency to shrink during the curing process. There is no way to prevent this shrinkage. This fact may become evident to you in a couple different places when you closely examine your **left** and **right fuselage shells** [6 and 7]. First, you may be able to see or feel the weave of the fiberglass cloth through the exterior primer. This may be particularly apparent at seams where one layer of cloth overlaps another. Second, you may notice that the surface could be slightly sunken around the door and window cutouts in places.

Neither of these conditions is of any structural significance whatsoever, and most observers of your Sportsman will be hard-pressed even to notice them. However, if you find them aesthetically objectionable, they can be corrected with a little extra work. See the discussion of surface finishing in "SECTION II: TOOLS AND TECHNIQUES."

Step 1: Remove the Mold Lip from the Fuselage Shells

When fiberglass parts are trimmed at the factory before being removed from the molds, a small lip of excess resin often remains around the edges. This "mold lip" can be easily sanded off. As shown in Figure 2, use a long sanding block (12" minimum) to remove the lip from the upper and lower mating edges of the left and right fuselage shells. Hold the block **perpendicular** to the edge and sand just enough to remove the lip.

Note Do **not** sand the aft or the top edges of the vertical fin halves at this time. These will be sanded after the fuselage shells are joined.

Hint You can often **feel** the remaining mold lip more easily than you can see it, so check for adequate sanding with your fingers. To avoid over sanding, use a pen to mark the lip and then sand just until the ink line disappears. Use as long a sanding block as possible. Try using contact cement or spray adhesive to glue strips of sandpaper to a straight 12"'-long 2 X 4. While sanding, rest the shells on blankets or foam pads to protect the surface finish. Weight the shells with sand or shot bags to hold them steady.

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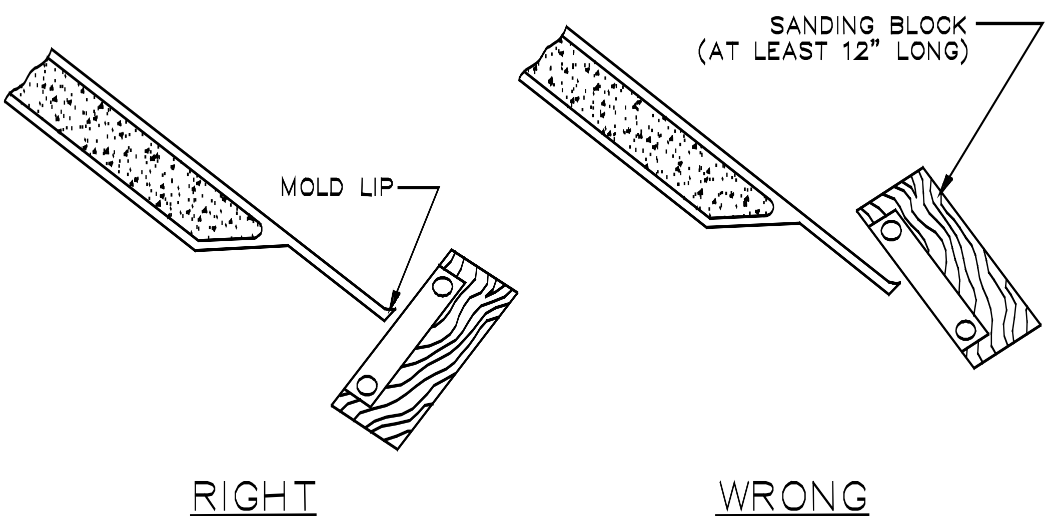

Figure 2: Removing the Mold Lip from the Fuselage Shells

Step 2: Sand the Window and Door Cutouts and Joggle Seams and Prepare the Shells

Use100-150 grit sandpaper on a 6" sanding block to smooth the trimmed edges of the window and door openings in the fuselage shells. Sand just enough to remove any roughness resulting from factory trimming without decreasing the width of the flanges any more than necessary. Sand until the edges are all even and smooth to the touch; this will make the parts more comfortable to handle and produce a cosmetic window edge.

Thoroughly sand the external surface of all right side joggle seams with about 36 grit sandpaper until all traces of shiny surface are gone. These include the belly seam, upper-aft seam, upper (short) firewall seam and the right side vertical fin seam. Then sand the inside surface of all corresponding joggle overlaps on the left side. Trim to a uniform 3/4 –7/8" width and the top deck bonding flanges with 36 grit as well.

Trim the vertical fin joggle to a width of 1-1/4". Verify that the cowl joggle and tail cone joggles are 7/8" wide. Windows flanges are 5/8" wide and door sill flanges are 1/2" wide. The top deck and hatch cover flanges are 7/8". Trim as necessary to obtain even flanges for all of these.

Run a line of tape along the foam bevel on the both upper and lower joggle seams. This will help you keep the Zolotone finish a little cleaner when the adhesive oozes out during the bonding step.

Completed: [ ]

Step 3: Make the Cutouts for the Wing Strut Lugs

As shown in Figure 3, the fuselage shells come from the factory with pre-molded dimples for the cutouts for both tricycle and taildragger main landing gear legs and the wing strut lugs. The wing strut lug dimple is the one above the tricycle gear cutout dimple. Hold a 1/2" diameter drill normal to the surface of the strut lug dimple and drill through. While the drill is turning and still in the shell, lift the drill

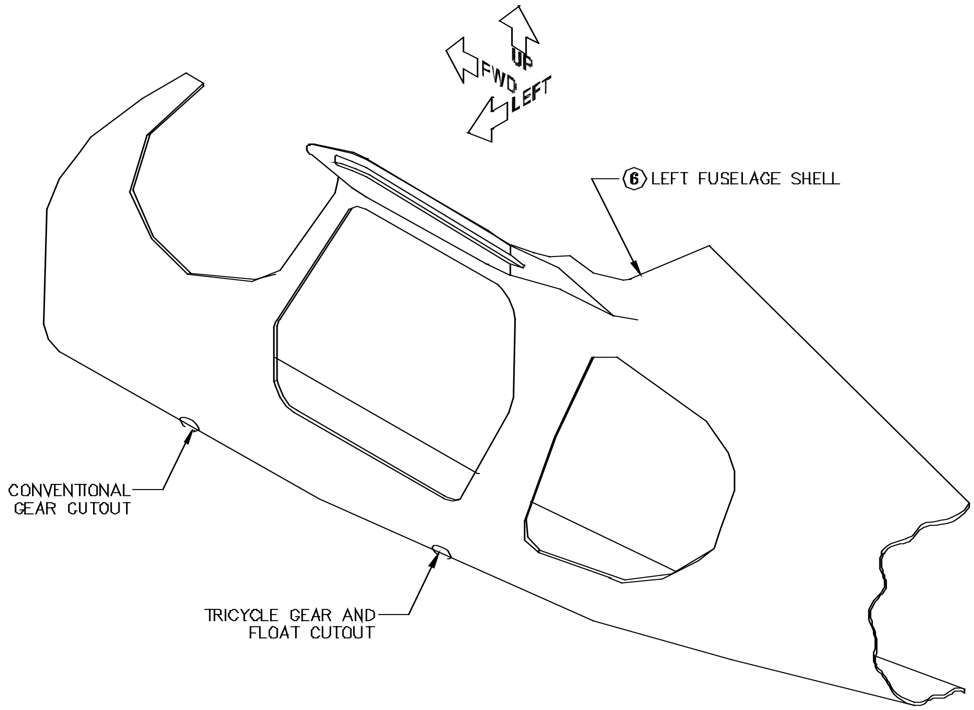

Figure 3: Landing Gear Leg Cutouts

so it is approximately parallel to waterline. Then enlarge the holes to a 1.38" diameter centered about this horizontal axis using a rotary file or sanding drum in your drill motor. You can even use a 1-3/8 hole saw in the same manner as described above.

Note If you are installing tricycle landing gear or floats, use the aft pair of gear leg cutouts; if you are installing conventional gear, use the forward pair. This is best done in a subsequent step. The gear cutouts should be done after the cage is installed in the shell.

Completed: [ ]

Step 4: Install the COM Antenna in the Vertical Fin (Optional)

Since fiberglass doesn't interfere with radio reception or transmission, the communications (COM) antenna can be mounted internally. This offers the advantages of reduced drag and easy installation. The forward part of the left shell vertical fin is an excellent location for this antenna. The COM antenna needs to be mounted as close to vertical as possible and as far away from the metal vertical spar a possible. If you wish to install your COM antenna there, it's best to do it now before you bond the fuselage shells together.

The optional Sportsman COM antenna available from Glasair Aviation, LLC (P/N 211-0112-501) consists of two 20-1/4" lengths of 1/2"-wide, adhesive-backed copper foil, a length of triaxial cable, several small ferrite toroids and a triaxial cable connector plug. Contact our Order Desk for pricing and availability.

Note Before affixing your antenna to the shell, wipe the area thoroughly with acetone to remove any dirt, oil or other contaminants.

Begin with the copper-foil element that is soldered to the **central** conductor of the triaxial cable. Position the upper end of this element about 12" below the top of the left fin and, peeling off the backing paper as you go, run the element down the fin approximately as shown in Figure 4. Bulkhead B is located (in Step 39) and is 43" forward of the tailcone joggle.

Caution Be certain that the element attached to the **central** conductor of the triax is positioned on **top**. Also, be sure that the element is fastened to the full-thickness, foam-core portion of the fin so it won't interfere with the seam laminates you'll apply later.

Continue down the fin leading edge with the second copper-foil element. However, make sure to leave a gap of approximately 1/4" between the soldered ends of the two elements.

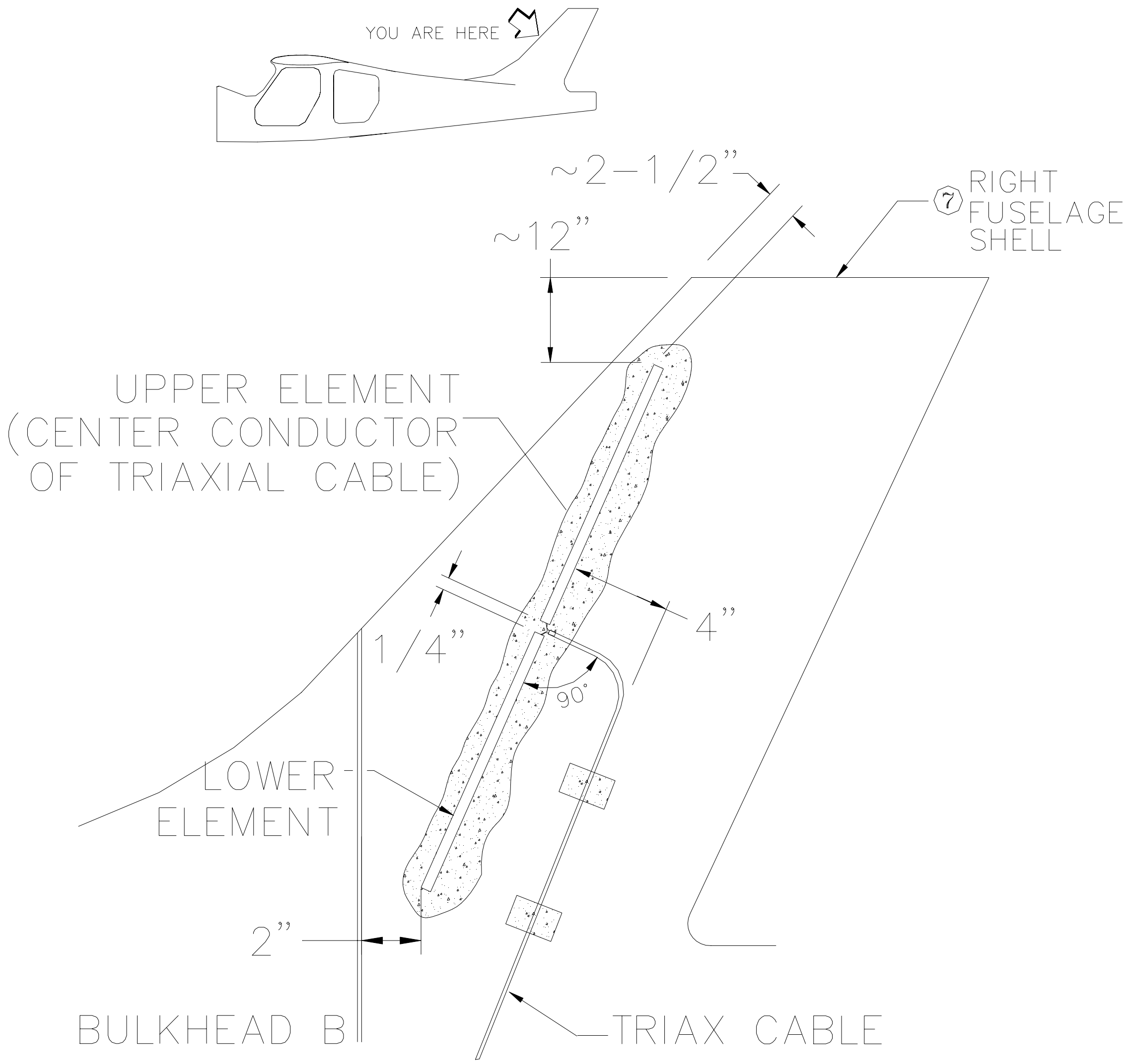

Figure 4: Installing the COM antenna

Secure the antenna, including the central connection, to the inside of the vertical fin with a one-layer laminate of bi-directional cloth, as shown in the figure. First take a small portion of the mixed resin and make a thick Q-cell paste to pack around the toroid bead at the end of the yellow cable. Then apply the one layer laminate so it will smoothly cover the antenna and central cable bead portion. The cable is secured away from the antenna elements with small, single-laminate tack strips of bi-directional cloth—one every six or eight inches. These can be applied immediately after the main laminate that secures the antenna elements; there's no need to wait for it to cure.

As shown in Figure 4, route the cable aft from the central connection at a **90°** angle for at least **4"** before making the turn downward and forward. Coil the extra cable at the bottom of the fin; it will be routed forward later.

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Step 5: Prep and Prime the Steel Parts

Most steel parts supplied in your Sportsman kit come powder coated or primed. You should prep and prime any unprotected parts that you have received.

Each steel part must be completely free of both surface rust and contaminants such as oil, dirt or dust before priming and painting. If your parts are free of surface rust, you can get by with a thorough scouring with coarse Scotch Brite and application of a degreaser such as Prep-Sol or lacquer thinner. A Scotch Brite wheel on a bench grinder is especially effective for cleaning the smaller steel parts.

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Note Acetone is **not** an appropriate solvent for removing grease from metal parts.

Surface rust requires stronger measures. Sandpaper, buffing wheels and compounds and wire brushing are all acceptable methods of attacking rust, but it is extremely difficult with any of these methods to prevent the accumulation of residual corrosion and steel particles in the tiny surface pits that will inevitably remain in the parts. For this reason, we recommend sand or bead blasting as the best method of removing surface corrosion. Blasting will remove all surface corrosion much more surely than hand methods, and it minimizes the amount of residue remaining on the part.

Whichever cleaning method you use, prime and paint the cleaned part as soon as possible after the cleaning, and in any event, keep the part dry before painting. We recommend the use of a self etching metal primer or an epoxy primer for maximum protection and durability.

Hint Traditionally, most steel aircraft structure has been painted black. We have found, however, that a lighter color is more desirable because it makes inspection of the structure for cracks much easier. The only exception to this concerns the V-brace in the windshield area. To minimize glare, this should be painted a darker color with a matte finish.

Hint FAA Advisory Circular 43-4A, *Corrosion Control for Aircraft*, is a good source for further information on this subject. See also the article "Rust Protection" by Tony Bingelis in the October 1995 issue of *Sport Aviation*, pp. 86-91.

Warning **Under no circumstances** should you drill holes anywhere in the fuselage cage tubing. Besides possibly weakening the structure directly, such holes could provide an avenue for moisture to enter, which could cause corrosion inside the tubing. If you need to attach anything to the tubing, use nylon cable ties or loop clamps.

Completed: [ ]

FITTING FABRICATION

Step 6: Cut the Angle Stock to Length for the Shell Attach Fittings

The fuselage shells are attached to the cage in part with sixteen aluminum fittings. These fittings must be fabricated from the **.125" X 1" X 1-1/2" aluminum angle stock** [28] provided.

Begin with the **27"** length of stock. Use a bandsaw or hacksaw to cut this length into two **6-1/8"** pieces and two **6"** pieces. Then, from the **57"** length of stock, cut twelve **4-1/2"** pieces.

Note The instructions in the previous paragraph assume that your aluminum angle stock [28] was shipped as one 27" length and one 57" length, the most common way for this stock to be shipped. If you were shipped different lengths of the stock, lay out all of the fittings onto it before making any cuts to make sure you don't end up short.

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At the time of publication, Glasair Aviation, LLC was working on a prefabricated parts option for the parts in steps 6-10 and many others. Contact the order desk for more details.

Step 7: Fabricate the Upper Shell Attach Fittings

Two upper shell attach fittings must be fabricated from the **6-1/8"** pieces of stock. Figure 4 shows the dimensions of these fittings. Cut the basic shape with a bandsaw or hacksaw, and use fine-toothed files and/or a belt sander to smooth the cut edges and radius the corners.

> **Note** The two fittings are **not** identical, but rather are **mirror images**. Figure 4 shows the **right-hand** fitting; be sure to transpose the dimensions in cutting and drilling the **left-hand** fitting.

After the basic shapes have been cut and finished, lay out the hole locations shown in Figure 5 and center punch each firmly.

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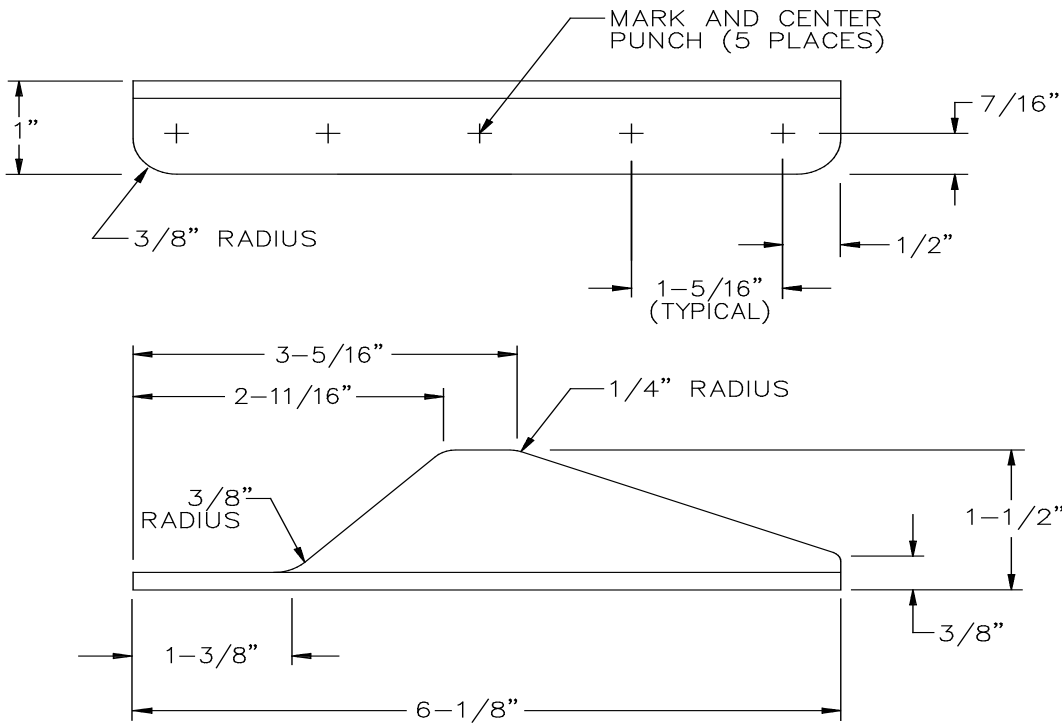

Figure 5: Upper Shell Attach Fittings

Step 8: Fabricate the Lower Shell Attach Fittings

Two lower shell attach fittings must be fabricated from the **6"** pieces of stock. Figure 6 shows the dimensions of these fittings. Cut the basic shape with a bandsaw or hacksaw, and use fine-toothed files and/or a belt sander to smooth the cut edges and radius the corners.

Note Unlike the upper fittings, the two lower fittings **are identical**.

After shaping and finishing, mark and center punch the five hole locations.

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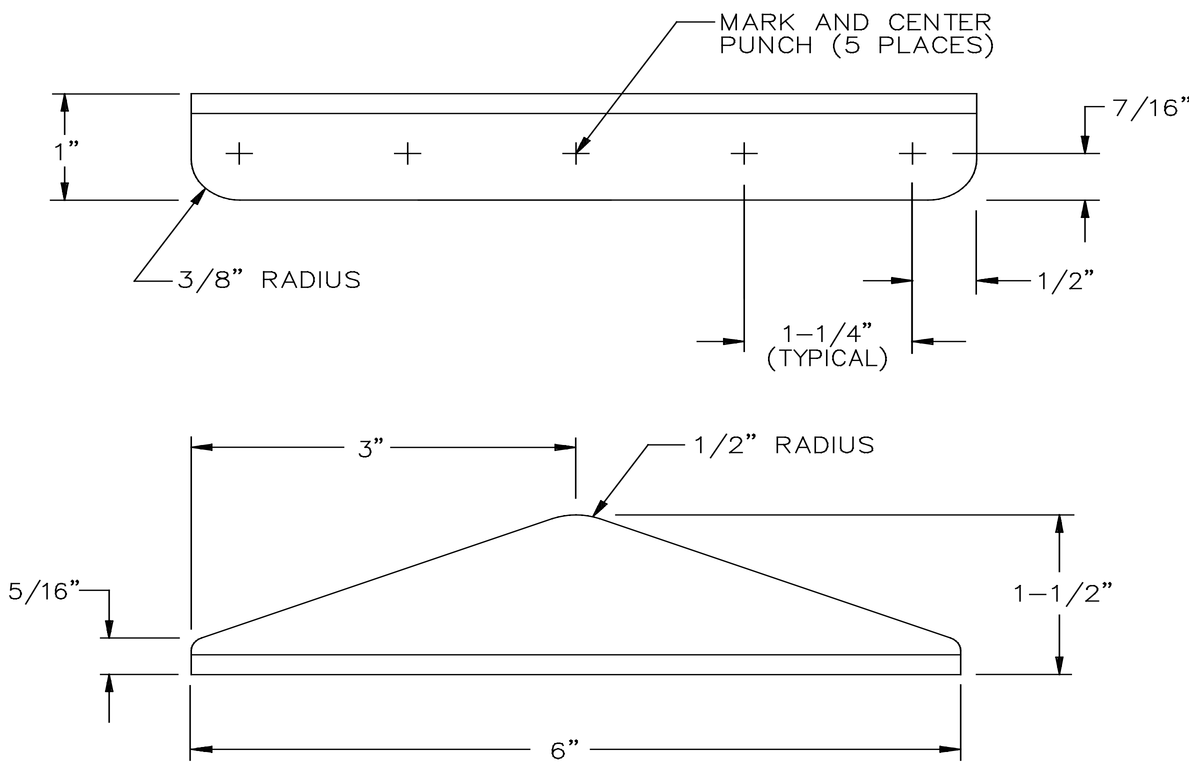

Figure 6: Lower Shell Attach Fittings

Step 9: Fabricate the Aft Shell Attach Fittings

Twelve aft shell attach fittings must be fabricated from the **4-1/2"** pieces of stock. Figure 7 shows the dimensions of these fittings. Cut the basic shape with a bandsaw or hacksaw, and use fine-toothed files and/or a belt sander to smooth the cut edges and radius the corners.

> **Note** These fittings come in left- and right-hand varieties. Be sure to make **six left-hand** and **six right-hand** fittings. Finally, prime all sixteen fittings with a self-etch primer and a color coat to match the gray powder coat on the cage. The matching paint is available from NGA in small spray cans, part number 027-00001-01.

After all twelve fittings have been cut to shape, mark the locations of the four holes and center punch each of them firmly.

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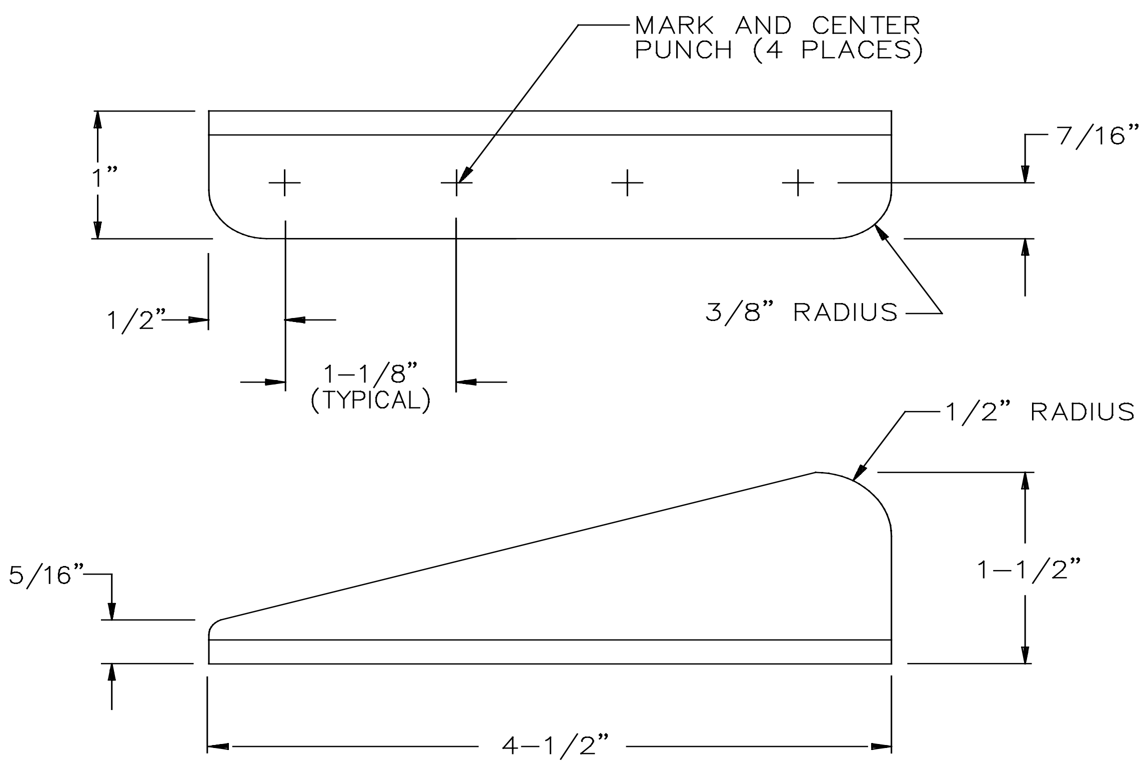

Figure 7: Aft Shell Attach Fittings

Step 10: Fabricate the Forward Shell Attach Fittings

Four fittings that serve as attach points between the forward end of the cage and the fuselage shells must be cut from the **.063" X 12" X 12" aluminum sheet** [40]. There are two types of these fittings—inboard and outboard. Figure 8 gives the dimensions for each. Cut the fittings out with a bandsaw, and file or belt sand the edges smooth. Drill the holes as indicated with a **#10** bit and deburr.

Note Use as little material as possible to make these fittings. You will use the remaining 6" X 12" piece to fabricate the rudder pedals in "SECTION IX: SYSTEMS INSTALLATION."

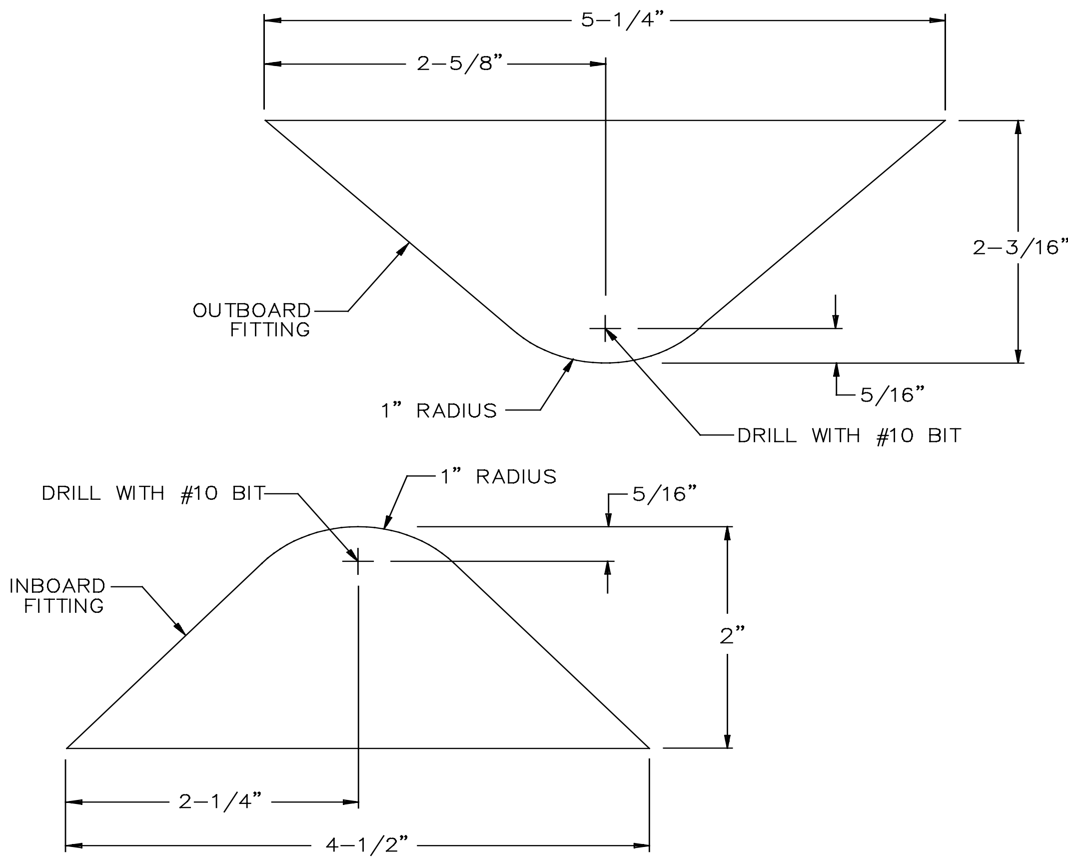

Figure 8: Forward Shell Attach Fittings

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External Structure

Step 11: Press Bushings into the Wing Pivot Lugs on the Cage

Flanged steel bushings must be installed in the wing pivot lugs on the cage. Press an NAS77-7-025 bushing [88] into the upper lug with the flange on top, as shown in Figure 9. The lower lug takes an NAS77-7-019 bushing [87] with the flange on the bottom. Because of the close quarters between the upper and lower lugs, you'll be unable to use a bench vise here; a large C-clamp is probably the best option. As in "Section VI: Wing Assembly," the use of Loctite or a similar bushing compound is recommended, both for a tighter press fit and for corrosion protection.

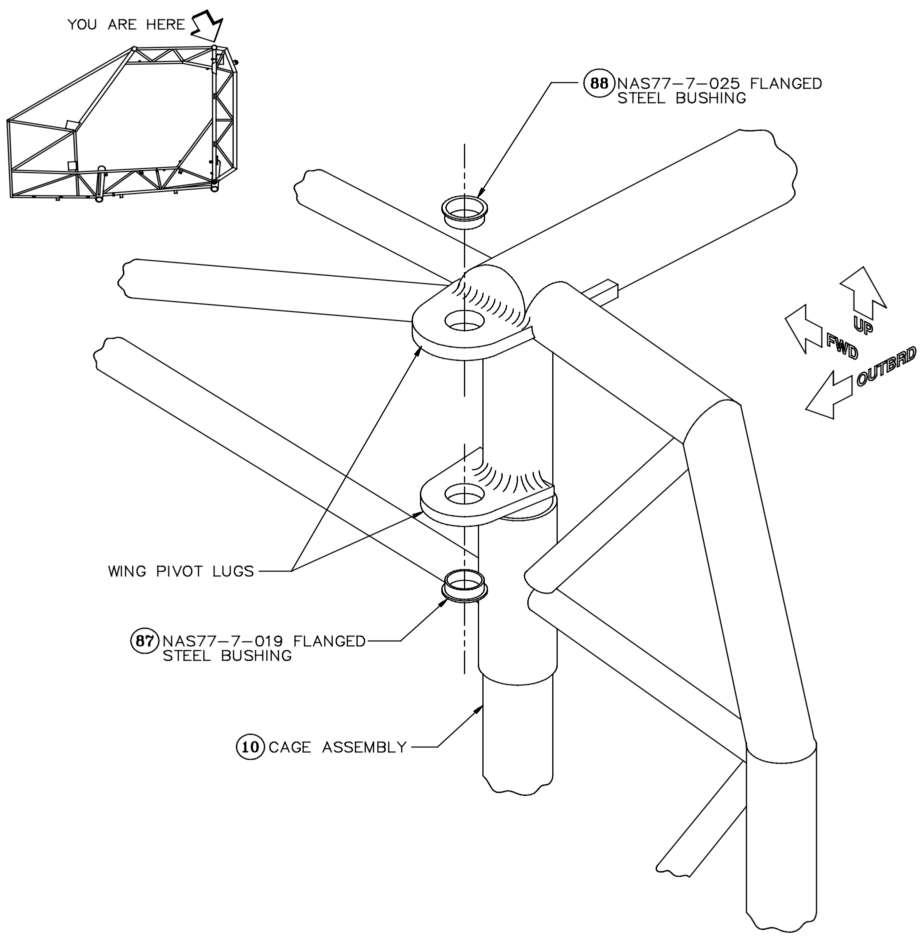

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Figure 9: Pressing Bushings into the Wing Pivot Lugs

Step 12: Install the Wing Pivots

As shown in Figure 10, use an AN7-44 **drilled-shank bolt** [69], two AN960-716 **washers** [75], an AN310-7 **castle nut** [44] and an AN380-3-3 **cotter pin** [52] to bolt each wing pivot between the wing pivot lugs on the cage.

Note Remember the purpose of the wing pivots is to pivot! Grease the assembly prior to securing the bolt and do not over tighten.

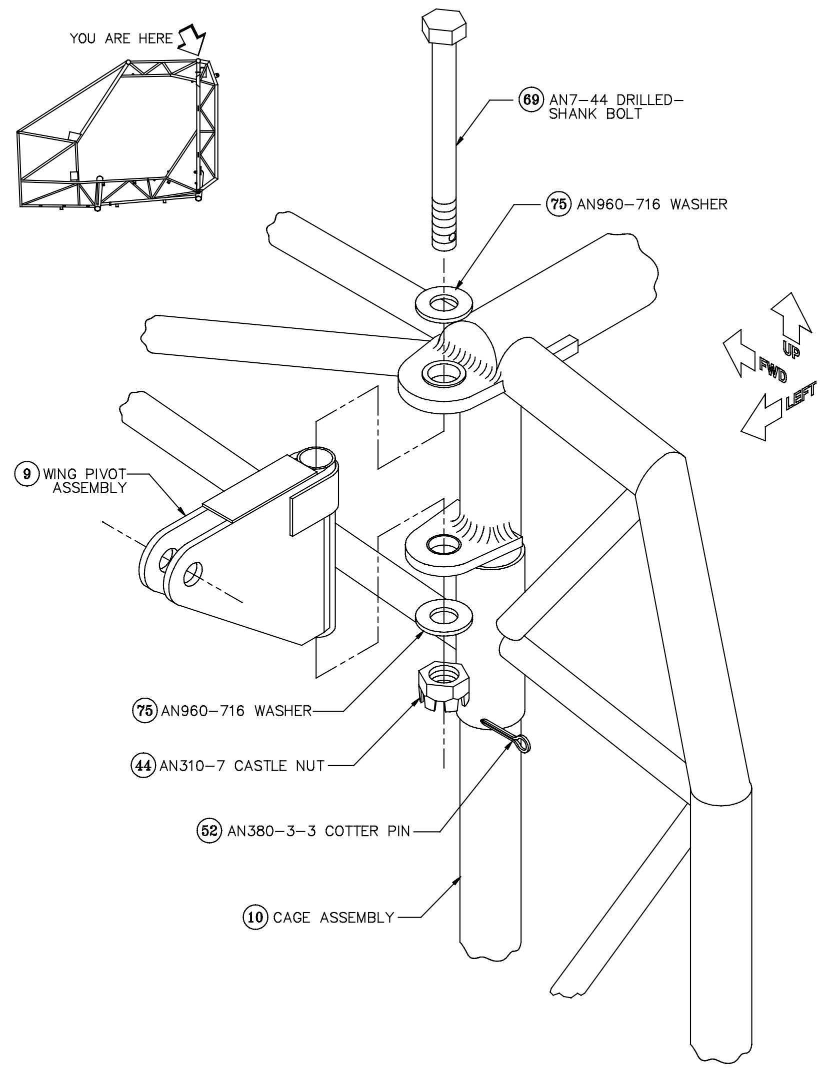

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Figure 10: Wing Pivot Installation

Step 13: Fasten the Alignment Jigs to the Fuselage Shells

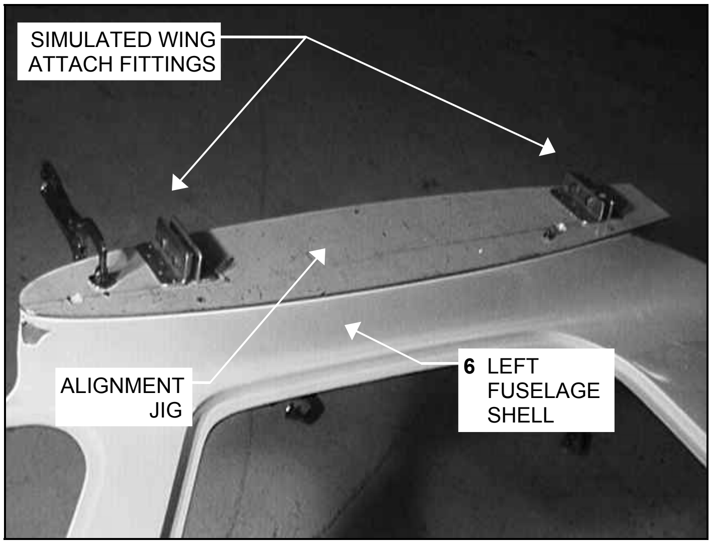

Figure 11a: Fuselage Shell Alignment Jig

In order to hold the fuselage shells in proper alignment with the cage while these components are bolted together, a pair of temporary alignment jigs will be used. These jigs consist of airfoil-shaped metal plates with fittings that duplicate the size and spacing of the attach fittings on the inboard ends of the wing spars. These plates are bolted temporarily to the wing-root portion of the fuselage shells, and then the simulated wing attach fittings on the jigs are bolted to the wing attach lugs on the fuselage cage. The shells are thus held in the proper horizontal and vertical position relative to the cage. The jigs also allow you to set the wing-root portion of the fuselage shells at the proper dihedral angle and suggested 1/10" gap to match the root rib of the wing.

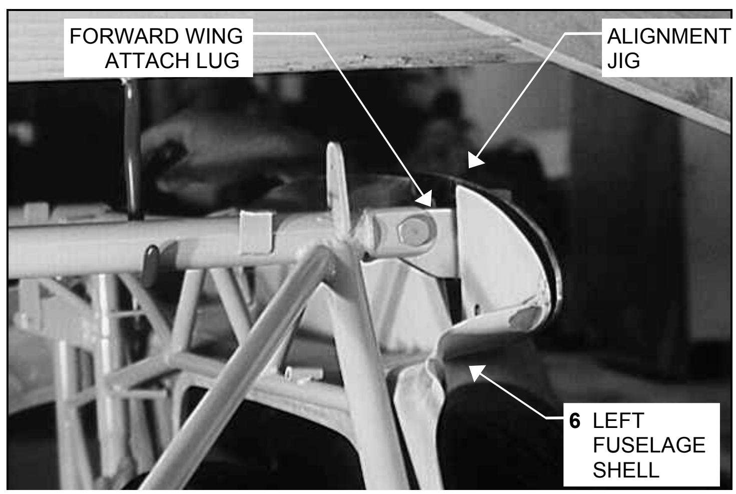

Figure 11b: Fuselage Shell Alignment Jig

Figure 11a shows the left-hand jig being bolted to the left-hand shell; in Figure 11b, the left-hand jig, with the shell attached, is bolted to the cage.

Note The shell alignment jigs are available on a rental basis from Glasair Aviation, LLC (P/N 981-01000-01). Contact our Order Desk for pricing and availability.

Before the jigs can be mounted on the shells, you must cut away enough of the fiberglass shell to accommodate the simulated wing attach fittings. Scribe lines have been provided on the shells to guide this cutting. To determine how far down to trim, measure the distances on the alignment jig from the lower edge of the airfoil-shaped portion to the simulated wing attach fittings. Transfer these measurements to the wing root area of the fuselage shell and mark horizontal lines between the vertical scribe lines. Use a hacksaw or a saber saw to cut out the material between the vertical lines so the alignment jig can be installed. The rest of the cutout, for the spar flanges, will be enlarged and finished later, so don't worry too much about neatness for now. The material to be cut away is represented by the shaded areas in Figure 12. Again, do not cut out the horizontal spar notches at this time. It will weaken the wing root are before the cage is secured.

Next, position each jig against the wing root area of the shell with the attach fittings protruding through the slots you just made. The fiberglass wing root is slightly larger than the alignment jigs. Align the jigs fore and aft with the leading edge airfoil shape of the shells and vertically by centering the edges of the jigs evenly within the lower edges of the shell wing-root area Clamp the jigs in place with C-clamps. Figure 12 illustrates these procedures.

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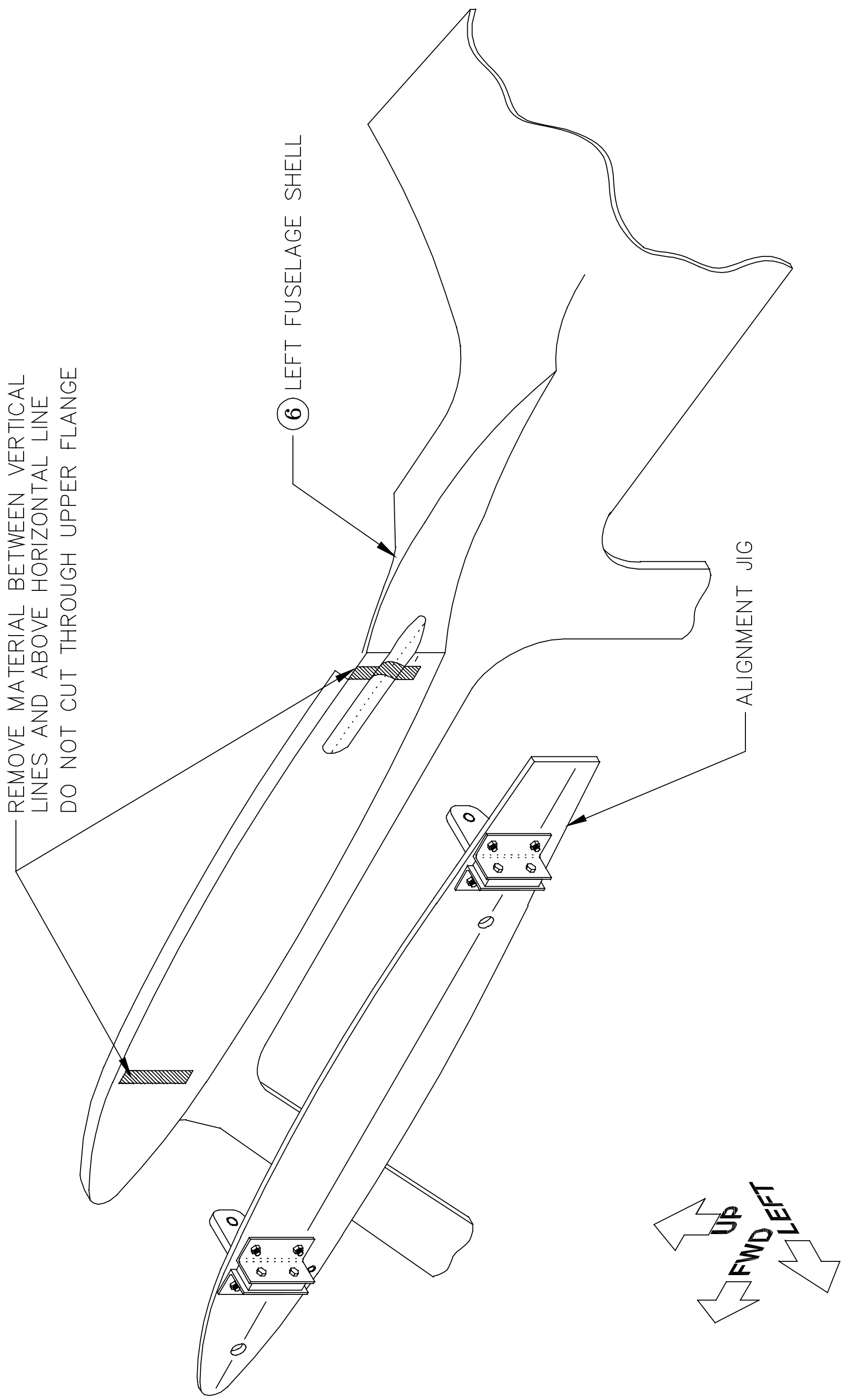

Figure 12: Mounting the Fuselage Shell Alignment Jig on the Shell

Before beginning the next few steps, take a long, deep breath! The process becomes slow and even tedious. Pulling, tweaking, and aligning can be a frustrating process as you push and pull everything together. **DO NOT RUSH IT!** The payoff in the end will be many hours of headaches saved because your fuselage is aligned correctly and you won't need to go back and re-work all of these steps.

Step 14: Mount and Rough-Fit the Shells on the Cage

Hang the fuselage cage on the hanging framework you constructed earlier, with the bicycle hooks on the main cross-tube between the forward wing attach lugs. Now place each fuselage half in position over the lower wing strut attach lug, then mount the jigs on the cage as shown in Figure 11b, using a **forward spar attach pin** [9.1] through the forward spar attach lugs and an AN8-14 **drilled-shank bolt** [68.1] through the aft lugs. There's no need to put a nut on the bolt or safety the pin at this time.

Hint You'll find that the aft ends of the fuselage shells are quite flexible, and this flexibility will make mounting the jigs on the cage difficult without a helper to support the shells. Once you have the jigs mounted on each side, throw a loop of duct tape or a bungee cord around the tail ends of the shells to hold them together temporarily and rest the joined tails on a padded stool or sawhorse to relieve the strain on the jigs.

Step 15: Lower Shell/Cage Assembly and Cleco the Nose and Tail

Once the shells are hung, you will need to lower the entire assembly onto a pair of supports as described in the Workspace section earlier and as shown in Figure 13. Place two supports under the wing strut mounting lugs and a sawhorse under the tail. Lower the entire assembly carefully until the entire weight is carried by your supports.

At this point it is important to join the two fuselage halves in a few places. This is best accomplished by lining up the cowl and tail cone flange joggles at the nose and tail and then drilling and clecoing the halves together on the lower seam. The result is just 2 clecos that hold the two fuselage halves together. Have a helper press against the opposite fuselage side at the aft end of the cage and drill a few additional cleco's in the lower overlap seam making sure to get as much of the 1-1/4" overlap as possible. The minimum overlap is 1-1/8".

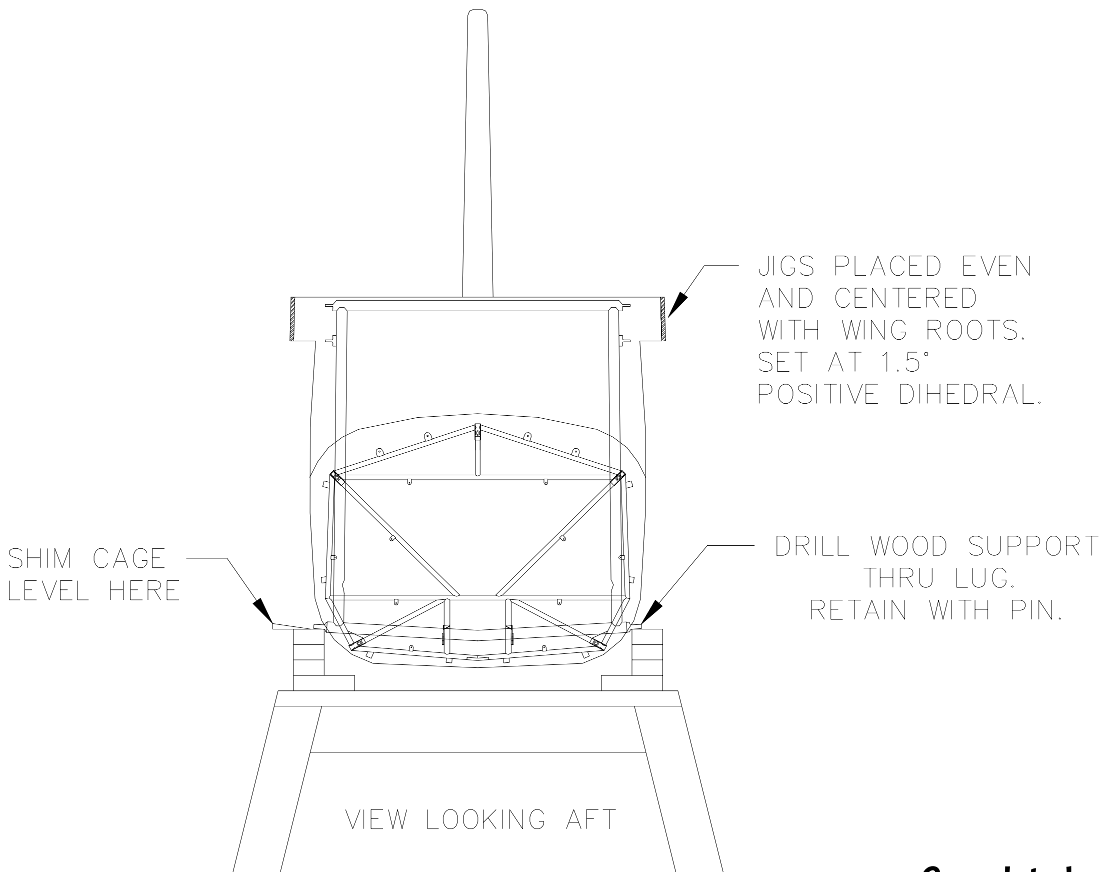

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Figure 13: Supporting the cage about the strut lugs

Step 16: Align the Cage With the Fuselage Centerline

Although it may appear to be so, the seam line between the left and right fuselage shells is **not** a reliable centerline. A simple way to establish this line is to sight along a string that has been stretched taut between two points in the forward portion of the fuselage known to be on the centerline.

Begin as shown in Figure 14.1 by marking the midpoint of the cross-tube at the forward-most end of the cage. Tie a string around this tube on the midpoint. Locate the center point of the tricycle gear cross tube, shown in figure 14.2, by measuring between any two common points on the tricycle main gear sockets. Stretch a piece of tape between the upper sockets, pinch the sticky sides together and mark the centerline on the tape. The center frame between the pilots is not necessarily on center. Run the remaining string through the fuselage and out the aft end.

Then, from the aft end of the fuselage, pull the string taut. Sight forward along the string and move it left or right as necessary until the string aft of the bottom cross tube centerline is perfectly aligned with the string forward of the bottom cross tube. Adjust the cage between the shells relieving the shells as necessary until you feel you have a best fit where the string is centered over the cage and ends up in the center of the tail cone.

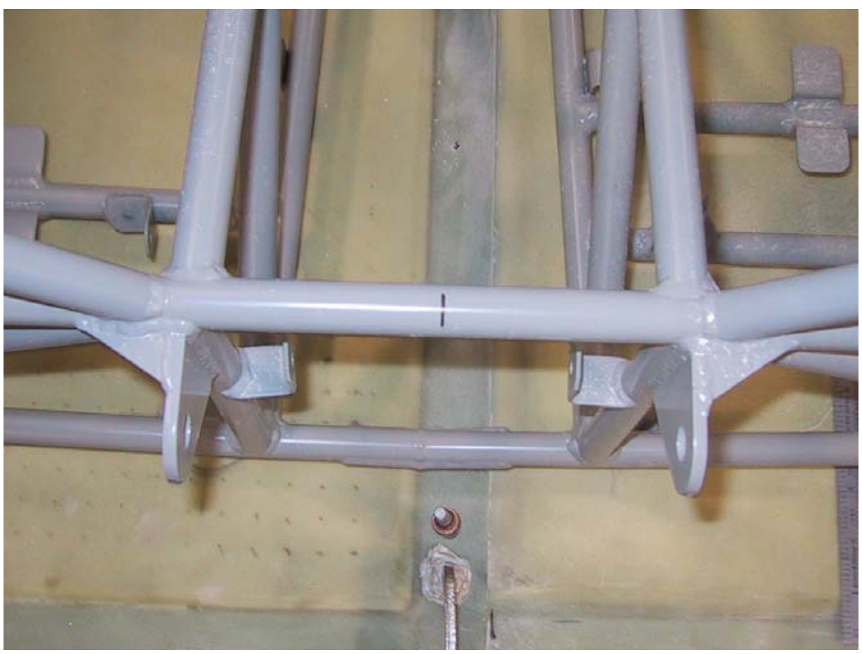

Figure 14.1 Marking the centerline on the firewall

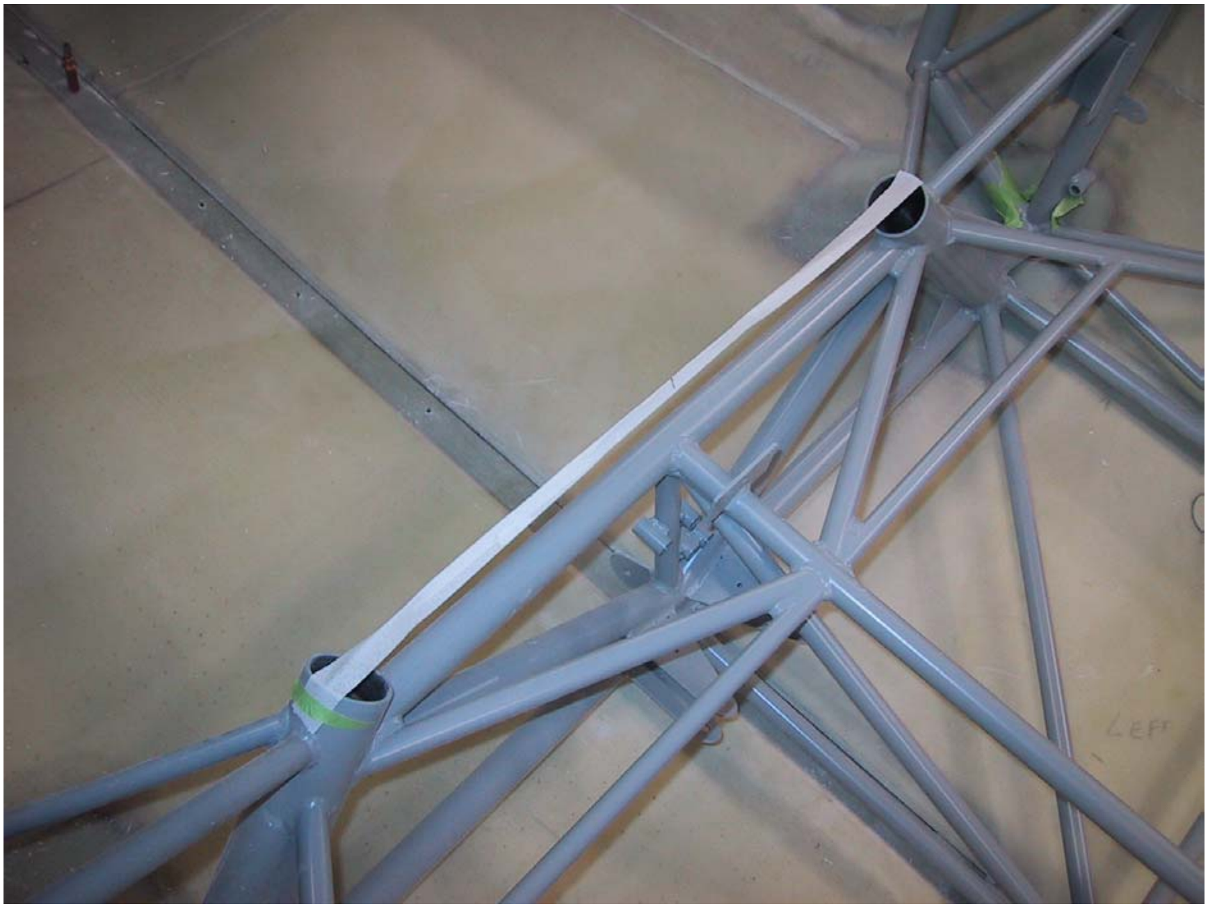

Figure 14.2: Establishing centerline on the gear truss

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Step 17: Cleco the Shells Together and Set the Wing-Root Dihedral Angle

Note Before beginning this step it is a good idea to set aside about 60-70 clecos. These will later be dipped in paste wax to protect them from the adhesive that will be used later to bond the joggle seams together. Don't dip them now. Wait until you are actually doing the adhesive step so as not to accidentally contaminate the joggle surfaces.

With the shells fitted cleanly around the cage and the previously drilled (3) clecos in place, drill and cleco along the lower seam. Use #30 or #40 clecos and make sure your drill size matches to keep the hole tight. Make sure the shells fit together tightly along their entire lengths with a **minimum of 1-1/8" overlaps on the joggles**. **Do not let the internal overlap ride up on the foam bevel. If necessary, trim the overlap back to prevent this from happening.** Begin at the forward and aft end, placing one cleco at each spot. Then move to the middle, placing one cleco there. From this point begin clecoing halfway between your previous clecos until you have one cleco every 2 - 3 inches apart. The purpose for such a close spacing will become apparent later when you are seaming the shells together. The close spacing will reduce waviness and body work.

Note: As you are drilling the holes, do not spin the drill any longer than necessary in the fiberglass as it will quickly expand the hole size. Expanded holes will not hold the clecos very well especially when the get wet with adhesive. Mis-drilled holes? Not a problem. Just pick another location and drill again. The holes will eventually get filled with adhesive or body filler.

Line up the hatch cover joggles and begin to drill and cleco the upper seam. The distance between the two flap track recesses should be between 11.3 and 11.4", reference Figure 119. When drilling the small seam at the firewall, be sure the joggles are properly lined up and the seam retains a rounded shape. There is a tendency for this small seam to "sag" especially when pressing down with the drill. Support it in the correct shape from underneath when drilling as shown in Figure 15.

Figure 15. Incorrect Correct

Next, check to see whether the fuselage is level laterally by placing a level on the main cross-tube between the forward wing attach lugs. Place shims between the top tube of the cage and the hanging hooks or under the strut lugs on your saw horse frame.

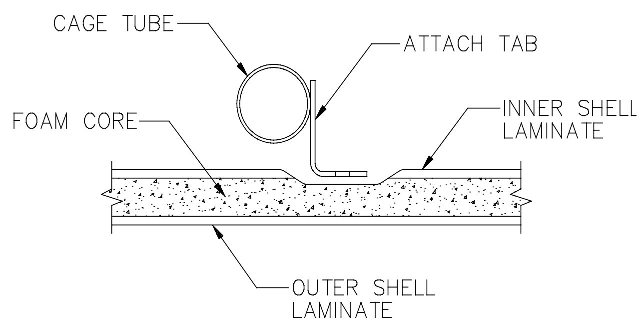
The next step is to set the angle of the wing-root areas of the shells to match the dihedral angle of the wings.

Figure 16: Wing root jigs mounted on the fuselage

Figure 16 shows the method for raising the shells (and thus setting the angle), as well as the method for checking your results. In the former, a rigid bar or board is inserted through the door openings and drawn upward against the shells with a pair of C-clamps attached to the top cross-tube of the cage assembly. When the clamps have lifted the fuselage shells to match the wing root jigs, you can check the resulting dihedral angle with a digital level. The target value is **1.5° off the vertical**, with the tops of the jigs angled **inboard**. The inside edge or face of the jig represents the inboard edge of the finished wing skins. Place shims between the jigs and fiberglass wing root to simulate the desired gap.

Be sure to check the angle on **both** sides! Try to bring both angles to the correct figure (within the limits of your level's accuracy), but don't lose too much sleep if you are unable to make it perfect; this procedure does **not** affect the actual dihedral of the wing, but rather only the match-up of the wing-root area of the shells with the root rib of the wing with a suggested 1/10" gap. Therefore, any inaccuracies have only aesthetic effects, not aerodynamic ones.

Hint If you don't have a digital level, you can check the angle with a spirit level and a little trigonometry—and we've even done the trig for you! This method requires two small scraps of sheet aluminum from your sheet metal practice kit, one piece of **.040"** and one piece of **.032"**. The pieces can be any size or shape as long as they each have at least one straight edge about 2" long. As shown in Figure 17, tape the two sheet scraps to the alignment jig, one on top of the other, with their straight edges aligned and exactly **2-3/4" above** the chordwise line on the jig. Then, place one end of your spirit level **on** the chordwise line and rest the body of the level on the scrap metal shims. When the jig is at 1.5°, the thickness of these shims and their distance from the end of the level will cause the bubble to be centered.



Relieving Interference Between the Shell and the Attach Tabs

If attach tabs that stick out too far (or any other cage interference) prevent you from fitting the shells, rout out some of the foam core to provide clearance. As shown in the figure, cut through the inner shell laminate and remove as much foam as necessary to allow the shell to clear the tab. Bevel the edges of the cutout. A single layer laminate can be applied over the cutout later.

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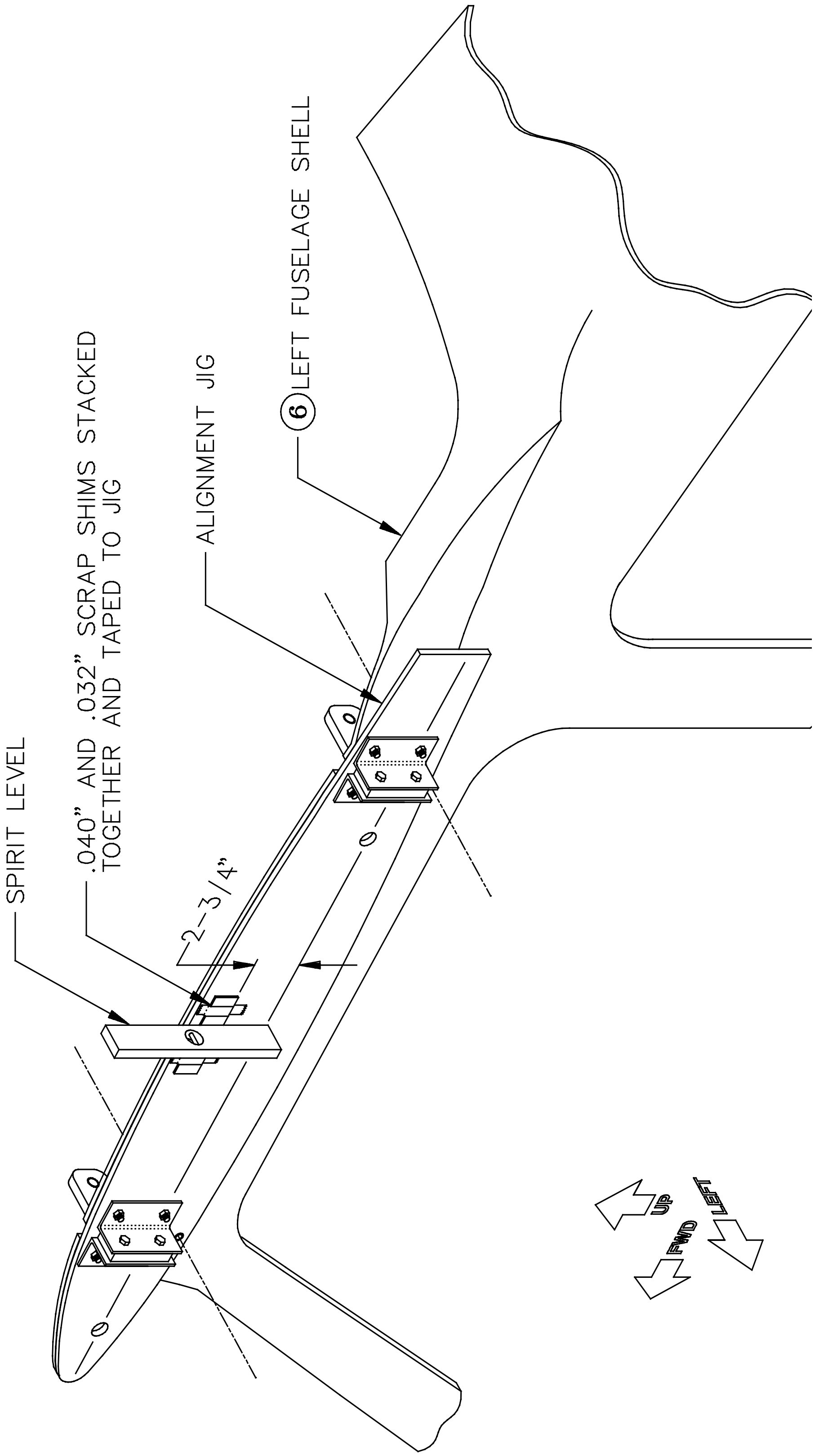


Figure 17:Alternate Method of Checking the Dihedral Angle of the Wing-Root Areas

Step 18: Bond the Belly Seam Joggle

Hint This step really requires an assistant, and a pair of them is even better. It's important to complete the step before the resin begins to cure, and this demands some quick work. Regardless of how many hands are at work on the job, make sure you have all the required tools and materials ready to go at the start.

Once you have verified that the cage is centered within the shells and both the lower and upper joggle seams are clecoed, you are ready to bond the belly seam. A clean, well-bonded seam is the ultimate goal of this step. Clean your joggles with liberal amounts of acetone.

First remove all the clecoes holding the joggle seams and dip them in a past wax so they will release from the adhesive after it has cured.
Do not let any wax get back into the joint. Then mix a 300 gram batch of vinylester resin with 25 grams of milled fiber and thicken the cabosil until it clings to a tongue depressor. It is best to catalyze first, before adding the fiber and cabosil.


Figure 18: Bonding the Belly Seam Joggle

Begin at the front of the belly seam and pull enough clecos that you can separate the belly seam joggle 2-3 inches apart. It's best to have an assistant at this point, but you can do it alone using a small block of wood to keep your seam separated (as shown in Figure 18) while you work. Lay a 3/16 to 1/4 inch bead of resin along the joggle joint using a 2 or 3 inch wide putty knife or plastic bondo spreader. For best adhesion, spread a thick bead of adhesive mix centered along the joint. Fill a ziplock baggie with the mixture and snip one corner to squeeze out a bead.

Have the helper insert the clecos behind you as you move from front to back. Check to see how much resin squeezes out so you can make adjustments as you go. **You should see resin squeeze out both on the inside and outside to ensure you have complete coverage.** Excess resin can be collected and used again if you run a little short at the end. As a side note, you may want to drill small pieces of metal to use as backing plates for the clecos because, if the holes are too loose, once the arms of the clecos are coated with wax and resin they may not grip as well.

The best practice is to have someone working ahead of you and someone behind you. Have the person ahead of you maintain the separation of the seam by pulling clecos as necessary and moving a block of wood. The person behind you can then bring the joint back together and reinstall the clecos.

Wipe any excess resin away from the joint with a tongue depressor. Use a broom handle with a tongue depressor taped to the end to clean the joint in the hard to reach tail section. Allow the adhesive to cure until it feels hard before moving the fuselage. Avoid wiping acetone on the zolatone finish, as it will dissolve it.

Completed: [ ]

Step 19: Bond the Dorsal Seam

The dorsal seam is bonded in exactly the same way as the belly seam. Mix up a 100 gram batch of adhesive. Lay down some paper or other material on the floor of your airplane to protect it from drips. Starting at the front of the dorsal seam, carefully separate the seam, insert resin, and then re-cleco after you are done. Don't forget the small section of seam located ahead of the firewall. Do not place adhesive in the upper seam at the very forward end of the left vertical fin half. Allow this to cure before proceeding.

Completed: [ ]

Step 20: Drill the Holes for the Cage Floor

The shells are positioned to the cage assembly with machine screws through **twenty-eight** tabs that contact the fuselage shells; their locations are shown in Figures 21 and 23. (Five more tabs contact the top deck, which will be installed in a later step.

IF your cage alignment is centered and the wing root positioning is set to 1.5 degrees and the contours match, you are ready to attach the cage to the composite shells.

Note The attach tabs on the **bottom** of the cage (shown in Figure 21) will be secured to the shell first; the position of the shell can then be fine-tuned vertically by adjusting the thickness of the shims between the cage tabs and the shell. Once you are satisfied with the vertical position of the shell relative to the cage, the holes for the **side** attach tabs (shown in Figure 23) will be drilled and the side fasteners installed.

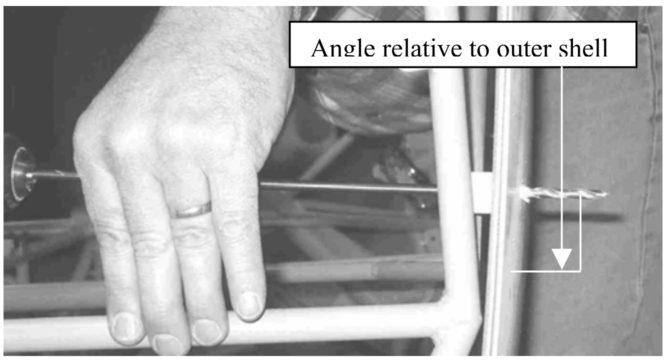


Figure 19: Maintaining drill alignment relative to outer shell

As shown in figure 19, it is important to maintain the drill perpendicular to the outer shell and NOT to the tubes or cage tabs. Any error here will show up when you insert your screws because the screw heads will not lie flush against the skin. Have a helper align the drill for you.

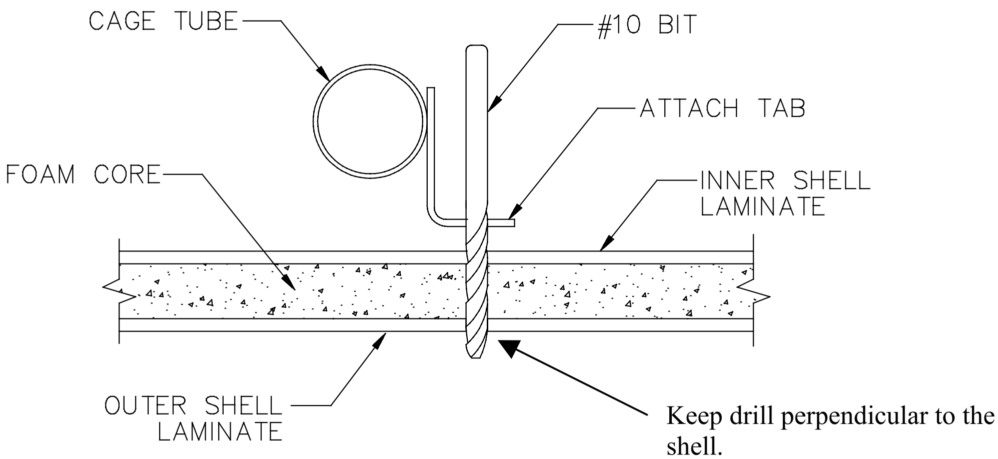


Figure 20: Drilling the Initial Attach Tab Hardpoint Holes

Drill through each of the fourteen attach tabs on the floor of the cage with a **#10** bit. As shown in Figure 20, use the holes in the tabs as guides and drill **all the way through** the fuselage shells. You can drill the tabs in any order, but refer to Figure 21 to make sure that you don't miss any.

Note For any locations where it was necessary to relieve interference by removing laminate, a single layer of cloth needs to be set down. Sand the relieved areas smooth and apply a single layer of resin-saturated cloth over each one. The cloth should extend roughly **3/4"** onto the original inner laminates all the way around the relieved area. Work the cloth down into the indentation in the foam core and lap it over the inner shell laminate. Let the patch laminates cure.

Note Any gaps between the shells and the attach tabs on the cage will later be shimmed with nylon washers. The three things that must be satisfied prior to drilling are:

1. the cage must be level
2. the cage must be centered inside the shells
3. the wing roots must match up to the wing jigs.

Completed: [ ]

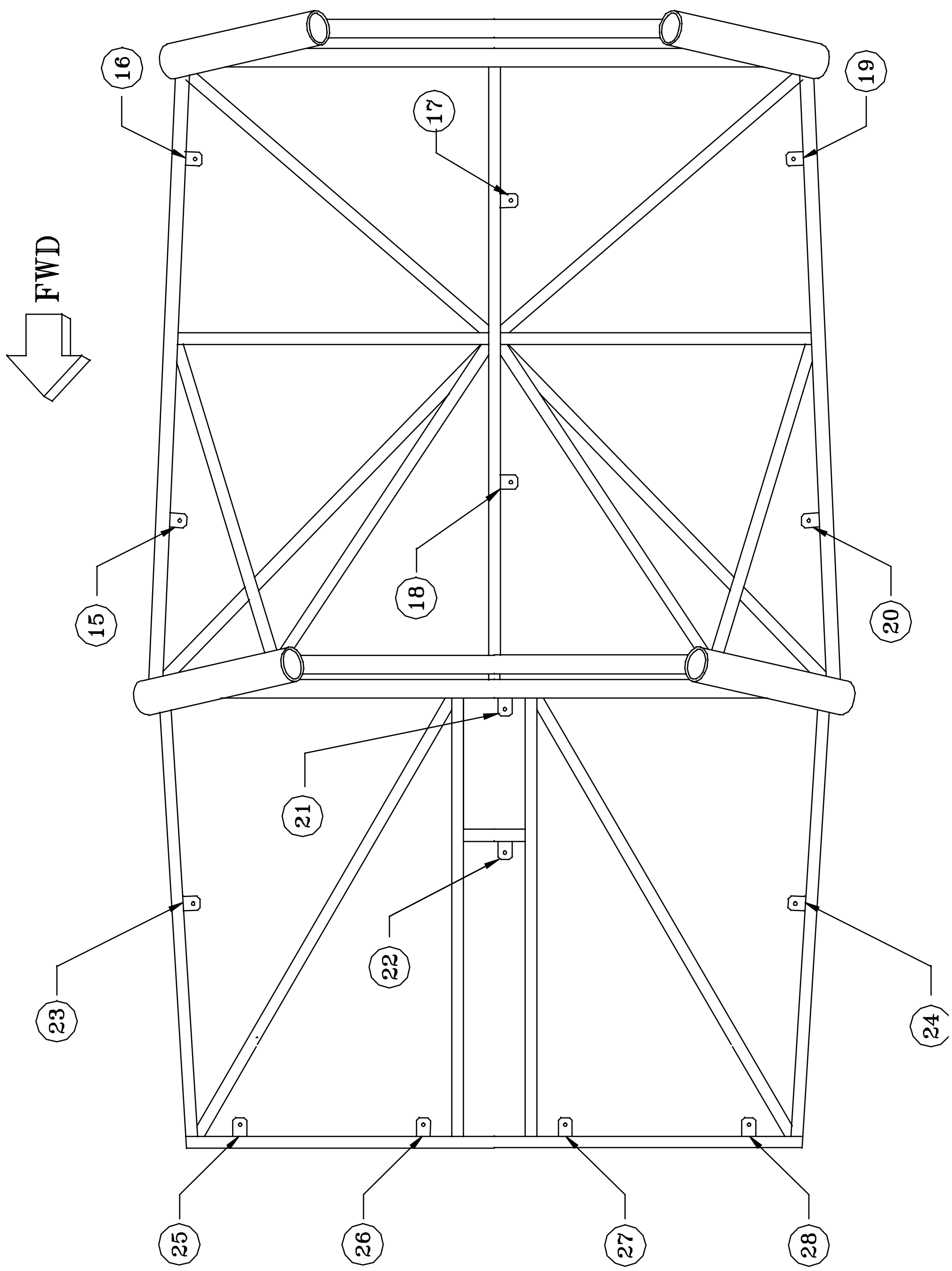


Figure 21: Attach Tab Locations (Cage Floor)

Step 21: Fasten the Shells to the Cage Floor

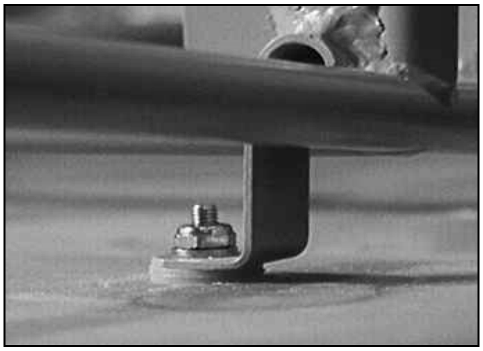


Figure 22: Nylon Washer Shims

The shells are fastened to the cage with AN507-10R16 and -10R20 **flush-head machine screws** [62 and 63] through the attach tabs. Due to slight variations in the placement of the tabs and the thickness of the fuselage shells, there may be gaps of between 1/32" and 3/8" between the tabs and the shells. These gaps are **not** structurally important; as shown in Figure 21, they are easily bridged with **nylon washers**. The kit contains an ample supply of these washers in thicknesses of .032" [26] and .064" [27].

Install the screws as follows: first, countersink each hole on the **outside** of the shell to accommodate a screw. The core, under the tabs have a 20# hard foam insert and extra laminates for countersinking. Test your microstop countersink tool on some scrap material to make sure the depth is correct. Particularly avoid countersinking too deeply. Second, insert as many nylon washers as necessary (if any) to completely fill the gap between each tab and the shell; follow up with a screw of appropriate length. Finally, secure the screw with an AN364-1032A **nylon self-locking nut** [46] and an AN960-10 **washer** [70] or -10L **thin washer** [71]. At a minimum, one-and-a-half threads of each screw should be visible beyond the nut; screws that protrude more than this can be left as is or can be ground or cut off closer to the nut at your discretion.

Note Be careful to avoid over-tightening these nuts. They should certainly be tightened with a wrench, but because they are so small, they are easy to over-torque. The consequence of this will be a very evident depression of the outer shell surface around the screw head. Ideally, if the holes were slightly under-countersunk, the tightening of the nuts will be enough to bring the fastener flush with the skin. Over countersinking will cut through the exterior laminates and cause the fastener head to sink into the core. If a hole was drilled at an angle to the exterior surface not allowing the fastener to sit flush, file or grind a small slot in the hole of the steel attach tab in the desired direction.

Completed: [ ]

Step 22: Fasten the Shells to the Cage Side Attach Tabs

With the cage floor fasteners all installed, once again verify that the wing root portions of the shells remain at the proper dihedral angle, as described previously. If necessary, fine-tune the shell's position relative to the cage by adjusting the thickness of shims under the cage floor attach tabs.

When satisfied, drill the fastener holes and install the fasteners for the cage **side** attach tabs (Tabs 1—14 in Figure 22), using the same procedures described for the floor attach tabs in Step 21.

When setting the nylon shims spacing of the fasteners bordering each door opening, take the doors and temporarily hold them in position so that the fuselage shape best matches the door shape. (Tabs 1-4, 9-14)

Completed: [ ]

Note At this time, the clamps and cross support member can be removed. Leave the alignment jigs in position until the top deck is bonded in place.

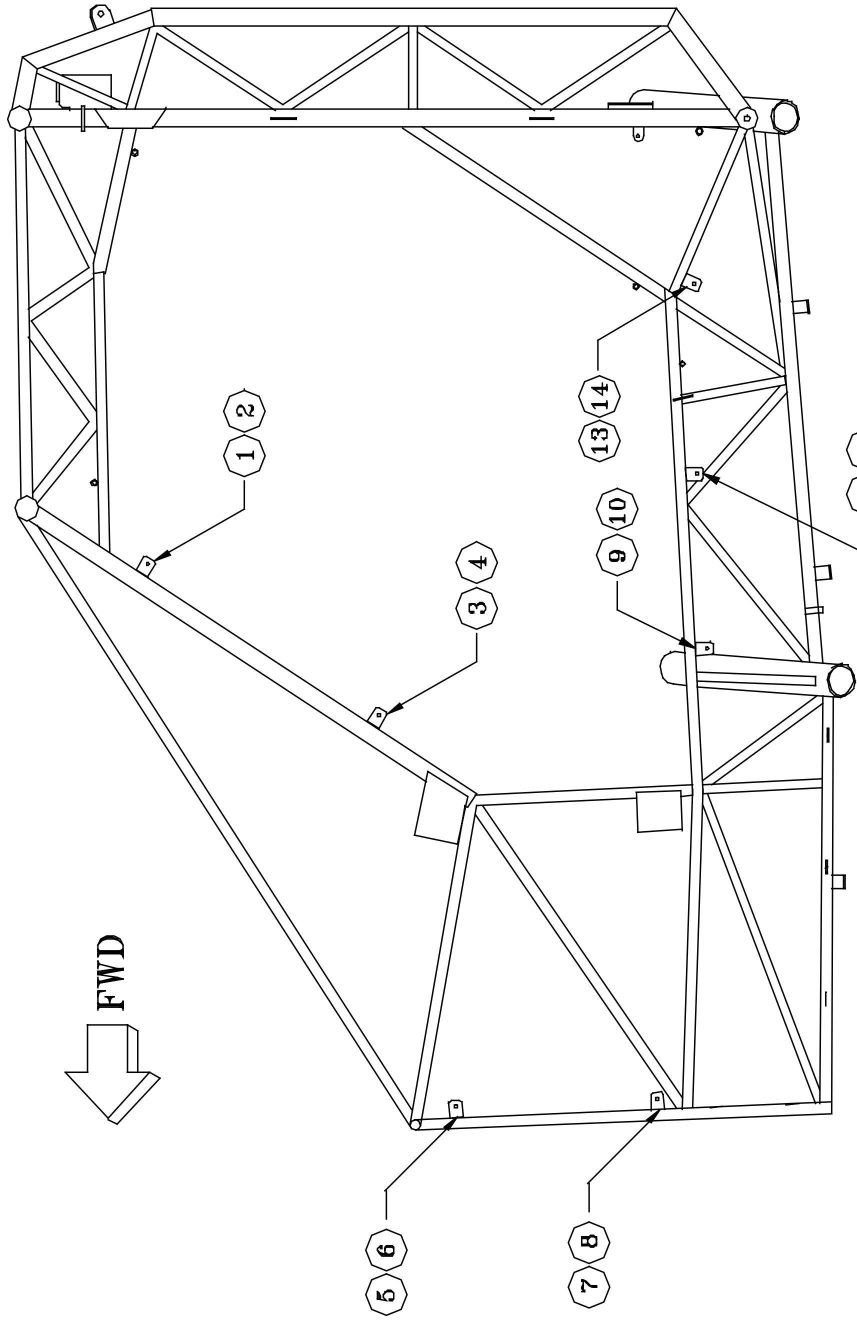


Figure 23: Attach Tab Locations (Cage Side)

Step 23: Top Deck Installation

With the wing strut alignment jigs in place, now is the time to fit and bond the top deck into position. The **top deck [24]**will lay on top of the flanges at the wing root and overlap the joggles at the leading edge of the airfoil and eventually be secured to the cage using the five tabs**. Insert some 1/10" (suggested) shims between the wing root jig and the fuselage shells along the upper and lower surface profile. This will set the fuselage shells inboard of the wing skins this same distance.**

As shown in Figure 25, slots must be cut in the top deck for the lifting eyes on the cage to protrude through. ***The dimensions shown are approximate dimensions. Depending on your cage and shell alignment, these dimensions can vary significantly!*** Before cutting, measure the distance (X) between the lifting eyes on the cage. Use this dimension to accurately lay out the distance between the slots. Do not cut the full
1-1/2" width to begin with. Make it undersize and expand the slot length is the desired direction to obtain the best fit. Cut the slots **1/4"** wide by **1-1/2"** long to start, and center them **2-7/8"** in from the outboard edges of the deck with their forward ends **1-7/8"** aft of the windshield joggle, as shown.

Note The gaps around the lifting eyes can be sealed with silicone caulking after the airframe has been painted. If you want to keep the size of these gaps absolutely as small as possible, study the next step for an understanding of the goals to achieve in fitting the deck to the fuselage.

Next, check the fit of the top deck by matching up the leading edge joggles while attempting to position the aft end of the deck approximately centered. As shown in Figure 25, take a measurement on both sides of the airplane where the hatch cover joggle flange runs out into the wing root to a point near the center of the top deck. Reposition the top deck aft end to get it centered. Make any adjustments in the lift eye slots necessary. When you are satisfied with the fit at the aft end, drill two #40 index holes hole thru the top deck and the joggle flanges, 1/2" off centerline (one inch apart from each other) and 1/2" forward of the joggle. Trim any areas along the leading edge joggle to get a good fit between the two surfaces. Again try to maintain as much joggle overlap as possible. You are trying to get a good fit so the two parts mate well and will require minimal body work later.

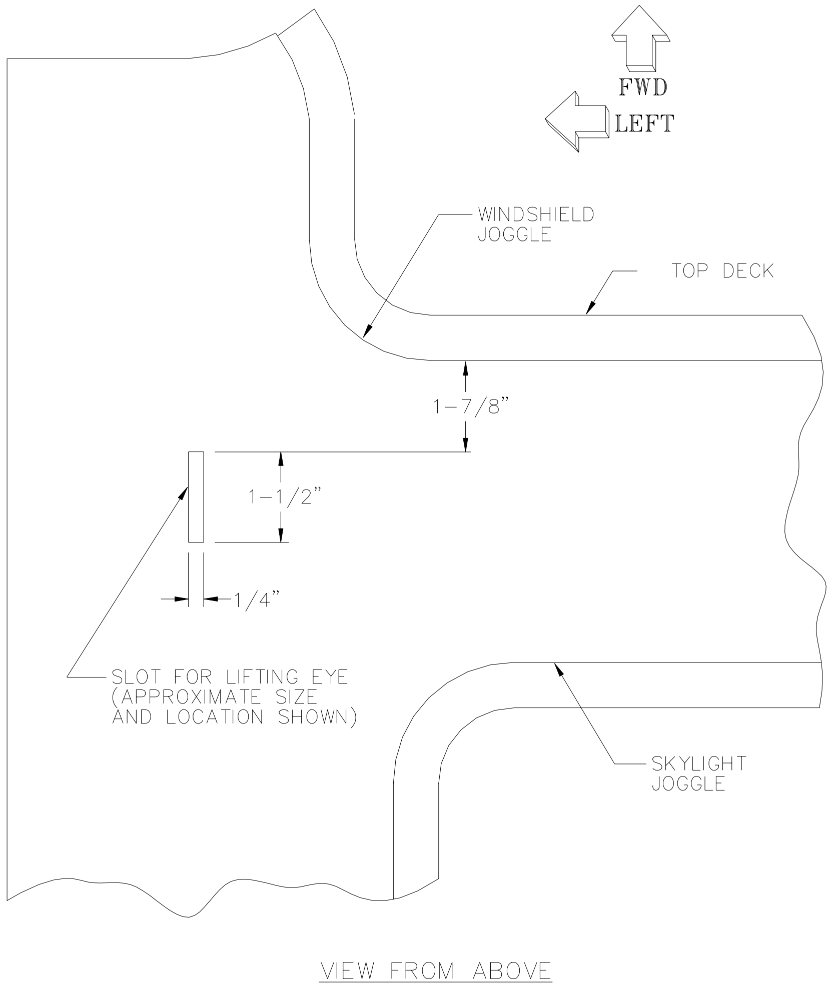


Figure 24 Approximate locations for cutting the lift eye slots

When all is in position, drill #40 holes every 2-3 inches and cleco the top deck to the upper fuselage flanges. Back-drill this hole pattern into a thin strip of wood or scrap aluminum. This will be used as a surface clamp later and will help keep down the surface distortion caused by the cleco clamps. Any portion of the top deck that overhangs the fuselage flanges can be trimmed later.

As an alternate method of avoiding cleco holes, the top deck may be gently weighted down as long as the wing roots are pushed outboard to contact the jigs and spacing shims set at 1.5 degrees dihedral.

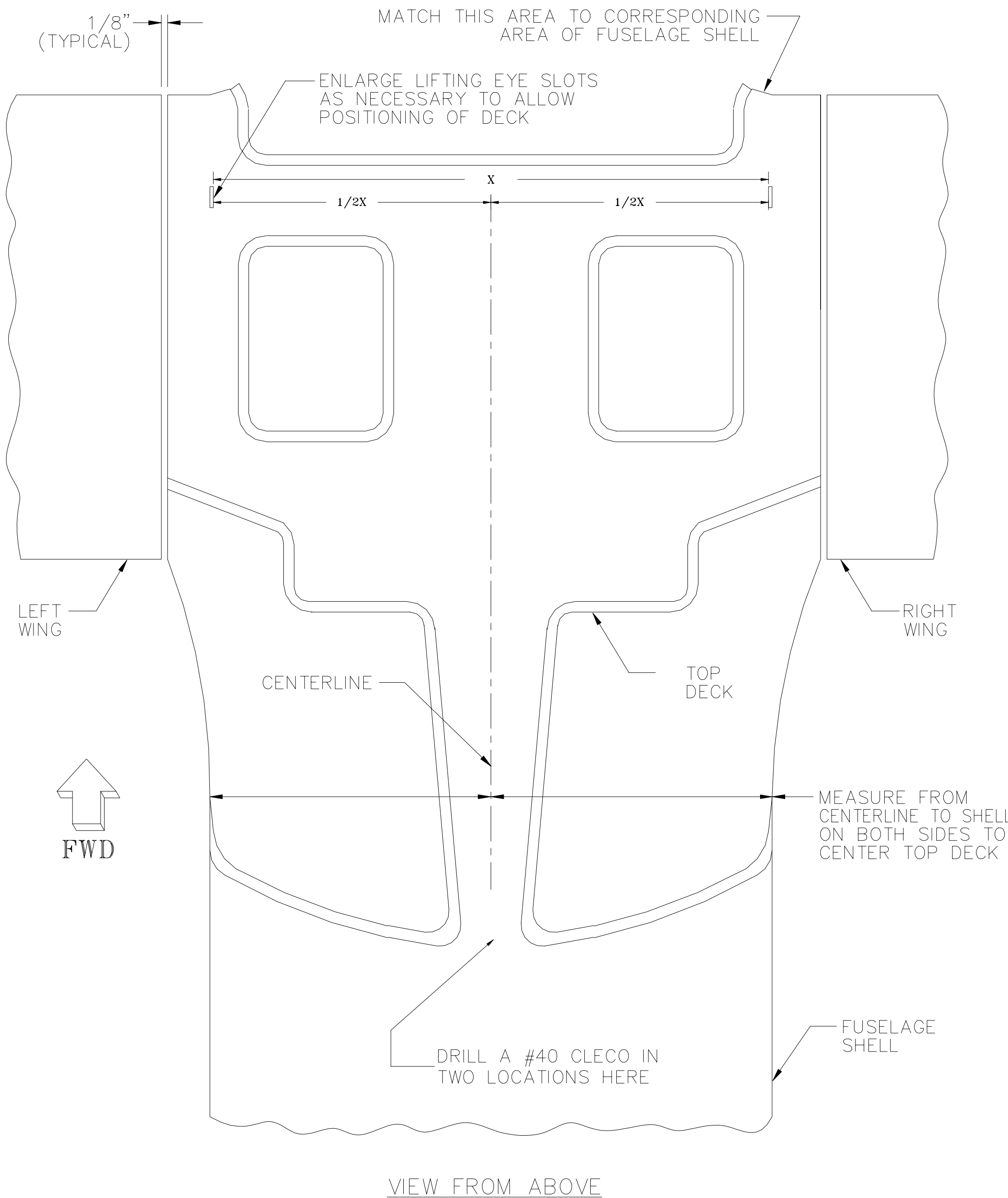


Figure 25 Centering the aft end of the top deck

Mark and tape off along the border flanges to protect the Zolatone finish.

The aft end of the top deck will need to be trimmed in order to get a good fit to the fuselage and to minimize body work later. Begin by marking a 45 degree line on the top deck that starts from the aft most tangent point in the fillet as shown in Figure 26. Project the fuselage flange line onto the top deck and trim the top deck to these lines.

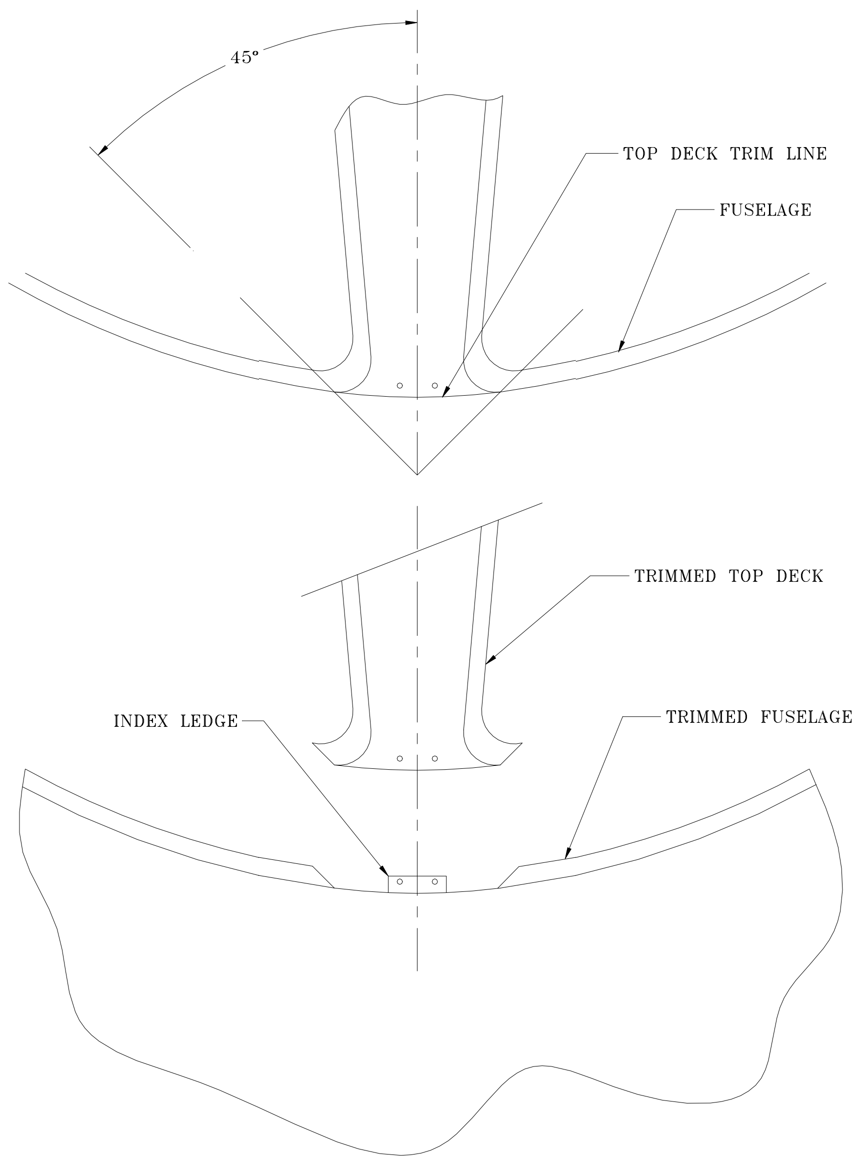


Figure 26 Trimming the aft end of the top deck and the fuselage

Next, a small ledge should be left on the fuselage so the top deck has a shelf to sit on. This will aid in holding the top deck relative to the fuselage during laminating. Relieve the corners of the ledge to allow for the top deck and aft fuselage to join together with a flush fit..

Sand, clean and prepare the top deck overlap along the wing root joggles for the application of the adhesive. Mix a small 50 gram batch of vinylester adhesive mix. Be sure the sides of the wing root fiberglass is tight up against the shims on the wing root jig and the dihedral is set to a positive 1.5 degrees. Apply a generous amount of the adhesive mix to the flanges and cleco the top deck to the flange and along the leading edge. Use the thin strip of wood or aluminum as a surface clamp. Remember to use waxed cleco clamps! If the leading edge overlap joggle joint did not line up properly, the leading edge can be bonded on the aft side (under the top deck) with a 2 ply 7781 laminate.

When the adhesive has cured, drill and install the fasteners through the cage tabs and the top deck in the same manner as with the rest of the cage fasteners. Sight the top deck across the windshield flange to be sure it I flat and straight. Shim as necessary.

The aft portion of the top deck will be laminated at a later step or can be done now if you wish. Refer to Step 94 in this section.

Remove the wing root jigs and return them to Glasair Aviation, LLC.

Completed: [ ]

Step 24: Laminate any Minimum Overlap Seams

Other than the top deck leading edge and sides, any areas that do not meet the minimum 1-1/8" overlap (which should rarely occur) will require a two-layer laminate on the inside. The laminates should extend 1" over each side of the seam. Tape a 2-1/4" wide path and remove any Zolatone and adhesive that is protruding above the surface by sanding the inside down with course grit sand paper. Cut the required lengths of bi-directional cloth on a 45° bias. Mix a small amount of resin and saturate the cloth as required keeping the cloth centered.

Completed: [ ]

Step 25: Position and Drill the Upper Shell Attach Fittings

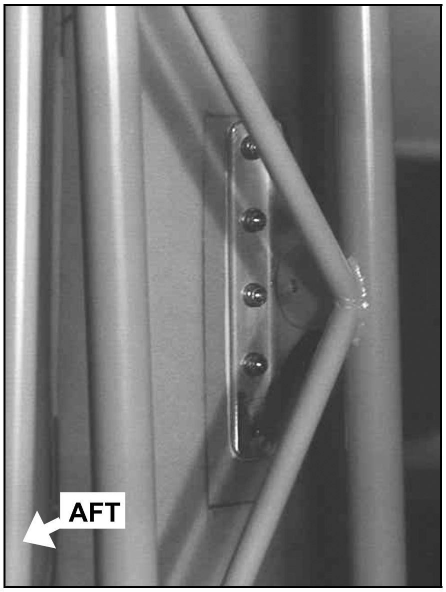


Figure 27: Placement of the Upper Shell Attach Fitting

The aluminum angle cage to shell attach fittings are the structural means of attachment between the cage and the fiberglass shell. As such, in the location of each fitting is a 20# foam core insert and multiple external reinforcement plies of cloth to provide countersinking grip. It is very important not to countersink these fasteners beyond a flush fit.

Figure 27 shows the placement of the left-hand upper shell attach fitting. On both sides, the flange of the fitting that sits against the shell (the one you center punched hole locations on) points **aft**, and the other flange goes on the **forward** side of the corresponding cage tab. These tabs are located a bit below eye level on the main vertical tubes at the aft end of the cage. (These are the same tubes that bear the wing pivot lugs.)

In addition to securing the fuselage shells to the cage, the upper shell attach fittings also support the outside door handles through a bushing pressed into the lowest of the five holes on each side. Before fastening the fittings to the shells, it's necessary to drill pilot holes for these bushings in both the fittings and the shells.

Temporarily position each fitting as shown in Figure 28. The cage tab should be centered on the fitting's triangular flange, and the rectangular flange should be pressed firmly against the shell over one of the rectangular hardpoints; measure to position the two fittings at the same height on both sides. If this flange does not meet the shell squarely, use a mallet to bend the cage tab slightly forward or aft to achieve a good, square fit. When the fitting is in place, clamp it to the cage tab with a small C-clamp or spring clamp. Verify you have adequate edge margin between the cage tab hole and the top of the angle. Then, using a 90° drill motor, drill a #30 hole through the fitting and the shell wall at the **lowest** hole location. **Drill only this hole at this time**.

Note The fitting isn't drilled through the cage tab at this time in order to maintain in-and-out adjustability for fitting the doors.

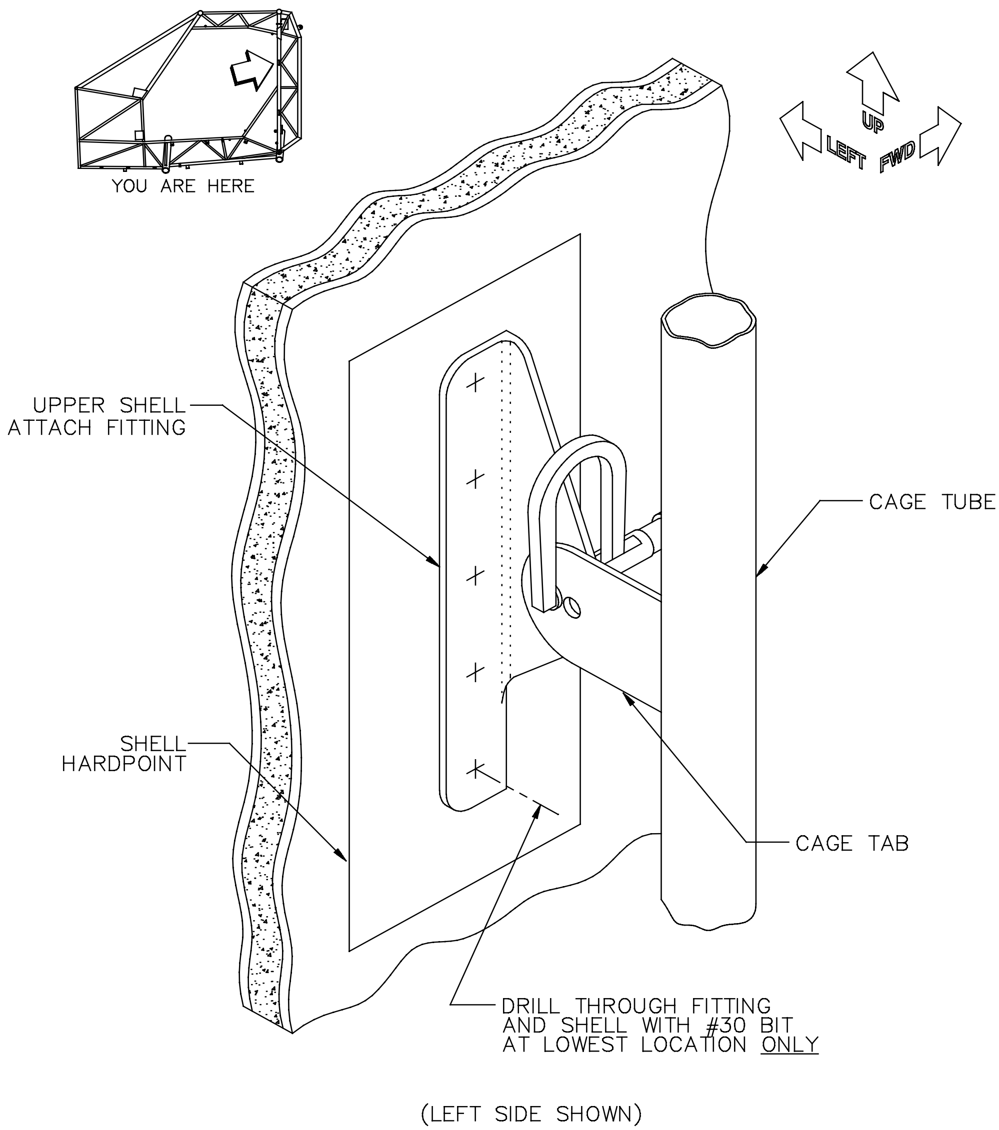


Figure 28: Pilot Drilling for the Door Handle Bushings

Once the lower pilot hole is drilled in each fitting, unclamp the fittings from the cage tabs. As shown in Figure 29, first drill each pilot hole up to **13/32"** diameter, and then ream this hole to final size with a **.4375"** straight reamer. Using a bench vise or a large C-clamp, press an NAS77A5-062 **flanged bronze bushing** [90] into this hole with the flange of the bushing on the **inboard** side of the fitting flange.

Hint If the bushings don't fit tightly, you may wish to "stake" them in place with a center punch, just as you did in "SECTION VI: WING ASSEMBLY" on the aileron hinges. The use of Loctite is also recommended.

Finally, drill the pilot hole in each fuselage shell up to final **1/2"** size; drill these holes in increments, beginning with a **3/16"** bit and progressing through **1/4"** and **3/8"** bits before finishing up with a **1/2"** bit. At each increment, check the position of the hole relative to the bushing in the fitting and shift the hole center as necessary to maintain concentricity. (A unibit works well for enlarging holes incrementally.)

With these preparations completed, you can now re-position the fittings and drill the remaining holes. Closely tape off the fuselage sides surrounding the fittings to protect the Zolatone finish and to make for nice clean lines. As can be seen in Figure 27, a thin layer of Q-cell is used as a kind of "liquid shim" between the fitting and the shell wall. The purpose of the Q-cell is **not** to **bond** the fitting to the shell, but rather simply to provide a perfectly flat mounting surface for bolting. For this reason wax the flanges of the fittings that will bed in the Q-cell and the exterior surfaces of the bushing with mold release wax. Mix a small batch of "thick mix" Q-cell and apply a layer about **1/8" thick** to the waxed flanges. You can even "tone" the Q-cell with a dark pigment to match the gray of the cabin. We have even used copier toner to achieve this.

Caution Be careful not to get any of the Q-cell **inside** the bushings or on the finished, visible surfaces of the fittings.

Position each fitting as you did before (except that now, of course, the bushing will protrude through the 1/2" hole in the shell), pressing each firmly against the shell with enough pressure to cause the Q-cell mixture to ooze slightly from behind the fitting. Be sure that the bushing sticks out **at least 1/32"** beyond the outside shell wall. Clamp the fitting to the cage tab as before.

After the fittings are clamped in place, remove any excess Q-cell that oozes out from beneath the fittings, leaving a smooth fillet between each fitting and the shell. Also, from the outside of each shell, remove excess Q-cell that may have oozed out. If any gaps surrounding the bushing are visible, fill them with Q-cell.

After the Q-cell has cured, use a 90° drill motor with a **#10** bit to drill through the fitting, the Q-cell shim and the fuselage shell at each of the remaining four center-

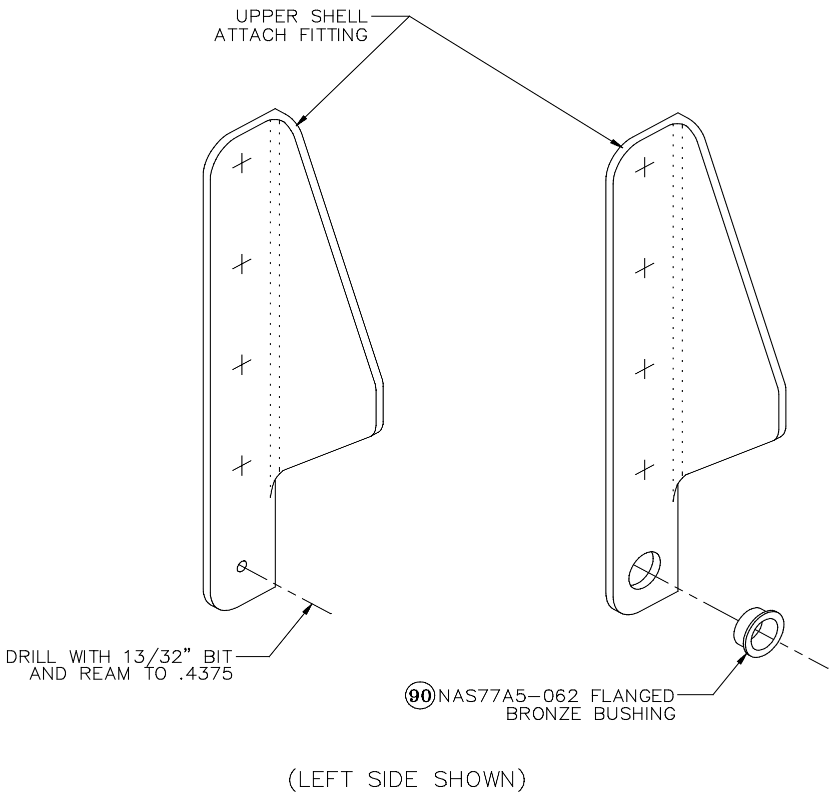


Figure 29: Pressing in the Door Handle Bushings

punched locations. **Do not** drill the hole through the cage tab yet; this will be done after the doors have been fitted in "SECTION X: FINAL ASSEMBLY."

Completed: [ ]

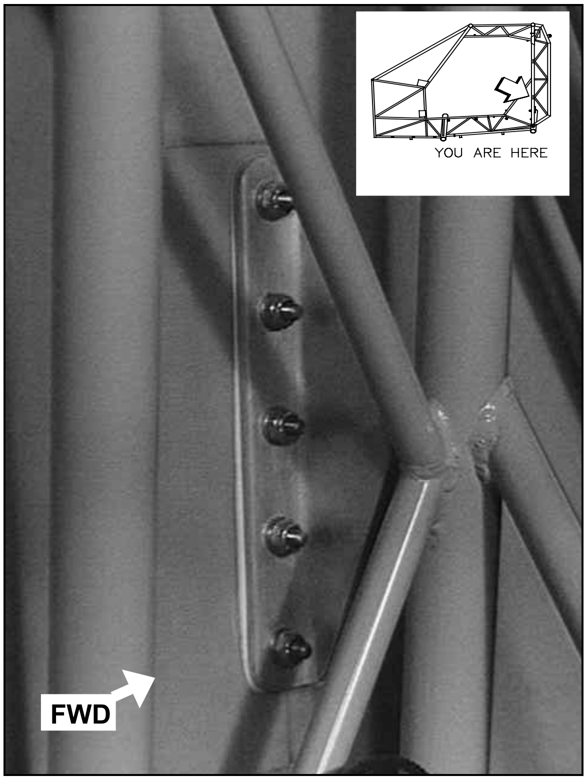


Figure 30: Placement of the Lower Shell Attach Fitting

Step 26: Position and Drill the Lower Shell Attach Fittings

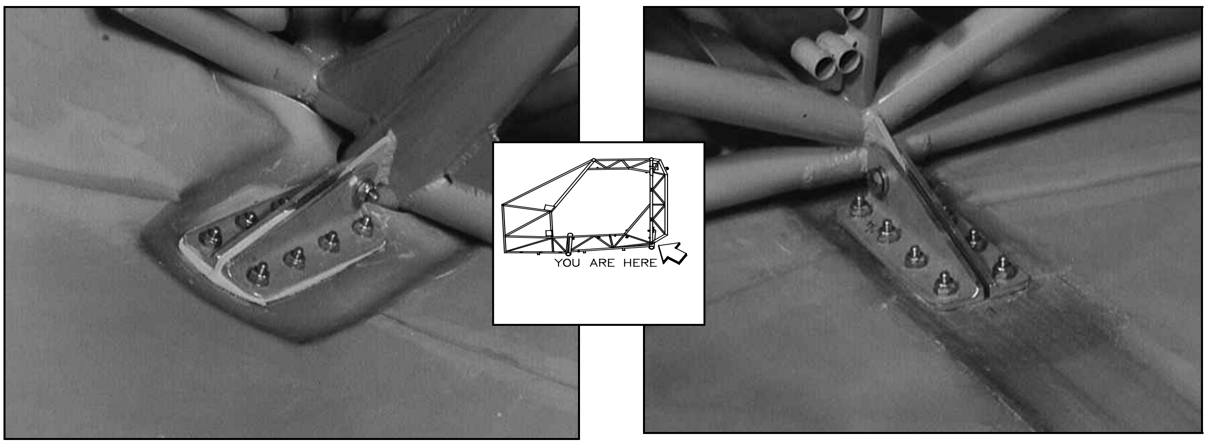
In most respects, the installation of the lower shell attach fittings is identical to the upper: once again, you will form a shim of Q-cell mixture, position the fitting by clamping it to the cage tab, and drill the mounting holes after the Q-cell has cured. Also, as with the upper fittings, the lower pair is positioned vertically by centering the cage tab on the triangular flange of the fitting.

However, as Figure 30 shows, there is one important difference. Whereas the triangular flange of the upper fittings was located **forward** of the cage tab, the opposite is true of the lower fittings; place them on the aft side of the cage tabs. Tape off the surrounding area to get a good detail on the fillet and the Zolatone. Apply the thick Q-cell mixture and clamp the fittings in place. After the Q-cell has cured, drill the five center-punched holes in each fitting with a **#10** bit. **Do not** drill the cage tab holes at this time.

Completed: [ ]

Step 27: Position and Drill the Aft Shell Attach Fittings

The panels of Figure 31 show the placement of the three pair of lower aft shell attach fittings. Figure 31a depicts the two left-side fittings and Figure 31b depicts the center pair; the right-side pair is identical to the left pair. The cage tabs to which these fittings are attached are at the aft end of the cage along the bottom-most tube—one at the left end, one at the right end and one on the aircraft centerline.



(a) **(b)**

Figure 31: Placement of the Aft Shell Attach Fittings

These fittings are installed using the same techniques used with the side fittings. However, these will be bolted to the cage tabs in this step, so before securing the fittings to the cage it's necessary to drill bolt holes in the triangular flanges of each fitting.

Begin by pairing the fittings off in sets of left- and right-flange fittings. Clamp one fitting from each pair to one of the aft cage tabs with its rectangular flange firmly against the shell. Then, as shown in the upper panel of Figure 32, use the hole in the tab as a guide to mark a hole location on the fitting. Remove the clamp.

This marked location is **not** where you will actually drill. Instead, the bolt hole must be drilled somewhat lower on the fitting for two reasons: first, as with the other fittings, the aft fittings should be bedded in a layer of Q-cell **at least 1/16"** thick. The position of the hole must be adjusted for the thickness of this bed. Second, the hole must be drilled low enough to leave an edge margin of **at least 3/8"** between the hole and the top of the fitting. Therefore, you must mark a new hole location **at**

least 1/16" below the original mark. If necessary to achieve adequate edge margin, you may have to go down further than that. The center panel of Figure 32 shows the specifications of this hole location.

Finally, as the lower panel of the figure shows, clamp the fittings of each pair together back-to-back and drill through both at the lower mark with a **1/4"** bit.

Once all six aft fittings have been drilled, apply a layer of thick-mix Q-cell of appropriate thickness to the bearing area of the shell. Seat the fittings in the Q-cell and align them with their respective cage tabs with AN4-6A **bolts** [58]. For now, don't bother with any washers or nuts.

Note If the position of the cage tabs dictates a Q-cell shim thicker than **1/8"**, substitute a 50/50 mix of **mill fiber** [35] and Q-cell for the straight Q-cell. This will make a stronger bed that is less liable to crack.

After the bolts are inserted, make sure that the aft ends of both fittings in each pair are pushed down firmly into the Q-cell beds. The fittings should be parallel with one another and as close to parallel to the shell-floor as possible. As can be seen in Figure 31a, the Q-cell mixture may be pushed up between the fittings, which is fine. Remove excess Q-cell from around the outside of the fittings, however, leaving a smooth fillet all the way around.

After the Q-cell has cured, use a **#10** bit to drill through the fittings and shell at each of the center-punched locations (four per fitting). Remember to drill perpendicular to the cage shell.

Note Having just positioned and drilled three pairs of aft fittings, you should have three pairs left. These will be used near the end of this section when you install the fuselage struts.

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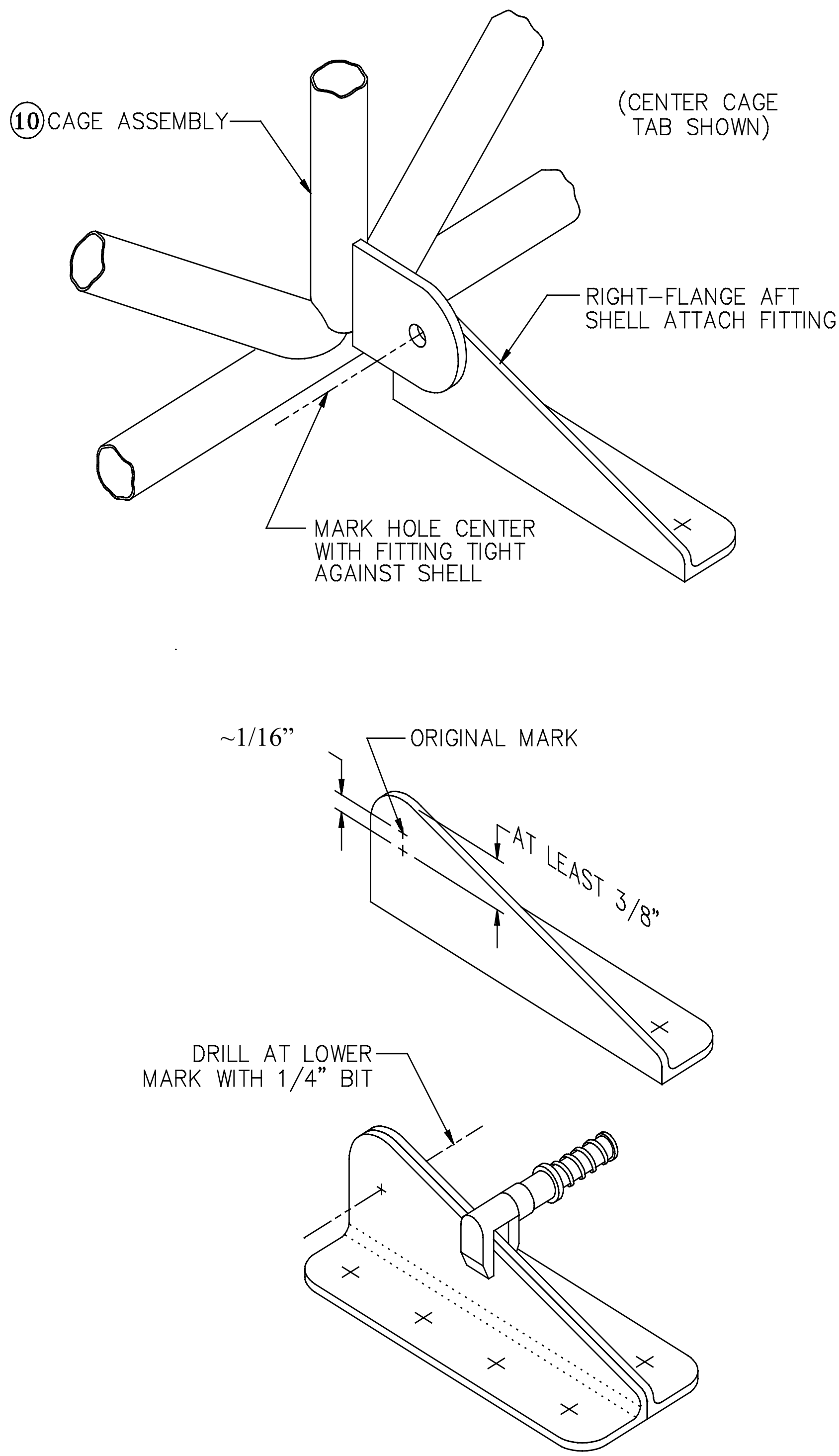


Figure 32: Drilling the Cage Attach Bolt Holes in the Aft Fittings

Step 28: Install the Upper, Lower and Aft Shell Attach Fittings

In positioning and drilling the ten shell attach fittings, you drilled forty-two #10 holes through the fuselage shells. Countersink each of these holes on the **outside** of the shell to accommodate AN509-10 **screws** [64—68]. Be careful to avoid countersinking too deeply.

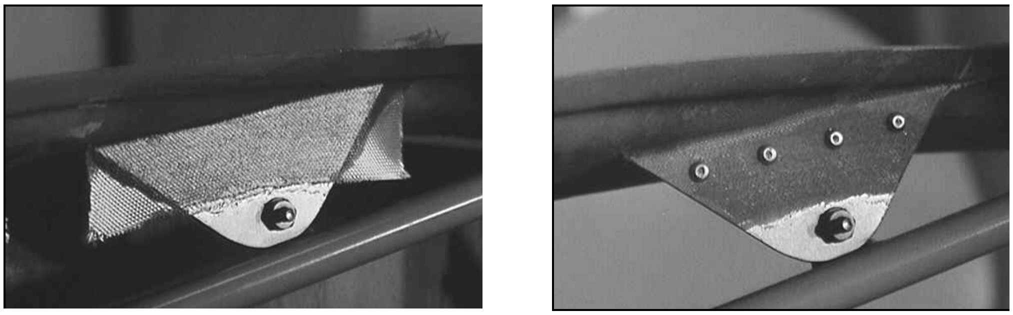
Install the fittings with screws of the appropriate length, AN960D10 **aluminum washers** [76] and AN364-1032A nylon self-locking nuts. Also, secure the lower aft fitting pairs to the cage tabs with AN4-6A bolts, AN960D416 **aluminum washers** [78] (under both the bolts and nuts) and AN364-428A **nylon self-locking nuts** [47]. Put the nut on whichever side of the fitting pair makes it easiest to tighten.

Note The door handle bushings should protrude slightly beyond the shells. Do not grind or file these flush; the offset is necessary for the door handles to clear. However, you should mix a small batch of Q-cell and fill in the gaps between the bushings and the shells. If a bushing protrudes more than 1/32", make a smooth Q-cell fillet between the shell and bushing.

Completed: [ ]

Step 29: Install the Forward Shell Attach Fittings

The forward shell attach fittings are used to hold the contour of the upper cowl flange. They are bolted to tabs on the cage assembly and riveted to fiberglass flanges, which in turn are bonded to the shells. Figure 33 shows the left, inboard fitting in the process of installation (a) and completed (b).



(a) **(b)**

Figure 33: Placement of the Forward Shell Attach Fittings.

Begin by sanding each fitting with 80-100 grit sandpaper and bolting each fitting to its respective cage tab. These tabs are arranged vertically on the two firewall tubes at the forward-most, topmost edge of the cage, two tabs per tube. Make sure the contour on the fuselage flanges matches that on the upper cowl. As Figure 33 shows, the fittings are bolted to the **aft** face of each tab. If necessary, trim the wide edges of the fittings so they follow the curve of the shell and bolt them to the tabs with AN3-4A **bolts** [41], AN960D10 aluminum washers (under the nuts only) and AN364-1032A nylon self-locking nuts.

Next, for each fitting cut four small rectangles of bi-directional cloth on the 45° bias. These pieces should be an inch longer and an inch taller than their respective fittings. Mix a small batch of resin and saturate the pieces. Laminate four pieces over the entire **forward face of each fitting** above the bolt and **in the forward direction** onto the fuselage shell. (Note: Figure 33 shows it incorrectly laminated on the aft face and in the aft direction.) Once cured, use a **#30** bit to drill four evenly spaced holes in each fitting directly through the laminate. Deburr these holes on the forward side of the fitting and install 1/8" AAPQ-42 blind rivets with the heads on the aft side of the fitting, as shown in Figure 33b. Finally, trim the laminate even with the edges of each fitting and, if necessary, with the edge of the windshield cut-out of the fuselage shell.

Completed: [ ]

INTERNAL STRUCTURE

Step 30: Mark the Fuselage Waterline

In this section of the fuselage assembly you will install several bulkheads in the fuselage, all of which are positioned with reference to the fuselage waterline—that is, the horizontal axis of the fuselage when the aircraft is in level flight. In this step, you will mark this line on both sides of the fuselage.

First, recheck to see that the fuselage is level laterally by holding a level on the main cross-tube between the forward wing attach lugs. Shim as necessary to bring the cage level.

Figure 34 shows how the endpoints of the waterline are established on the forward and aft ends of the fuselage shell. Hold a long carpenter's level (or a long straightedge with a shorter level attached to it) across the bottom of the fuselage shell at its forward end. As shown in the small side view in Figure 34, the level should be placed at the forward-most point on the shell **excluding the cowling joggle**.

With the level in position and registering level, run a plumb line down the forward-most edge of the shell (again excluding the joggle), past the level. Measure up from the level **20-5/8"** and make a mark. Repeat the process on the other side.

Perform the same process at the tail, placing the level on the aft-most portion of the shell, **excluding the tailcone joggle**. Measure up along the plumb line **2-5/8"** on each side and make a mark.

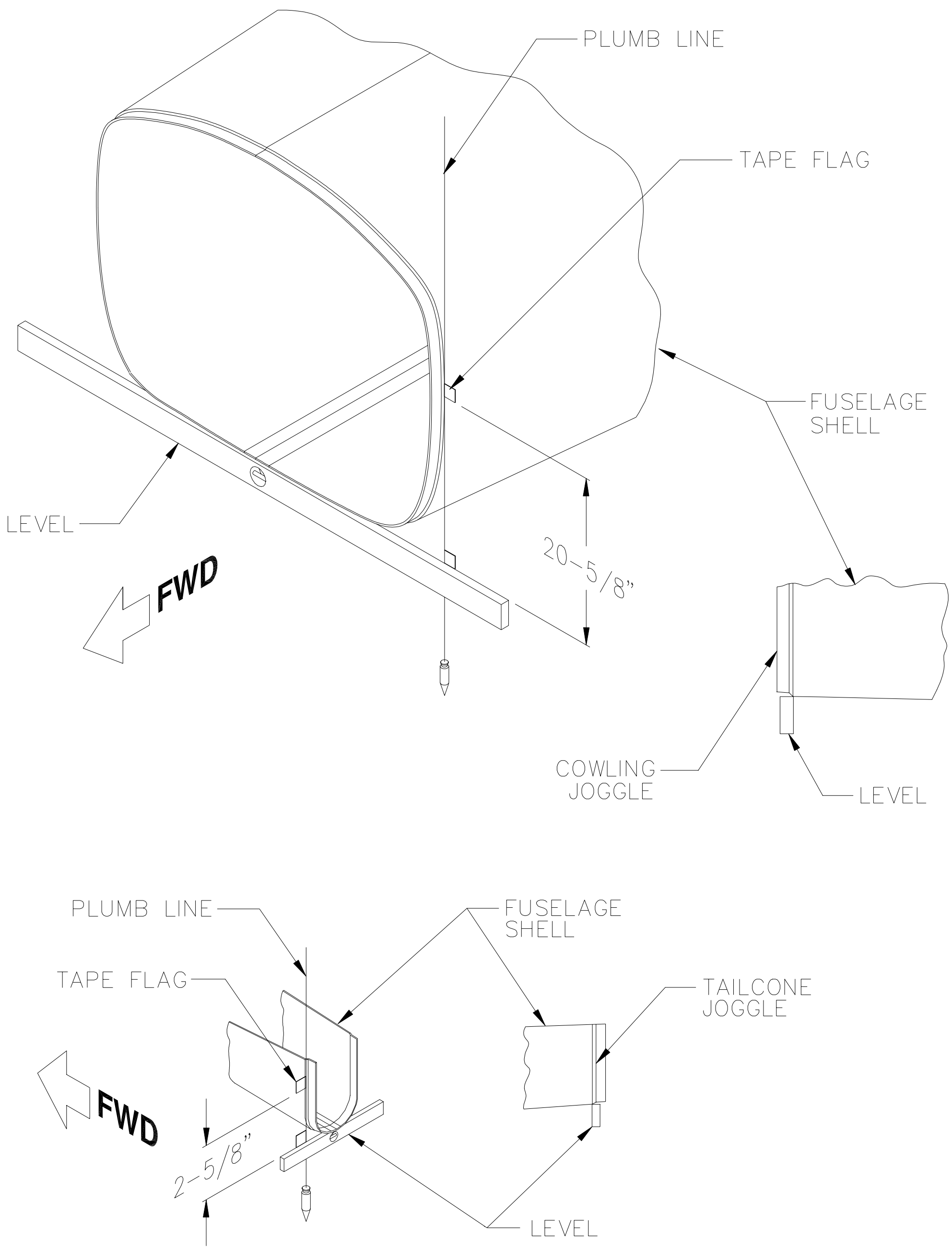


Figure 34: Marking the Waterline Endpoints

With the waterline endpoints marked fore and aft, the next step is to temporarily mount a long straightedge across the forward end of the fuselage between the two marked waterline endpoints, as shown in Figure 36. The straightedge can be metal or wood and of any convenient dimensions, but it should be at least 6' long. (A carpenter's level is ideal.) You can set the straightedge on short support pieces clamped to the shell, as shown in the figure, or you may be able to rest it directly on clamps positioned at an appropriate height. In either case, position the crosspiece such that its **upper** surface is on the waterline marks.

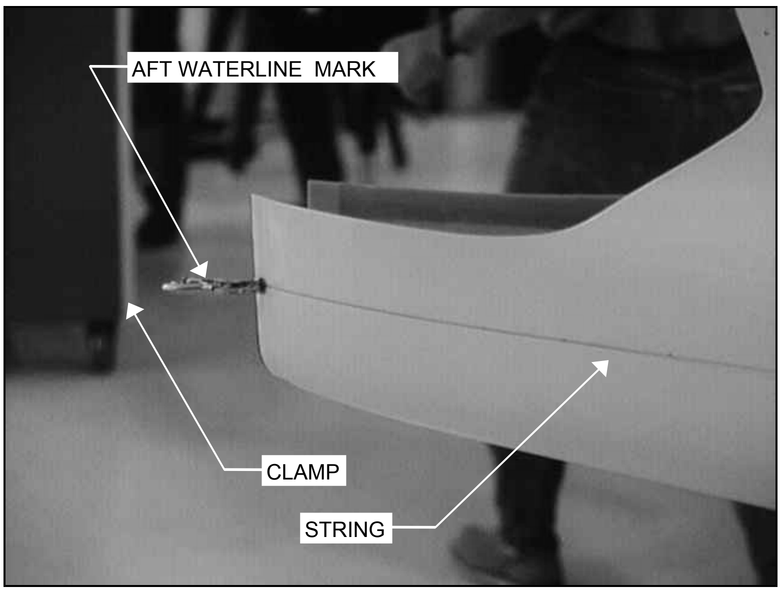


Figure 35: Securing the Aft End of the Waterline String

Next, secure a 21'-long piece of string to the aft end of the fuselage shell **on the waterline mark**. You can do this with a clamp, as shown in Figure 35, or simply by taping it in place with duct tape or masking tape. When the string is attached, have an assistant at the forward end of the fuselage pull this string taut so that it contacts the upper surface of the crosspiece you positioned there. This string is now in the plane of the waterline, and by moving it left and right along the crosspiece, your helper can bring it into contact with the fuselage shell at various points along the waterline. (See Figure 37.)

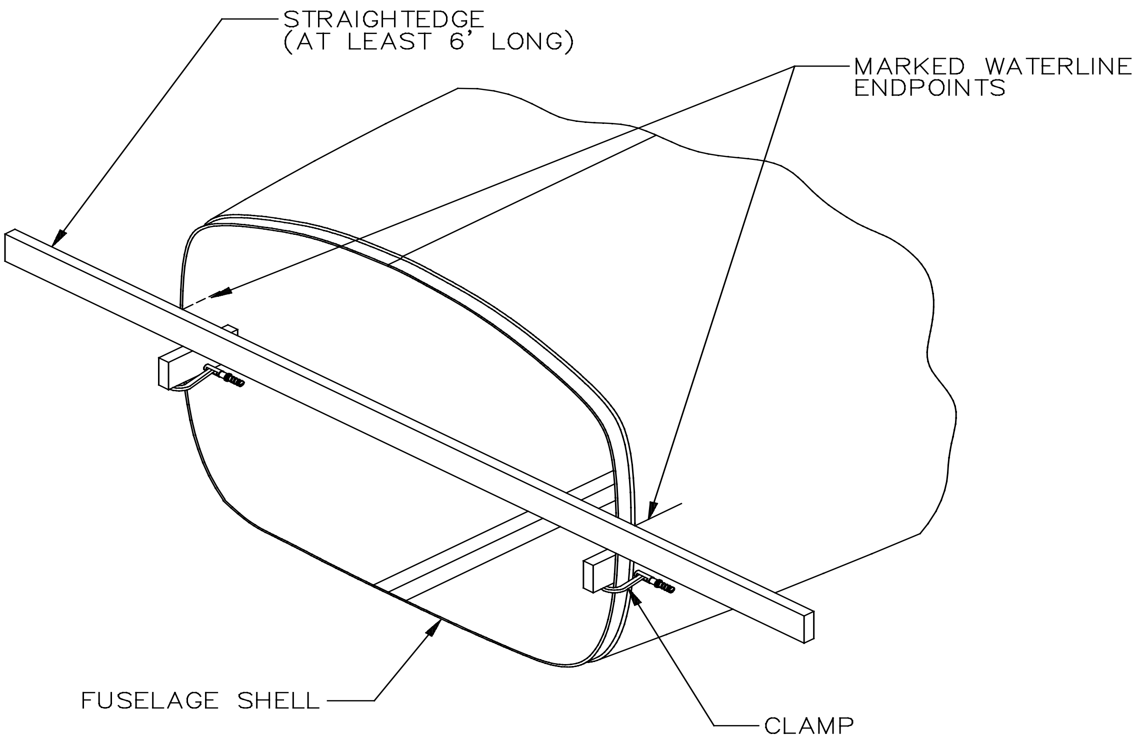


Figure 36: Positioning a Crosspiece on the Waterline

There are only a few locations on each side of the fuselage where you really need to mark the waterline. As your helper moves the string in or out as necessary, mark along the string once every three or four inches in the **aft-most 2'** of the fuselage. Then move forward and mark the waterline on the **forward and aft edges of the door cutouts**.

Hint Because of the curvature of the fuselage (especially in the aft-most section), the string will have a tendency to roll downward as it is moved in against the shell. To avoid this problem, simply use small pieces of tape to secure the string to the shell every few inches in the aft-most couple feet of the fuselage. Make permanent markings on the joggle flanges for future reference. This can be done with the edge of a file and will be covered up by the cowl and the tail cone.

After you've made these marks, remove the string and connect the marks at the aft end of the fuselage with a flexible straightedge. Then reattach the string on the other side of the fuselage and repeat the procedure.

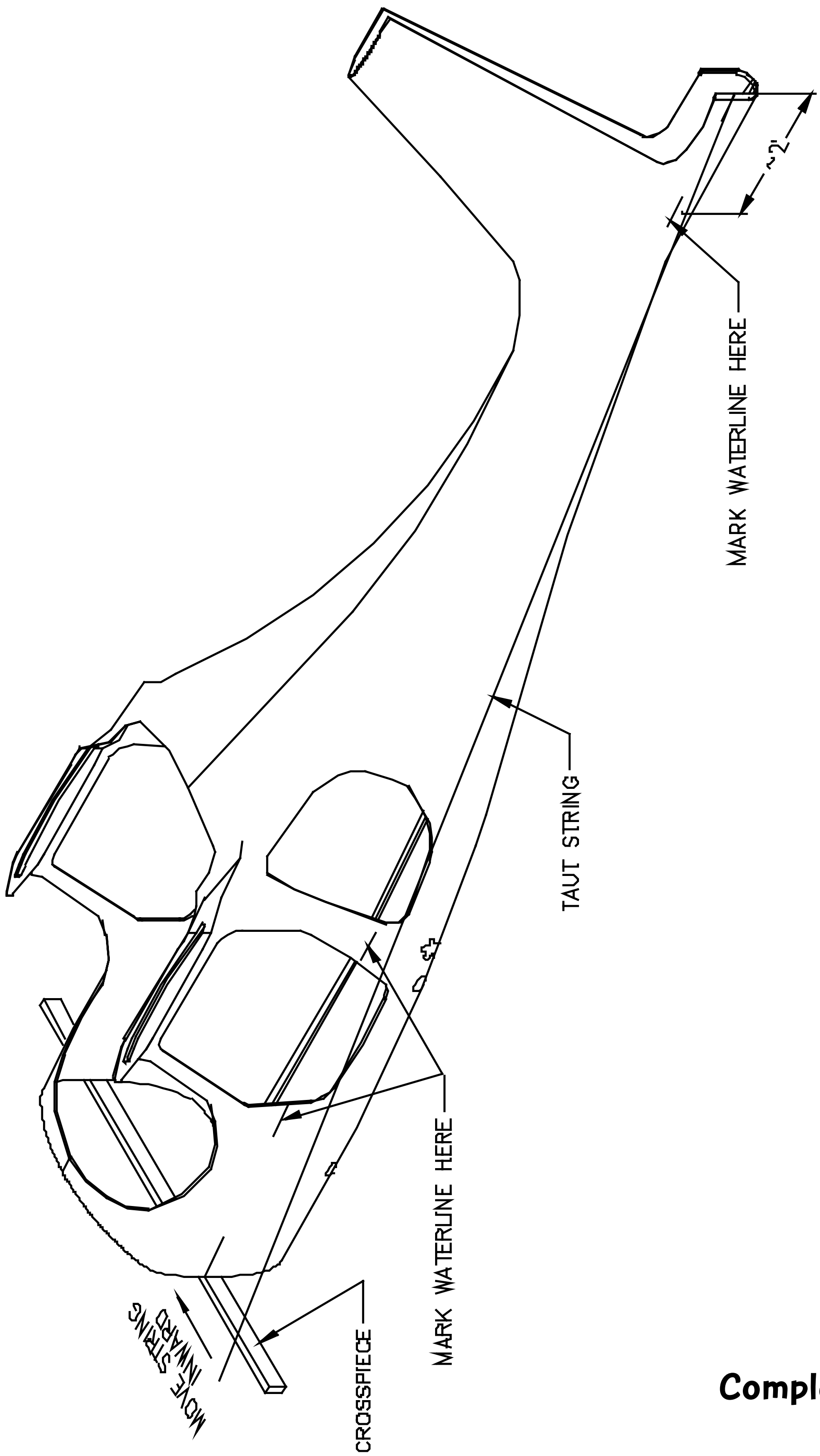


Figure 37: Marking the Waterline

Completed [ ]

Step 31: Cut Out the Vertical Fin Rib

Cut out the **vertical fin rib template** from the **Bulkheads D & E template sheet** [20], cutting about **1/2"** outside the lines all the way around. Use thumbtacks or push pins to tack this template down flat in one corner of the **1/4" X 24" X 30" sheet of 5-lb. foam** [34]. The long dimension of the template should be laid out parallel to the longer edge of the sheet. Use a utility knife to cut out the rib. Make it slightly oversized—about **1/8"** all around.

Caution The full-sized templates provided in the kit for various parts have all been laid out according to the dimensions of parts used in our prototype Sportsman. However, the precise shape and size of many of the parts represented on templates can vary slightly from Sportsman to Sportsman. As a **general rule**, therefore, wherever the use of a full-sized template is called for, we **strongly recommend** first using the template to cut out a mock-up piece from cardboard for trial fitting. After you have adjusted the mock-up piece to fit, you can use it to cut the final piece from the specified material. In the long run, this will save you time, frustration and expense.

Completed: [ ]

Hint In the following steps, you will begin laminating and installing the five fuselage bulkheads. Figure 38 provides a schematic view of the general locations of these bulkheads. Precise instructions for positioning them are contained in the text that follows. **At the time of publication, Glasair Aviation was in the process of developing a prefabricated set of flanged bulkheads. These bulkheads will save you many hours of assembly and greatly simplify the installation process. Contact the order desk for more information.**

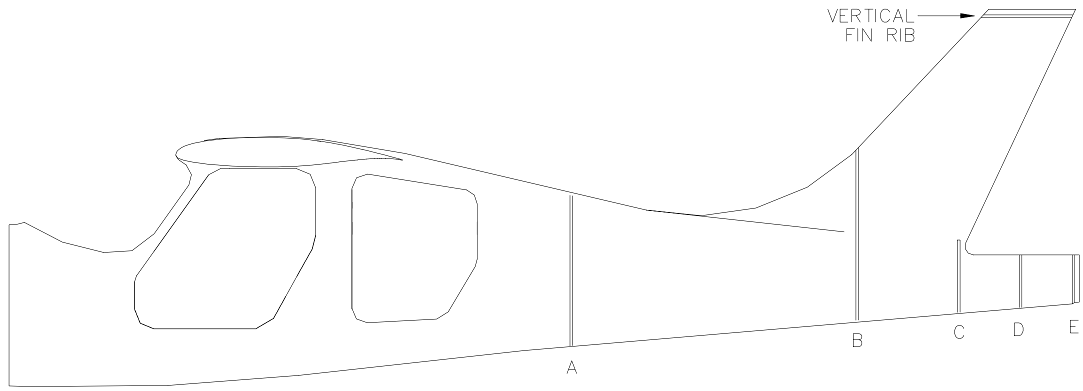


Figure 38: Approximate Bulkhead Locations; Aft face dimensions forward of tailcone joggle.
Bulkhead A = 106.25"; Bulkhead B = 43.0; Bulkhead C = 24; Bulkhead D = 11.56"; Bulkhead E = 1/8" (Reference each bulkhead for specific placement)

Step 32: Rough-Cut the Foam Core for Bulkhead B and Cut and Bevel the Center Hole

Cut out the template for Bulkhead B from the **Bulkheads B & C template sheet** [19], leaving **1/2"** or so excess all the way around the pattern. Tack the template flat on the remainder of the 5-lb. density foam left over from the previous step. Concentrate the tacks around the template's center hole in order to keep the paper taut against the foam in that area.

First, use a utility knife to rough-cut the exterior shape of the bulkhead, using the 1/2"-oversized edges of the template rather than the actual pattern lines as your guide. Then cut out the center hole, cutting right on the pattern line, as shown on the left-hand side of Figure 39. Remove the tacks and set the template aside for later use. Finally, using the utility knife and sandpaper, bevel the inside edges of the hole you just cut to approximately **30°**, as shown on the right-hand side of the figure.

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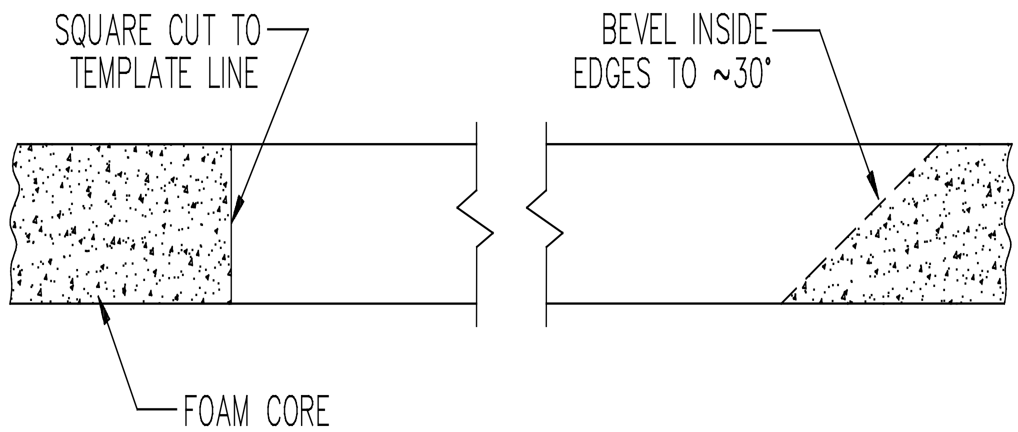


Figure 39: Beveling the Center Hole in the Bulkhead B Foam Core

Step 33: Lay Up and Trim the Bulkhead B Laminate

Bulkhead B is laminated with two layers of bi-directional cloth on one side and one on the other. This forms a three-ply laminate in the center hole. Before beginning the lamination, seal both faces and the beveled edge of the foam with a thin Q-cell mixture, as described in "SECTION II: TOOLS AND TECHNIQUES." Then cut three pieces of cloth on the 45° bias, each about **1/2"** larger all around than the foam.

Figure 40 illustrates the laminating procedure. Begin by laying the foam on a smooth, waxed or plastic-covered laminating surface with the beveled side up.

> **Hint** In a subsequent step, you will need a **30" X 30"** laminating surface to lay up Bulkhead A, so you may as well use such a surface for the smaller bulkhead laminates as well. Well waxed Formica, Masonite, plate-glass and sheet metal are all appropriate materials for this surface.

As shown in Figure 38a, apply one layer of cloth, making sure that it follows the bevel all the way down to the surface of the laminating table. Saturate the cloth with resin, both inside the center hole and on the foam. As indicated in the figure, try hard to eliminate any bubbles where the cloth leaves the beveled foam and contacts the table.

After the first ply is cured, turn the laminate over and use acetone to remove any residual wax or other contaminants. Then thoroughly roughen the smooth face of the laminate in the center hole with 80-grit sandpaper. Finally, apply two layers of cloth to the other side of the laminate, as shown in Figure 40b.

After the laminate has cured, use spray adhesive to re-affix the Bulkhead B template to the laminate, lining up the center hole of the template with the hole in the foam core. Use a saber saw to cut the laminate to the final outside shape.

Finally, remove the template and cut out the three-layer laminate in the center hole to finish the bulkhead. However, don't cut all the way to the edge of the foam core; leave at least a 3/8" lip of three-layer laminate, as shown in Figure 40c. Start this cutout with a large drill bit or hole cutter and proceed with snips or a sabersaw. Finish up the hole by rounding the edges with sandpaper (Figure 40d)

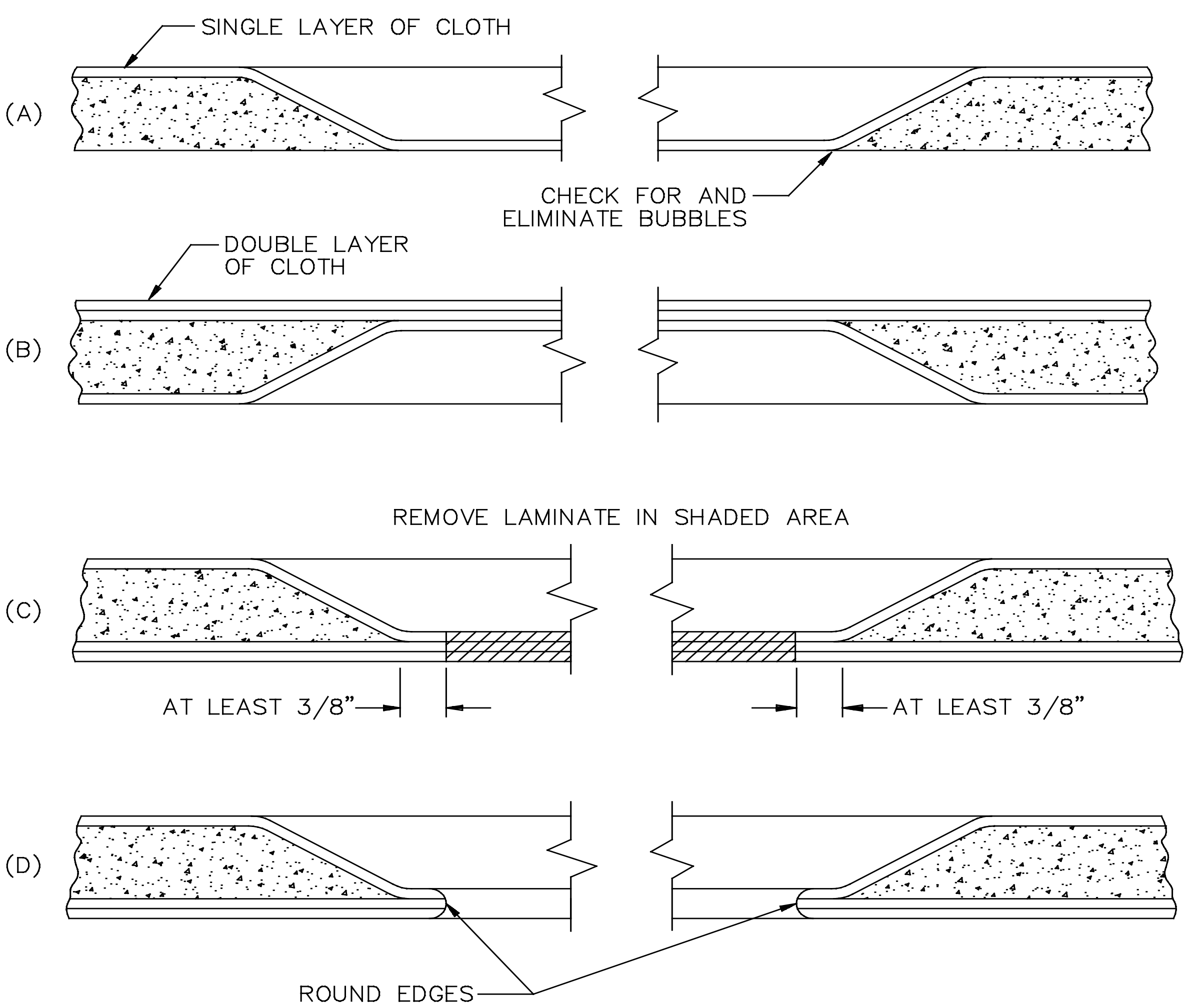


Figure 40: Laying Up and Trimming the Bulkhead B Laminate

Hint Cutting fiberglass laminates is hard on snips and saw blades. You may want either to dedicate a cheap pair of snips and/or a bandsaw blade exclusively to this purpose or else use a saber saw with a carbide grit blade designed expressly for cutting fiberglass.

Completed: [ ]

Step 34: Lay Up and Trim the Laminate for Bulkheads C, D and E

Bulkheads C and D are cut from a single laminate of 20-lb. density foam with two layers of bi-directional cloth on either side. Begin, therefore, by cutting four pieces of bi-directional cloth on the 45° bias, each large enough to cover the entire **3/16" X 24" X 24" sheet of 20-lb. foam** [17]. It is not necessary to seal the 20# foam core as is done with 5# density. Apply two layers of cloth to one side of the sheet, let cure, and then apply the remaining two layers to the other side.

Bulkhead E is fabricated from a (10) ply thick laminate of 7781 cloth. Wax your flat surface (approximately 8" x 10" in size) and laminate (10) plies together with a batch of 100 grams of vinylester resin.

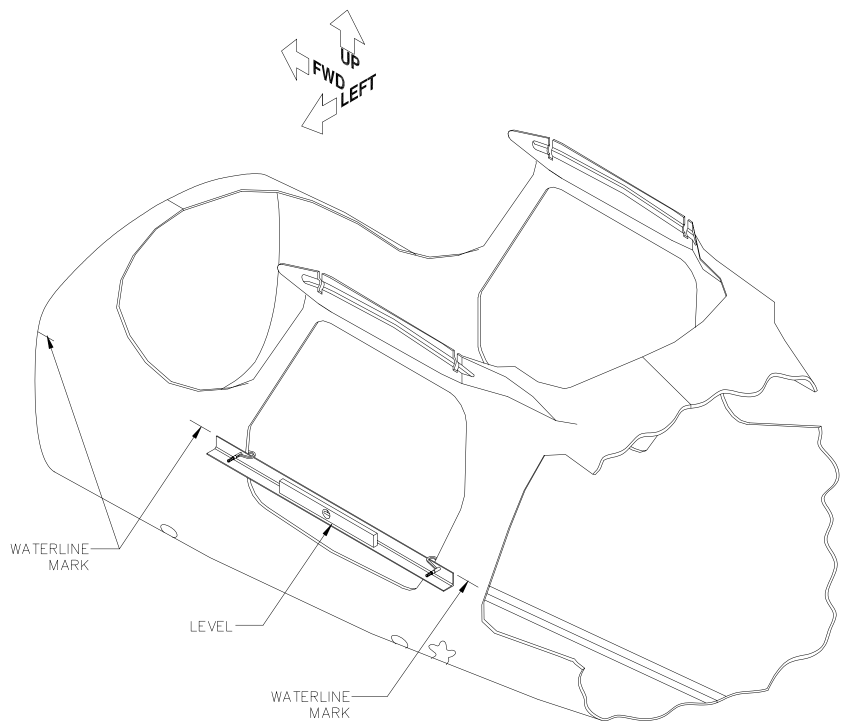
After the laminates have cured, use spray adhesive to affix the templates for the bulkheads to the laminates. Use a bandsaw or saber saw to cut out the bulkheads, cutting right on the pattern lines.

Hint When you've finished cutting out a part using a template (either our paper version or a cardboard one), **don't** toss it out. In many cases—especially with these fuselage bulkheads—the template will come in very handy just a few steps down the road for cutting cloth reinforcement laminates for the part in question.

Completed: [ ]

Step 35: Level the Fuselage Longitudinally

In order to install the bulkheads properly, it's necessary first to make sure that the fuselage waterline is precisely horizontal. You can achieve this using the waterline marks you made at the forward and aft edges of the door cutouts. As shown in Figure 41, clamp a piece of metal angle or a straight piece of wood across the cutout with its ends on the waterline marks. Then, with a level (preferably a digital level) on the crosspiece, raise or lower the tail of the fuselage as necessary to bring it level.



Completed: [ ]

Figure 41: Leveling the Fuselage Longitudinally

Step 36: Temporarily Install Bulkhead B

Bulkhead B is located in the aft fuselage **approximately 43" +/- 1"** forward of the tailcone joggle. An exact position of this bulkhead is not crucial, since no other structure or critical systems attach to it. It sits approximately perpendicular to the fuselage waterline and centerline with the narrow projection at the top inserted into the vertical fin, as shown in Figure 42. It should simply be placed as close to 43" as possible without distending the fuselage shells. Neither is it important which way the beveled side faces. Once the bulkhead is roughly positioned, use a level to check for perpendicularity to the waterline. Simply eyeball it for perpendicularity to the centerline.

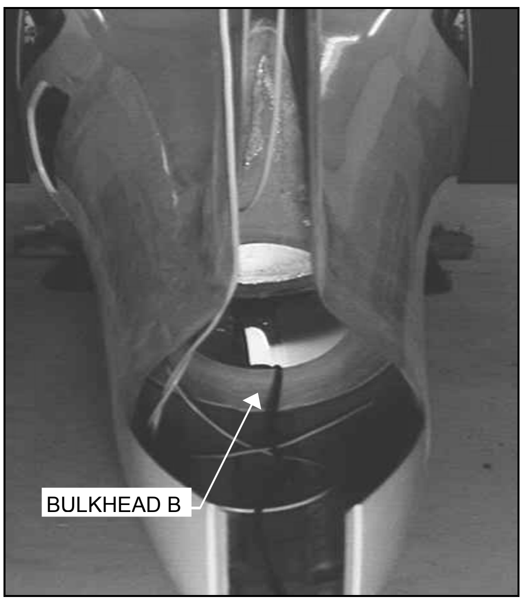


Figure 42a: Placement of Bulkhead B

When you're satisfied with the position of the bulkhead, tack-glue it into position if necessary with a few blobs of hot-melt glue. (The friction fit of the bulkhead may make this unnecessary.)

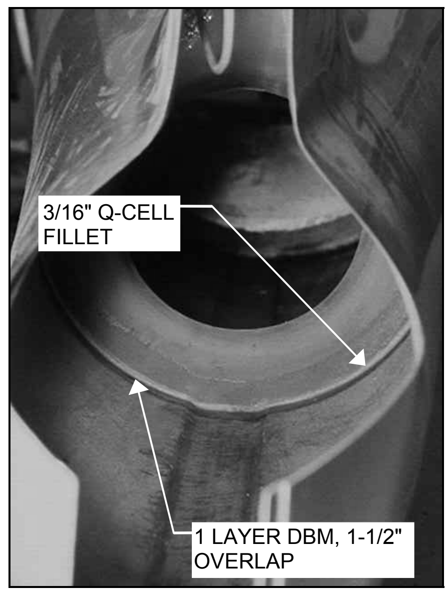


Figure 42b: Installing Bulkhead B

Completed: [ ]

Step 37: Align and Cleco the Vertical Fin Half

Now you will position the right vertical fin half and cleco it into place. The final bonding of the vertical fin will be done near the end of the fuselage section to provide installation access to bulkheads B & C, however it is important to attach and plumb it now.

The vertical fin half is put into position by overlapping the joggles from the fuselage and the other half of the vertical fin. The seam created by the overlapping of these joints may not be exactly in line with the seam that runs down the back of the fuselage. What is important is to create a clean leading edge that is evenly rounded in the front and symmetrical on both sides.

It is a good idea to clamp the **vertical fin spar [2]** roughly into place in the vertical fin. This will provide the fin with some support and alignment while you tweak the fin half into place.

Based on several Jump Start assemblies performed at the factory, there is a slight left twist tendency in the vertical fin that needs to be straightened. (The same holds true on all Sportsman for that matter.) We place a wood brace against the base of the vertical fin on the right side. Approximately halfway up the leading edge, we pull the fin to the right past center as we drill and install the leading edge clecoes and those at the base joggle. The pulling can be accomplished using a strap and will be done both at initial drilling and later at the final bonding.

There are three steps, which will serve to hold the vertical fin perpendicular to the stabilizer and straight with no twist. Care should be taken at all three of these steps to be sure it is aligned properly.

1. When the upper portion of bulkhead B and the vertical fin right side are bonded in place.

2. When the vertical fin spar is bonded, riveted and bolted in place.

3. When the upper vertical fin rib is bonded in place.

Begin by checking again to see that the fuselage is still level laterally and is secure. Once you're satisfied that the fuselage is level, drop a plumb line from the center of the vertical fin spar clamped into position as shown in Figure 43. Obviously, it's good news if this falls within 1/4" of the center of the tail cone opening. If it's off, then you'll have pull the vertical fin to one side and then reset the clamps.

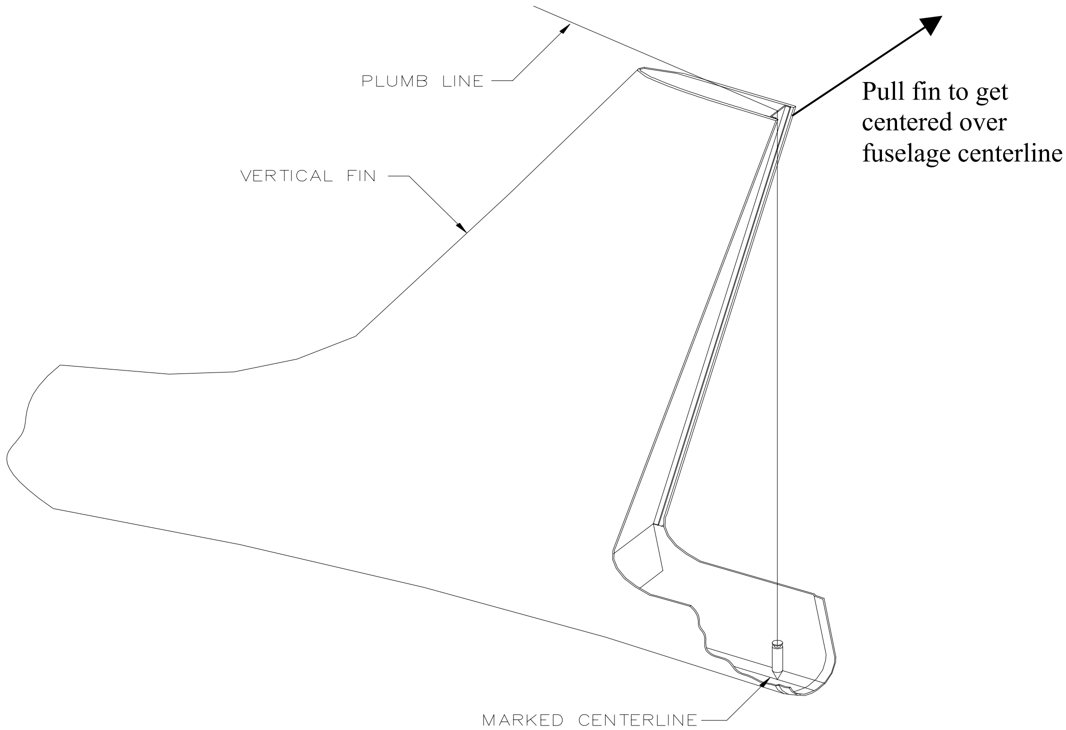


Figure 43: Plumbing the Vertical Fin

It's a good idea to tape a 3-4' straight edge along the top of the vertical fin so that it extends forward. Make sure that it is centered on the leading edge of the fin and the center of the trailing edge. Exact measurements are not necessary. Using a ladder, sight down the straight edge. It should be very obvious if there is a twist in the fin. Move around to the front of your airplane, and while standing on the ground, sight down the middle portion of the vertical fin. The fin should be of even thickness on both sides of the leading edge all the way to the top.

As you adjust one setting, you may have to reset and realign the other. **Be patient**. This is a setting that you will repeat later before final bonding of the vertical fin half, but you will save yourself work if you do it correctly now.

Once the vertical fin half is in place and there is no visible twist in the fin, drill and cleco every 2-3 inches along the leading edge and along the base of the right hand side of the fin. Do not drill any through the aluminum spar at this time.

Note: When sanding or grinding off material to smooth and round the leading edge, do not grind from the free vertical fin half. This would remove material from the joggle joint and weaken the bond. Instead, attempt to grind only from the side of the vertical fin that was formed with the fuselage. The only exception to this is the forward, pointed end where the joggle joint needs to be sanded to a point in order to fit properly.

Completed [

Step 38: Laminate the Lower Portion of Bulkhead B into Position

Remove the rear spar of the vertical fin and inspect the fit of the bulkhead to the vertical fin. High spots should be sanded down and low spots will be filled in with Q-cell radius material. When you're satisfied with the position of the bulkhead, you can begin the process of laminating the bulkhead into position. Remove the vertical fin and sand down the fuselage and vertical fin where the bulkhead is located and clean thoroughly. Be careful, as the inner ply of the shell is only one layer thick. Provide a 3/8" diameter drain hole on the very bottom of the bulkhead so water may pass and not collect.

Mix a **thick** batch of Q-cell and apply a 3/16"-radius (i.e., a finger's width) fillet around the entire perimeter of the bulkhead on both the forward and aft sides on the lower portion of the bulkhead only. Do not apply any fillet to the part of the bulkhead that contacts the vertical fin. Make sure the Q-cell mixture is thick enough to stick to the shells without running. Use extra Q-cell wherever it's needed to fill in all the gaps between the bulkhead and the shell. Do not fill the drain hole closed! **Before the Q-cell has time to cure, reinstall the vertical fin and pull into its straight position.**

Remove the fin after the Q-cell has cured. Bulkhead B is secured with a single layer of DBM cloth on both the forward and aft faces inside the round shell and a single layer on the aft face up the vertical fin. The upper portion on the left side is done now, the right side is done later. Cut eight strips of DBM, each about 20" long.

Hint You'll find it easier by far to pre-saturate the DBM pieces outside the fuselage. Remember, the mat side of the DBM goes down.

Catalyze a batch of resin and laminate some of these strips end to end into the angle between the bulkhead and the shell around the entire perimeter of the bulkhead and up the left side of the vertical fin. The strips should overlap equally onto both bulkhead and shell, and each strip should overlap the one next to it by an inch or so. As usual, be sure to press the cloth tightly into the corner radii and see that all air bubbles are relieved.

Reinstall the RH fin, cleco and support it in a vertical and streamline position. Do not move the fin until the laminates have cured. Laminating the RH fin will be done at a later step. Save one piece of DBM cloth about 12 inches long for this job.

Remove the fin after the DBM laminates have cured. Verify the drain hole is clear in the bottom of the bulkhead. This is necessary to allow any water that gets inside the fuselage to flow out of the aircraft rather than pooling behind sealed bulkheads.

Completed: [ ]

Step 39: Press In the Upper Rudder Hinge Bushing

The rudder pivots at its upper hinge on an NAS77A4-025 **flanged bronze bushing** [89]. Press this bushing using Loctite into the **upper rudder hinge** [3], as shown in Figure 44.

Completed [ ]

Step 40: Temporarily Mount the Lower Rudder Hinge on the Rudder Yoke

As shown in Figure 45, the tongue of the rudder yoke fits between the two tongues

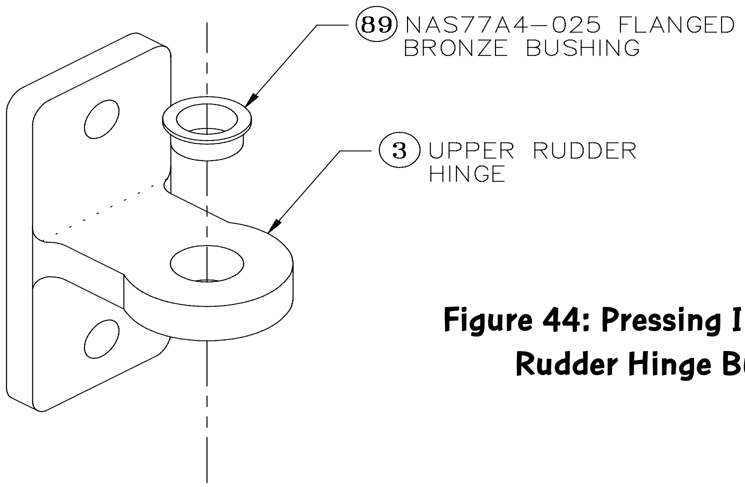


Figure 44: Pressing In the Upper Rudder Hinge Bushing

of the **lower rudder hinge** [1] with two AN960D416L **thin aluminum washers** [79] as spacers. Note that the tongues of the hinge angle **downward** so that the base of the hinge is vertical when the rudder yoke tongue is in place.

> **Note** You may need more than one AN960D416L spacer washer on one or both sides of the bearing in the rudder yoke. Install as many as necessary to minimize play. To simplify installation, use wheel bearing grease to stick the washers to each other and to the yoke bearing prior to sliding the whole assembly between the tongues of the hinge.

The hinge and yoke are then held together with an AN4-10 **drilled-shank bolt** [54], an AN960D416L thin aluminum washer and an AN310-4 **castle nut** [43]. At this point, you need only finger-tighten the nut.

> **Note** The hinge pivot bolt will be secured ultimately with an AN380-2-2 **cotter pin** [51], but there is no reason to install this now.

Completed: [ ]

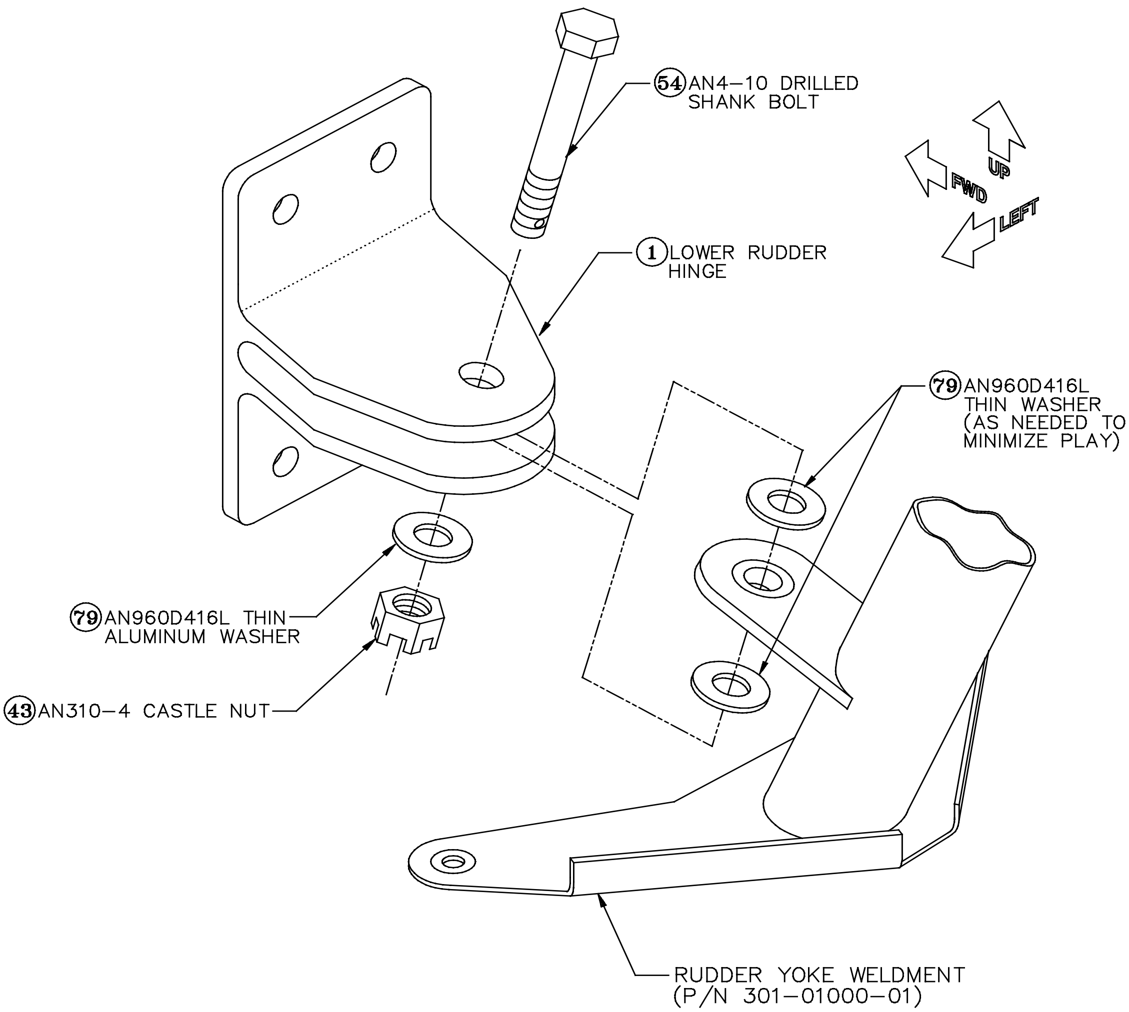


Figure 45: Mounting the Lower Rudder Hinge on the Rudder Yoke

Step 41: Temporarily Mount the Upper Rudder Hinge on the Vertical Fin Spar

Temporarily mounting the upper rudder hinge on the vertical fin spar facilitates positioning the spar and hanging the rudder. Begin, as shown in Figure 46, by marking a centerline on the web of the spar. The line should be marked on the face of the web **inside** the flanges and should extend at least **4"** or so down the spar from the tip. Next, mark a hole location on the centerline **1.6"** down from the tip of the spar. Center punch this location and drill a **1/4"** hole there.

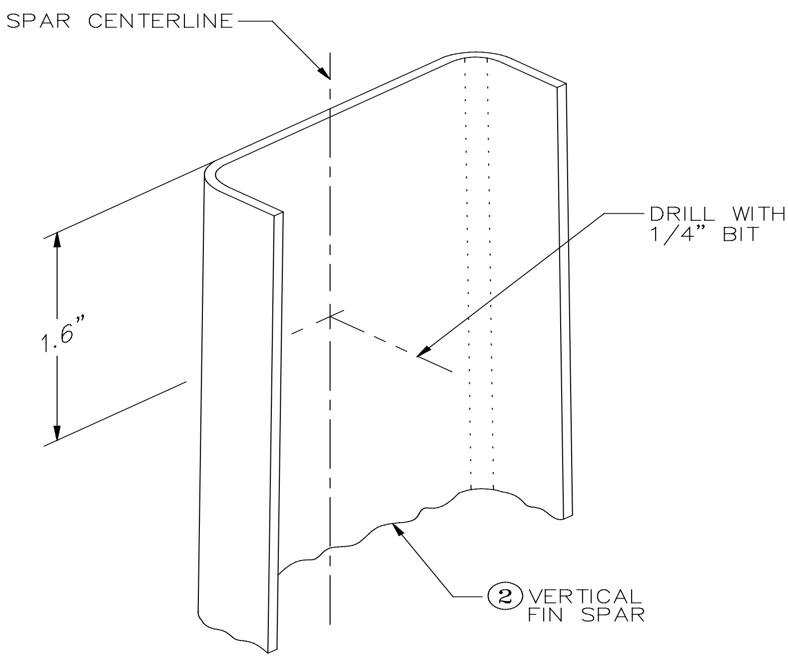


Figure 46: Marking and Drilling the Initial Upper Rudder Hinge Hole

Once the 1/4" hole has been drilled, insert an AN4-5A **bolt** [57] through the upper rudder hinge and the spar, as shown in Figure 47. The bolt should fit through both holes with a moderately tight press fit.

After you have inserted the bolt, secure it temporarily with an AN960D416L thin aluminum washer and an AN316-4R **jam nut** [45], as shown in the figure. Just make this nut finger-tight. Finally, rotate the hinge as necessary to center the lower hole over the spar centerline, as shown in Figure 47, and use the hinge hole as a guide to drill through the spar web. Secure the bolt temporarily with an AN960D416L thin aluminum washer and an AN316-4R jam nut as before.

Note The hinge will be permanently secured with nutplates in a later step.

Completed: [ ]

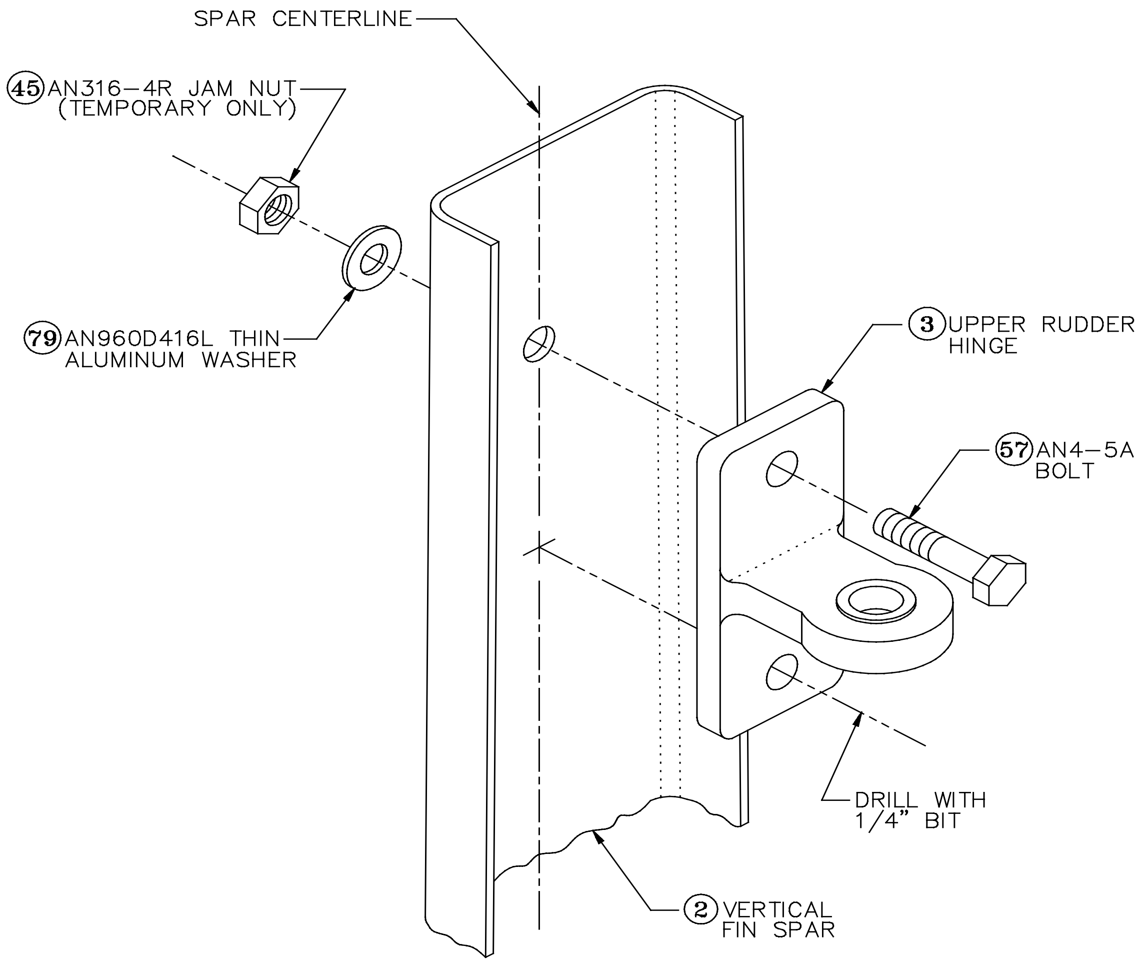


Figure 47: Mounting the Upper Rudder Hinge

Step 42: Temporarily Join the Upper Hinge Halves

In this step you will temporarily mount the upper hinge on the rudder, thereby positioning the vertical fin spar relative to the rudder in preparation for positioning the spar between the composite fin shells.

As shown in Figure 48, the tongue of the upper rudder hinge fits between the two tongues of the rudder-side hinge with two AN960D416L thin aluminum washers as spacers. The hinge halves are then held together with an AN4-10 drilled-shank bolt, a third AN960D416L washer and an AN310-4 castle nut. At this point, you need only finger-tighten the nut.

Note The hinge pivot bolt ultimately will be secured with an AN380-2-2 cotter pin, but there is no reason to install this now.

Note The base of the lower rudder hinge ultimately will be bolted through the flat, lower flange of the vertical fin spar to Bulkhead C. At this point, however, it is simply functioning as a spacer, holding the spar the proper longitudinal distance away from the rudder leading edge.

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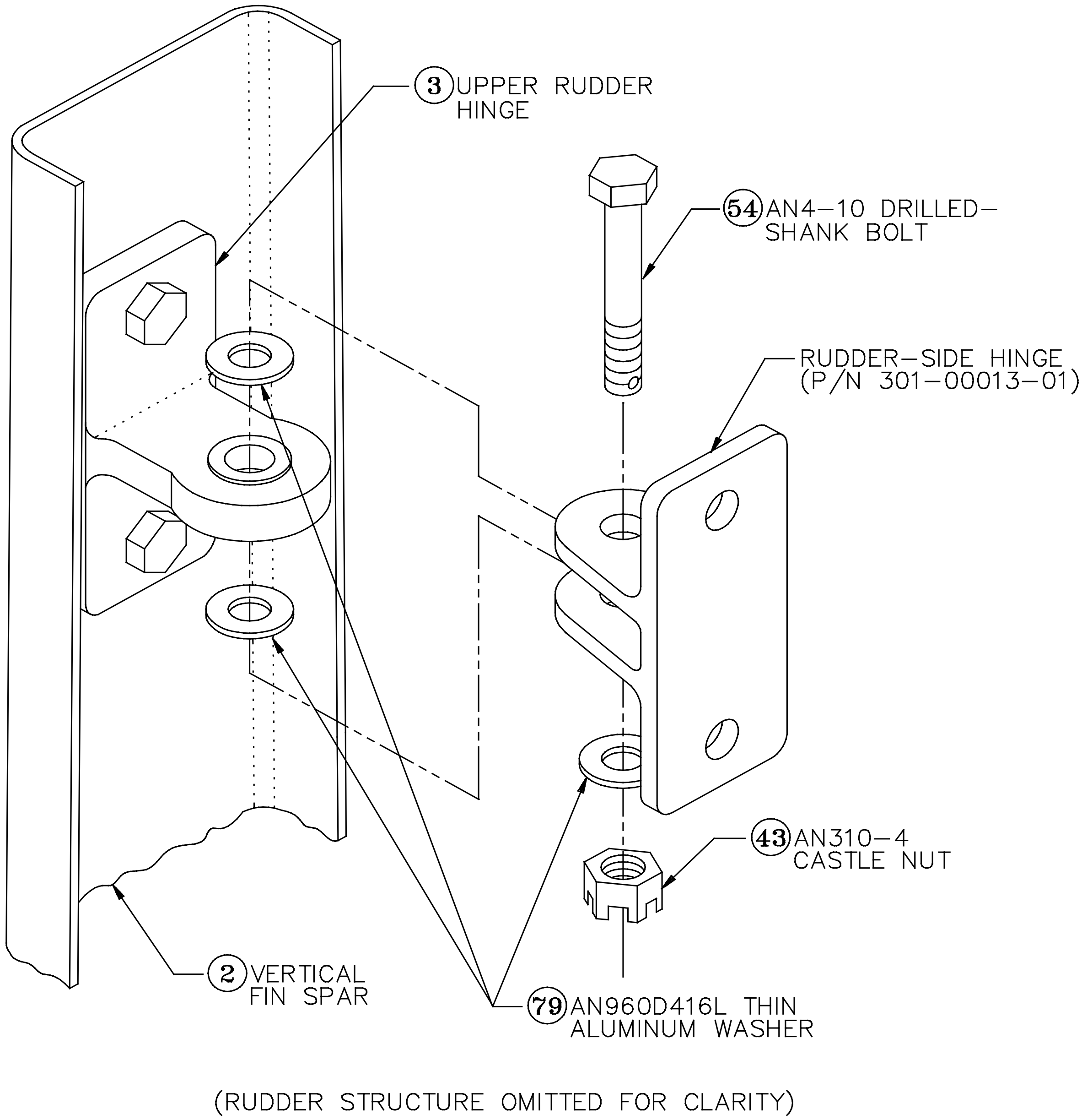

Figure 48: Joining the Upper Rudder Hinge Halves

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82:

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61:   By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

Step 43: Sand the Tops of the Vertical Fin Shells

In the next step, you will "hang" the rudder by its counterweight rib from the tops of the vertical fin shells to position the vertical fin spar between the shells. In order for this method to provide accurate positioning, it's necessary that the tops of the fin shells be parallel with one another and with the waterline plane of the aircraft. Install the right fin half if it is not already on.

First read and study steps 44 and 45 to gain a full understanding of how the rudder is aligned with the vertical fin, and that you do not sand too much off the vertical fin top.

Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel. Use a level both along the lengths of the shells and across them to check for parallelism.

Note Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section. Continue to ignore the trailing edges of the fin shells, however; they'll be dealt with a few steps later.

Note The right vertical fin half will be bonded in place after bulkhead C is in place. It will be much easier to laminate C into place with the access available when the vertical fin is removed. Keep in mind during the subsequent steps of positioning the rudder and the vertical fin spar, that the vertical fin will eventually have to be plumbed and bonded.

Completed: [ ]

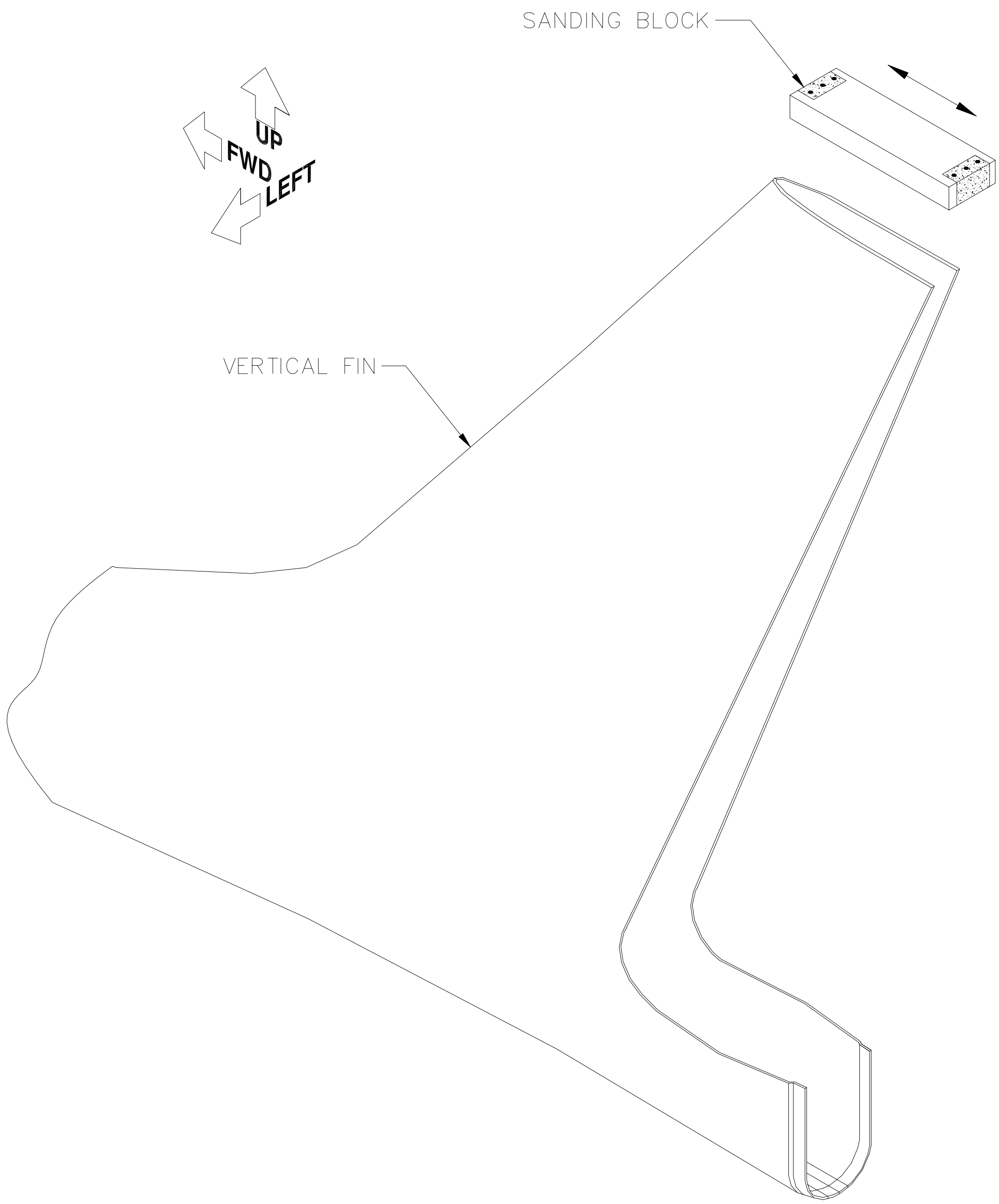

Figure 49: Sanding the Tops of the Vertical Fin Shells

Step 44: "Hang" the Rudder Assembly from the Tops of the Vertical Fin Shells

Note This step will be very difficult to accomplish without an assistant and a step ladder.

These next several steps will be used to position and bond in Bulkhead C. The rudder, rudder hinges, and the vertical fin spar all determine how and where Bulkhead C is located.

Slide Bulkhead C into position a little further forward than necessary.

Positioning the vertical fin independently would be a tremendous challenge because of the absence of firm points on the fuselage shells from which to take measurements. For this reason, you will essentially use the rudder assembly as a jig to hold the spar in position relative to the vertical fin shells until some index holes can be drilled and the bulkhead position marked.

Begin by arranging two shims across the tops of the vertical fin shells, as shown in Figure 50. These shims should be **1/8"** thick. The other dimensions are completely non-critical, as long as the shims are long enough to span the top of the fin. Place one shim near the leading edge of the fin and one near the trailing edge. Again, these placements are not critical.

Hint Two tongue depressors or popsicle sticks stacked together make a fine shim.

With the shims in place, have your assistant move the rudder assembly (with the vertical fin spar attached) into position, as shown in Figure 50. Hold the trailing edges of the vertical fin shells apart to allow the spar to nest in between them. Push the rudder assembly forward until its leading edge is even with the leading edge of the fin. Then lower the assembly until it contacts the shims.

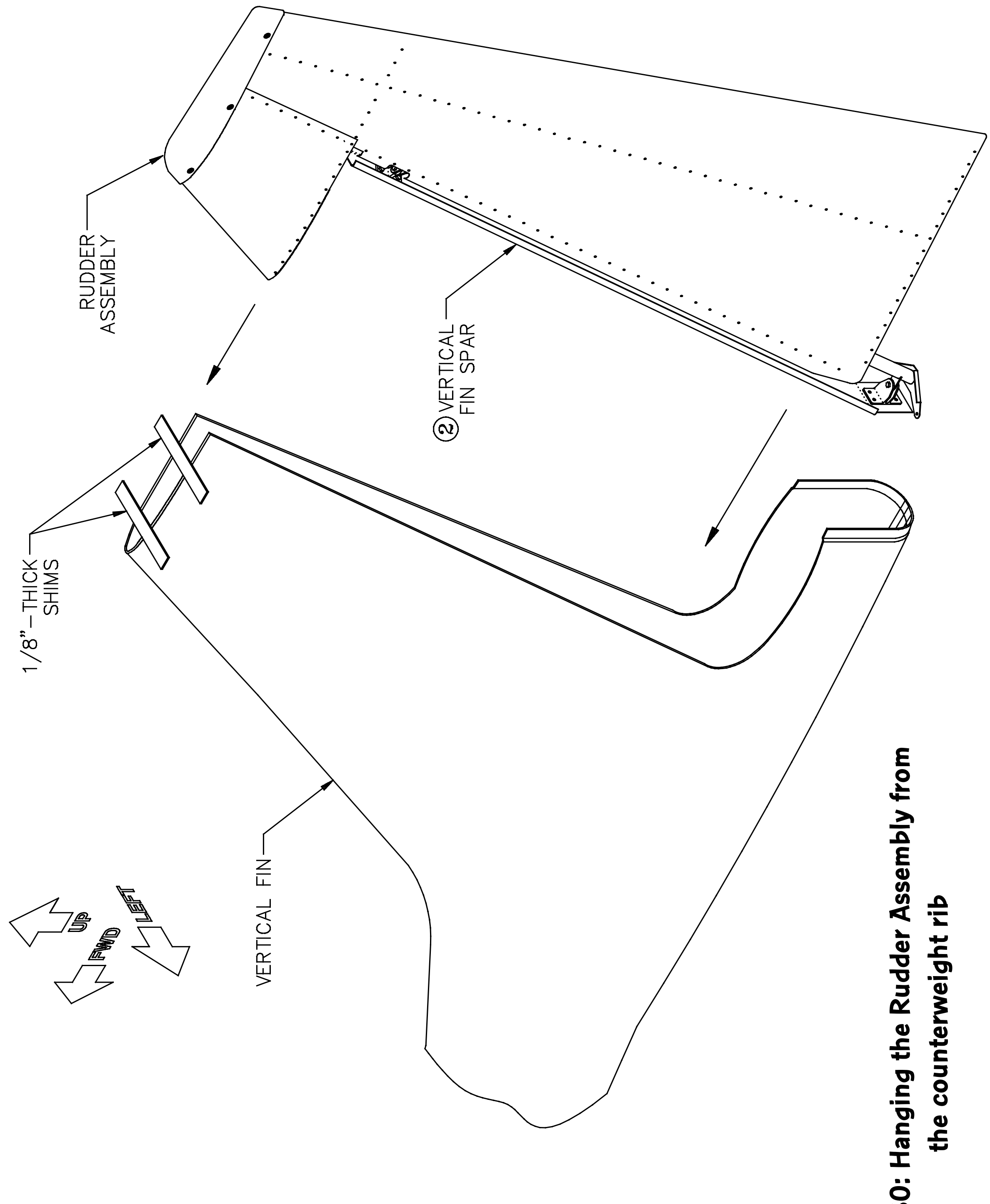

Figure 50: Hanging the Rudder Assembly from the counterweight rib

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86:

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

Note For the forward rudder skin to perform its function of positioning the vertical fin spar and rudder assembly relative to the fin shells, it's important that its lower edges—the ones that contact the tops of the fin shells—be level and parallel. It's not unusual for minor misalignments of the skin to result in one edge hanging down a little lower than the other or in a small downward projection at the very leading edge. Such misalignments are shown (exaggerated for clarity) in Figure 51. Use a fine-toothed file or a sander to dress these out. Avoid contacting the underside of the counterweight rib, but take off as much skin below the rib as necessary.

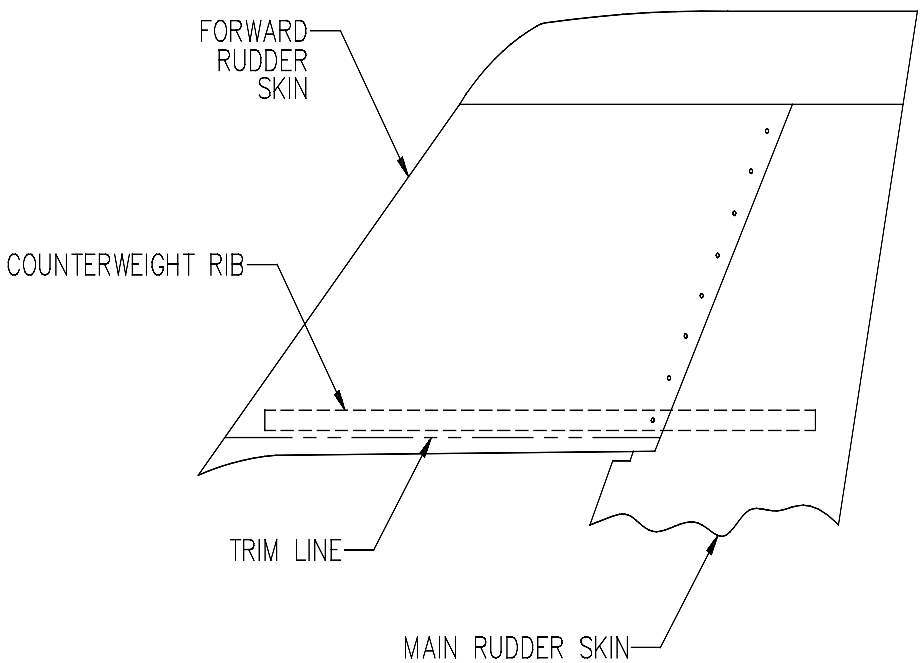

Figure 51: Trimming the Forward Rudder Skin

As Figure 51 shows, the **fore-and-aft** position of the vertical fin is set by the alignment of the leading edges of the rudder and fin. Before drilling index holes through the spar, it's necessary to lock in this reference relationship. A simple and effective method for doing this is to tape a length of aluminum angle stock across the gap between the two parts. As shown in Figure 52, simply slide the rudder assembly forward or aft on the shims until its leading edge forms a continuous line with the leading edge of the fin and then use duct tape or wide masking tape to secure a piece of angle stock across the gap. The longer the angle stock and the more tightly you tape it in place, the better your results will be.

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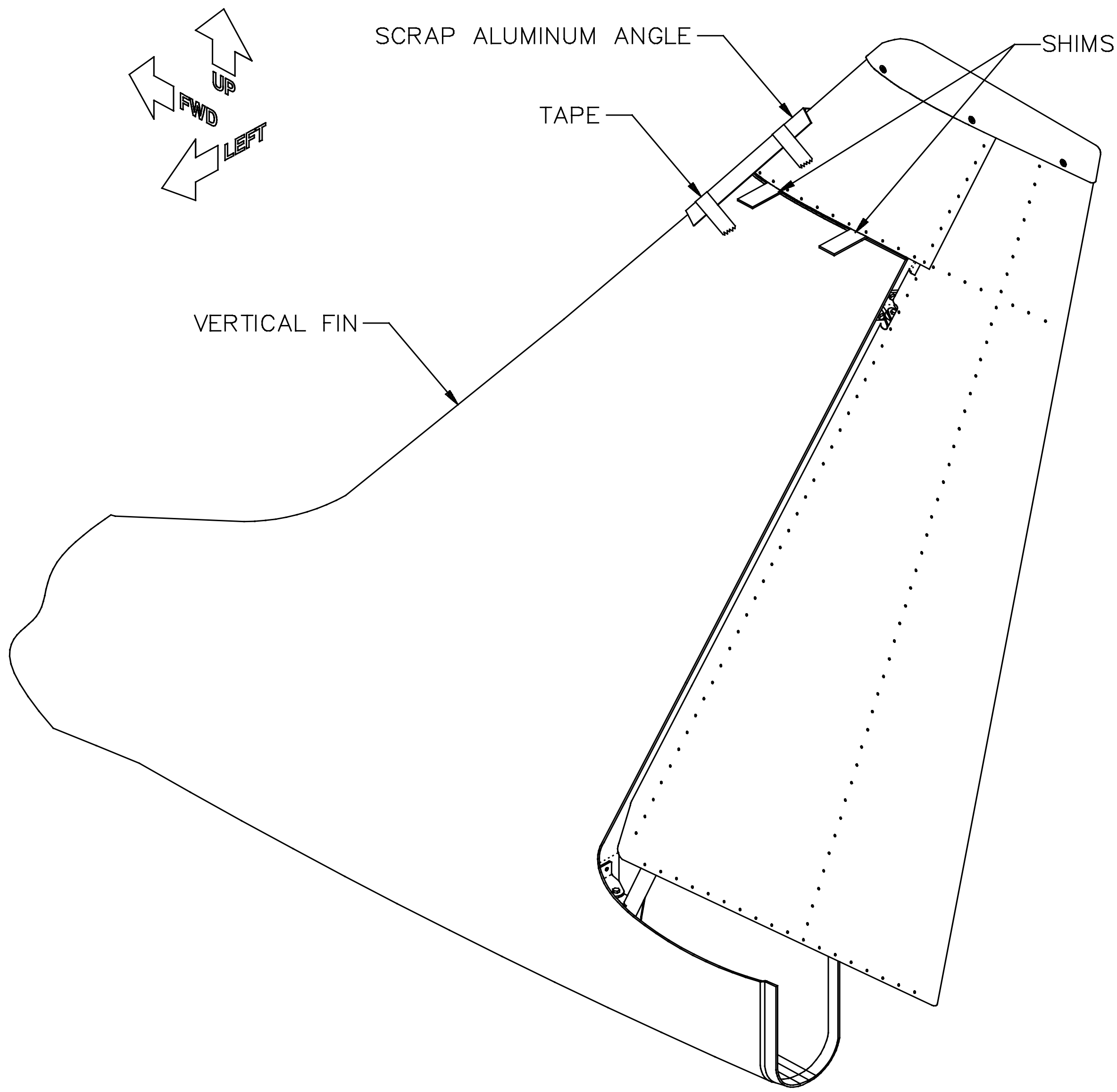


Figure 52: Aligning the Rudder and Fin Leading Edges

Step 45: Drill Index Holes Through the Flanges of the Vertical Fin Spar

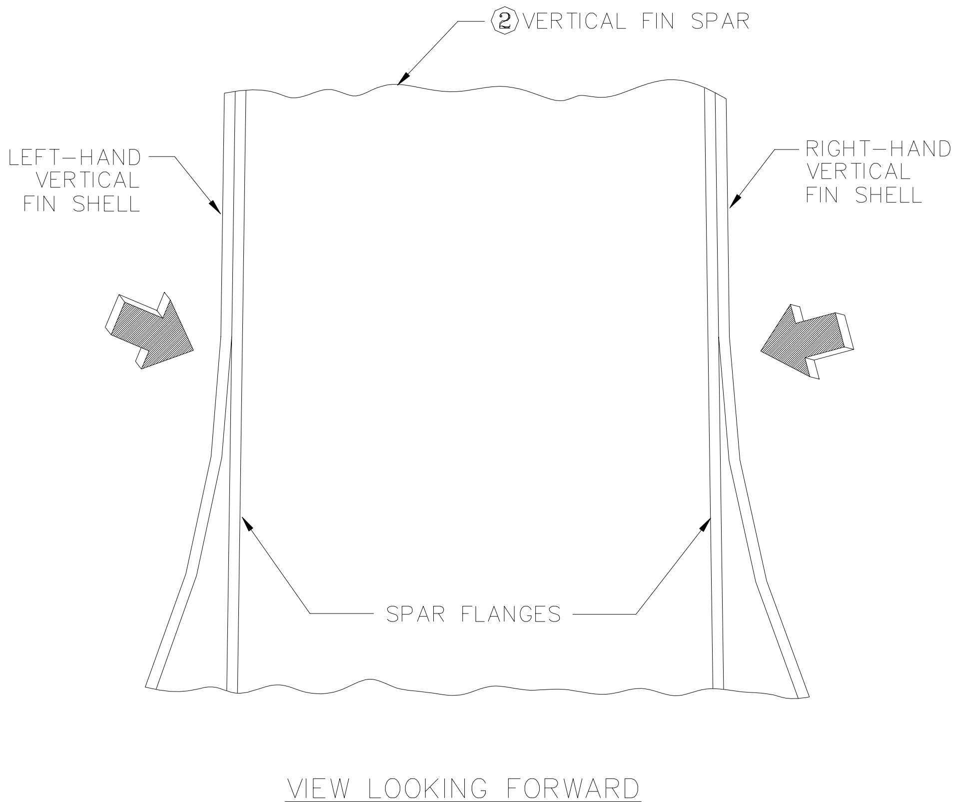
With the fin spar positioned, you can now drill holes through the fin shells and spar flanges to lock the spar in place.

> **Note** At this stage it may not appear that the rudder assembly and fin spar are properly positioned relative to the shells because the trailing edges of the shells likely extend aft quite a ways, perhaps even riding up over the rudder skin. Obviously, this isn't an acceptable final outcome. However, in a subsequent step, you'll trim a fair bit of material off the fin trailing edges to ensure sufficient rudder travel and a uniform gap, so at this point, you should simply ignore these trailing edges and let the leading edges be your guide in positioning the rudder and spar.

Begin by ensuring that the web of the fin spar is perpendicular to the aircraft centerline and the vertical fin is plumbed vertical with no twist. Check it both at the top and at the bottom and turn it as necessary to bring it into alignment.

Next, mark the point at the bottom of the spar on each side at which the flare of the fuselage shells departs from the flat surface of the spar flanges; these points are denoted by the bold arrows in Figure 53. You'll be able to reach alongside the rudder yoke to feel with your fingertips where the shells begin to flare.
From this point, mark a short line perpendicular to the trailing edge of the fin shell; this line is labeled Line A in the side-view panel of Figure 53. Measure upward from this line **1/4" along the trailing edge** and mark a second perpendicular line (Line B in the figure). On this second line, drill one **#40** hole through the shell and the spar flange on each side. These holes should fall roughly on the centerline of the spar flanges. Unfortunately, with the rudder in the way, there's no convenient way to measure the location of this centerline precisely. However, measuring along Line B approximately **1-9/16" forward** of the **forwardmost** vertical line of rivets on the rudder will put you on the approximate center of the flange.

After each hole is drilled, insert a Cleco.



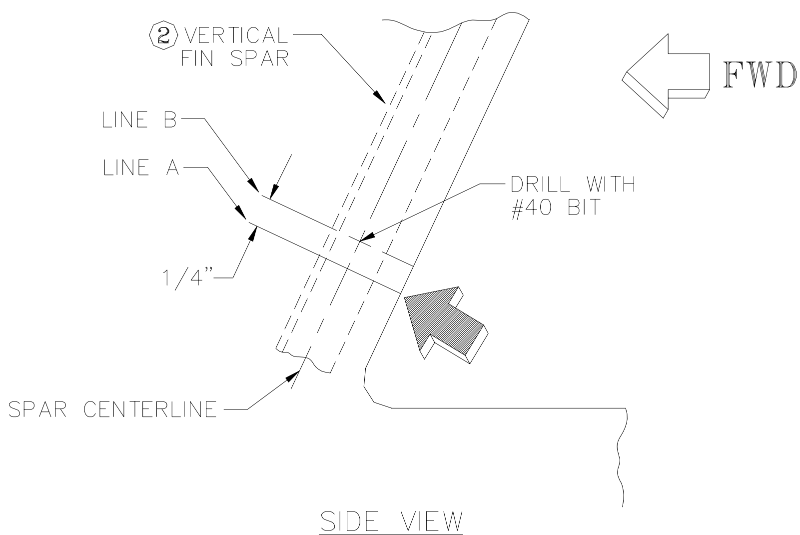


Figure 53: Marking and Drilling the Bottom Index Holes Through the Spar Flanges

Drill another index hole near the top of the spar on each side. Like the bottom holes, these should be on the centerline of the spar flange. As shown in Figure 54, the hole should be located **1/4" below the tip of the spar**. Once again, there is no way to measure the fore-and-aft dimension to the spar centerline precisely, but about **15/16"** forward of the forwardmost vertical line of rivets on the rudder will be close. Drill a **#40** hole at the marked location and cleco it.

Completed: [ ]

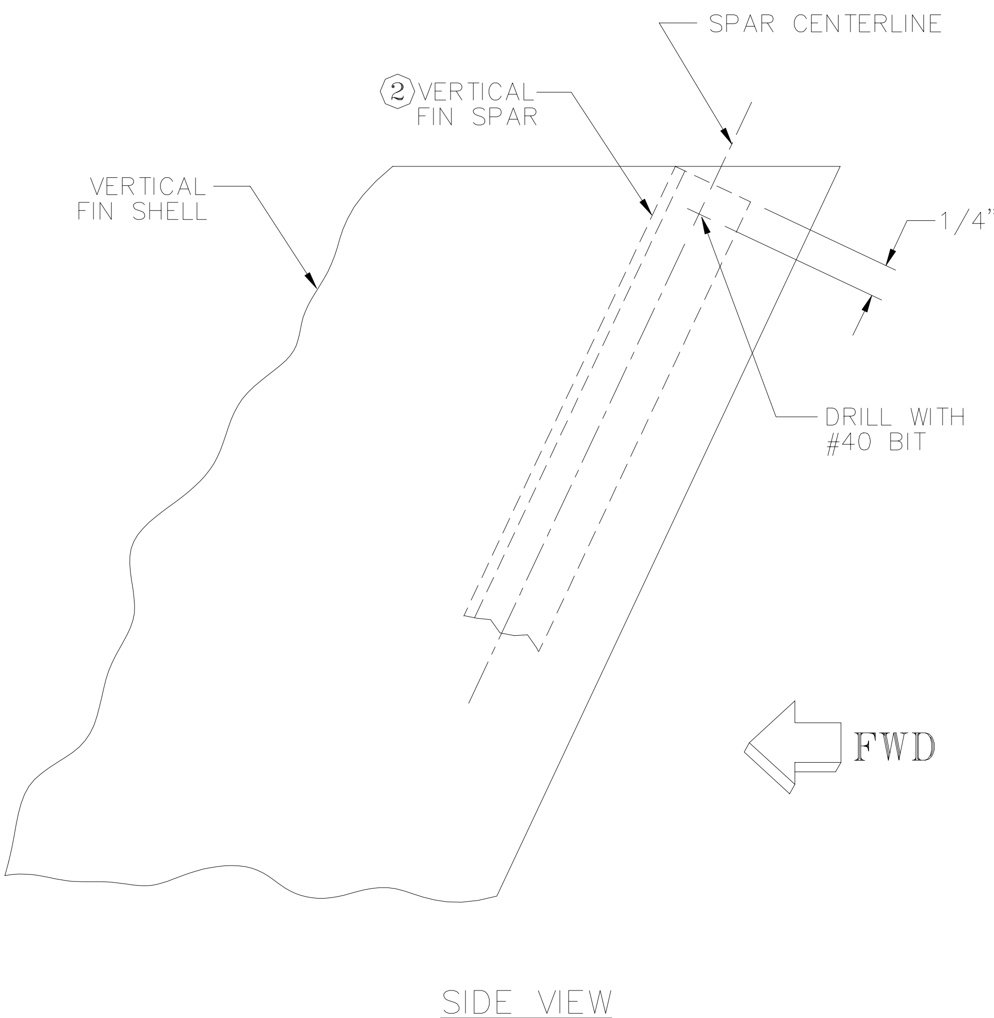


Figure 54: Marking and Drilling the Top Index Holes Through the Spar Flanges

Step 46: Center the Rudder Between the Fin Shells and Mark the Lower Hinge Location on the Fin Spar

Since the lower rudder hinge is not yet attached to the vertical fin spar, the rudder assembly as a whole is free to pivot left and right around the upper hinge. For aesthetic as well as aerodynamic reasons, you want the rudder centered between the fin shells along the entire length of the hinge line.

As Figure 55 shows, this can be achieved by taping a pair of stiff wooden or metal slats (two yardsticks would work fine) across the gap between the bottom of the fin and rudder on each side. These slats will force the rudder to center itself between them. Keep in mind the vertical fin should also be nearly in flight attitude as well.

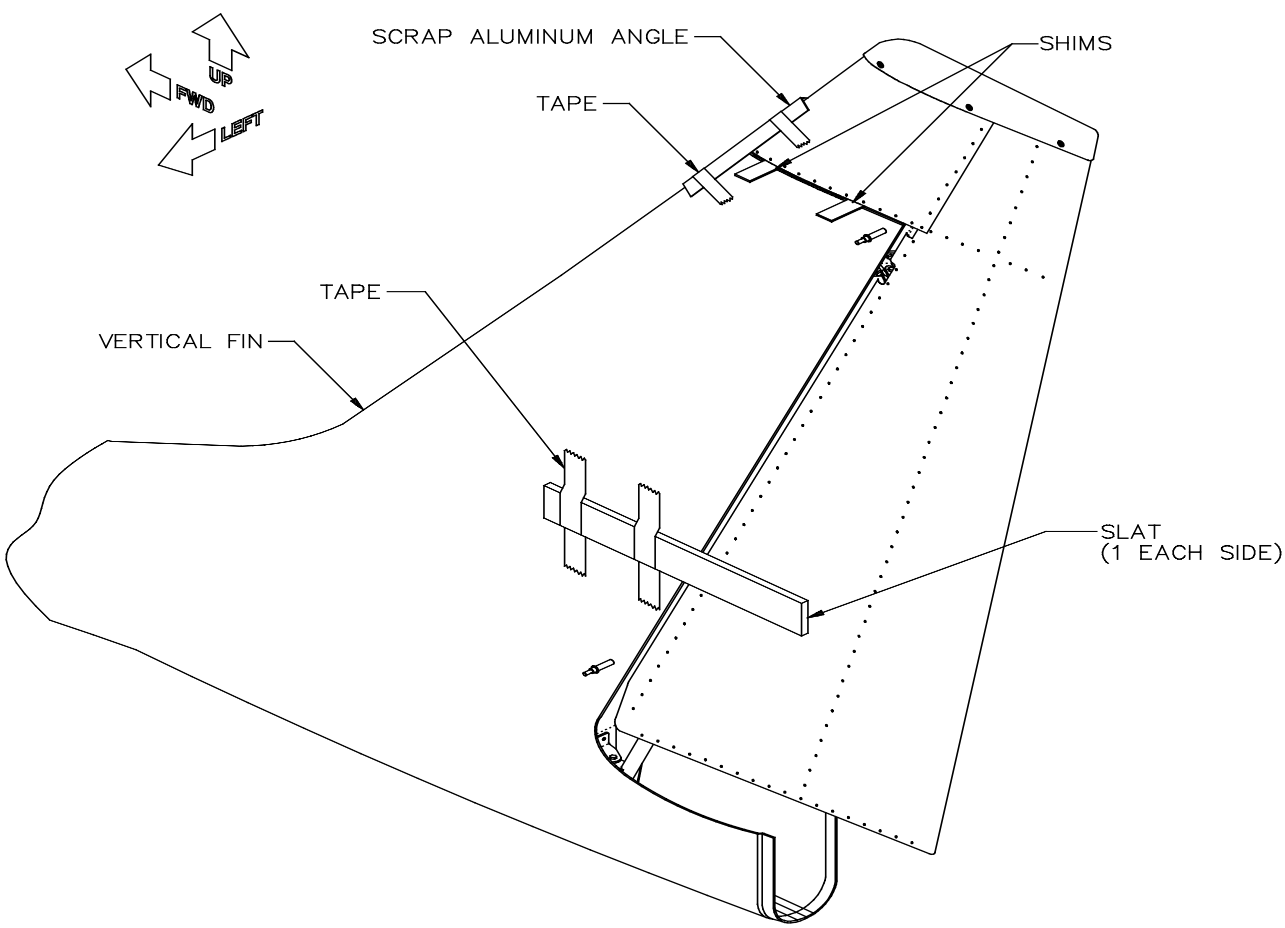


Figure 55: Centering the Rudder Assembly Between the Fin Shells

Once the rudder is centered, use a marking pen to mark the outline of the lower rudder hinge on the lower flange of the vertical fin spar.

After the location of the lower hinge has been carefully marked, remove the rudder assembly and fin spar from the fuselage and disassemble the hinges. Then replace the spar by itself between the shells, holding it in place with Clecos through the four index holes.

Completed: [ ]

Step 47: Position and Install Bulkhead C

Bulkhead C is located just forward of the lower flange of the vertical fin spar. The aft face is approximately 24" forward of the tailcone joggle. File or sand the bulkhead as necessary to achieve a good friction fit against the fuselage shells with the aft face of the bulkhead in contact with the forward face of the lower spar flange. If the fit is tight enough that the bulkhead will stay in position by itself, you can go ahead and remove the fin spar at this point. If the fit is a bit too loose for the bulkhead to stay in place, clamp it to the spar flange, as shown in Figure 57, and tack it to the shells with hot-melt glue. Then remove the clamps and the spar. **Make sure** that the top part of Bulkhead C holds the vertical fin trailing edges far enough apart to permit reinstalling the spar after laminating the bulkhead.

Note There is no **structural** reason a friction fit is necessary for any of the bulkheads. Gaps of up to **3/16"** can easily and safely be filled with Q-cell.

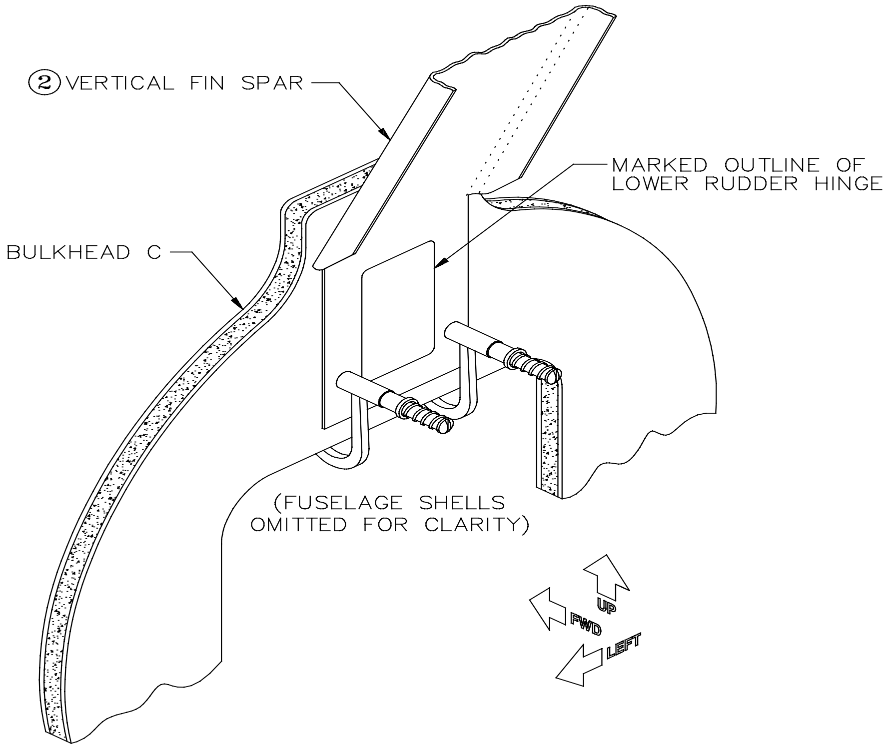


Figure 57: Clamping Bulkhead C to the Fin Spar

Bulkhead C is installed slightly differently than Bulkhead B, but you begin in the same way—with a 3/16" Q-cell fillet front and back (see Figure 58). Also as with Bulkhead B, follow the Q-cell with one layer of DBM cloth on the **forward** side of the bulkhead; use four strips end to end, each about 12" long. Once again, leave a 3/8-1/2" diameter drain hole on the bottom of the bulkhead so water may pass.

However, on the **aft** side of Bulkhead C, rather than DBM you will apply two plies of bi-directional cloth cut on the 45° bias, each one covering the entire face of the bulkhead and overlapping 1" onto the shells. Use the Bulkhead C template to cut these pieces, making each one about 1" larger all the way around than the bulkhead itself.

After the aft layers have cured, re-trim the center cutout in the bulkhead. Also, just as you did in Bulkhead B, make sure the drain hole in the bottom center of the bulkhead is clear of resin.

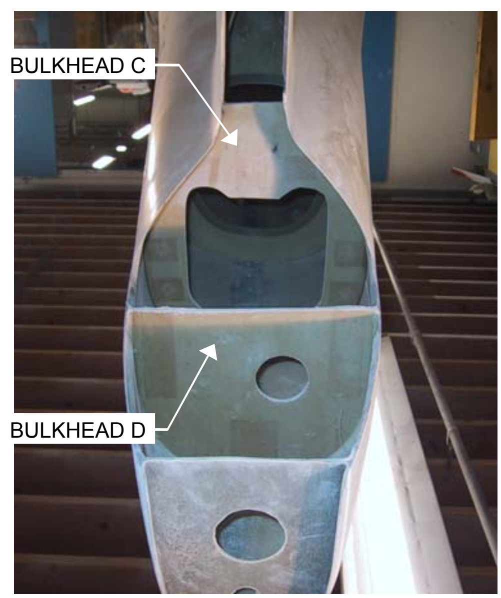


Figure 58: Bulkhead C Installation

Note You may note that the two layers of cloth applied to the aft face of Bulkhead C will have the effect of moving it aft and thus impinging on the lower flange of the vertical fin spar. As a practical matter, however, the layers will add no more than 1/32" to the thickness of the bulkhead, and given the flexibility of the spar flange, this is essentially negligible.

Completed: [ ]

Step 48: Install Vertical Fin Half and Finish Bonding Bulkhead B

The upper portion of Bulkhead B and the leading and lower edges of the vertical fin are now ready to be bonded in place. By now you know how to get the vertical fin plumb and streamline. Your joggle joints are all sanded and clean and you have a good fit of bulkhead B to the left fin half of the vertical fin.

Mix up a 150 gram batch of a thick adhesive mix using the same technique as described in the previous seam bonding section. Apply an adequate amount of mixture to both joggle surfaces running up the leading edge and along the lower edge. Carefully install the right half onto the left half and cleco the fins together. Clean up any adhesive that is oozing out of the joint.

Reinstall the aft spar, cleco the index holes and pull the vertical fin into a straight and plumb position. Secure it there until the adhesive is cured.

Remove the vertical fin spar after the resin has cured. Now apply a thick fillet compound along the upper portion of B bulkhead. Working quickly before the Q-cell radius cures, use the last of the DBM cloth that you cut out and laminate the aft face of the fin and the bulkhead attempting to get an even 1" overlap on each surface. It helps to tape a piece of wood as an extension to a varnish brush to accommodate the long reach. Install the aft spar again and hold it in a plumb and true position until that has cured.

When that has cured, you should never have to remove the right half of the vertical fin again!

Completed: [ ]

Step 49: Drill the Lower Rudder Hinge Mounting Holes in the Vertical Fin Spar and Bulkhead C

With the vertical fin spar off the fuselage and separated from the rudder, use a C-clamp to clamp the lower rudder hinge in position against the lower spar flange according to the outline you marked in the previous step. Use a **3/16"** bit to drill through the spar flange at each of the four holes in the base of the hinge.

> **Hint** Because of the downward-projecting tongues of the hinge, you will have difficulty getting a drill bit into the lower two holes. To avoid this problem, simply drill the upper two holes first, then unclamp the hinge and turn it around, inserting a couple Clecos through the newly drilled upper holes in the spar flange and the lower holes in the hinge. Now you can once again use the upper hinge holes as guides, but you'll be drilling the lower flange holes.

Reinstall the spar (without the rudder) between the fin shells with the four index Clecos and re-clamp the lower flange to Bulkhead C. For one last time, set up the plumb bob to be sure the vertical fin is straight vertically. Use a **#10** bit to drill through the spar flange and Bulkhead C at each of the four pilot holes.

After drilling, remove the spar and deburr the holes in the lower flange.

Completed: [ ]

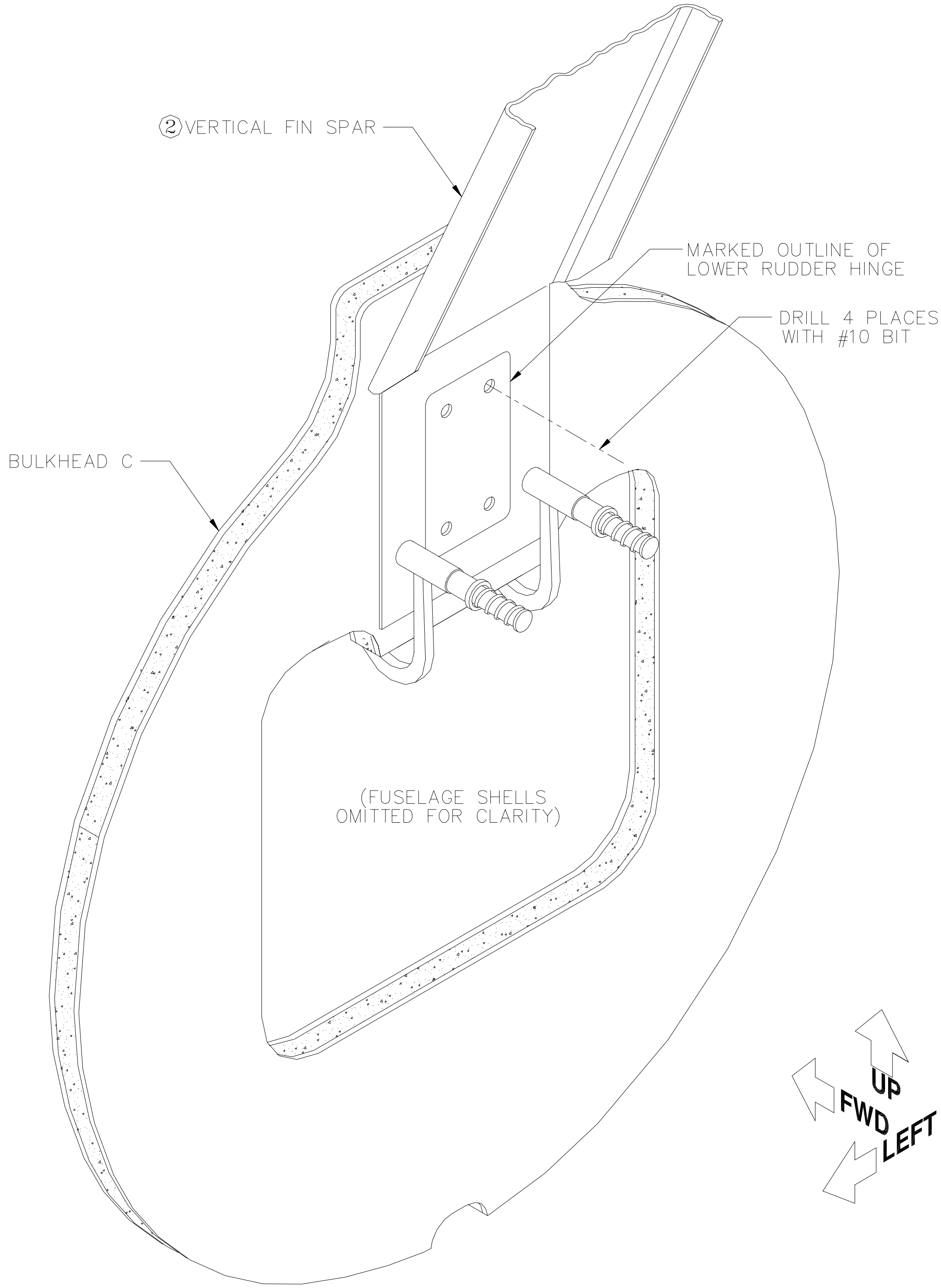


Figure 59: Drilling the Lower Hinge Mounting Holes

Step 50: Position and Drill Nutplates for the Upper Hinge

The upper rudder hinge must be secured to the vertical fin spar with nutplates since the forward face of the spar web will be inaccessible after the spar is riveted to the fin shells. You have already drilled the two bolt holes; at this time, remove the hinge from the spar, position two K1000-4 **nutplates** [84] and drill the **#40** mounting holes. As shown in Figure 60, countersink the aft face of the spar web to accommodate flush-head 3/32" rivets.

Note Figure 60 shows the nutplates oriented horizontally across the spar, but this is not at all critical.

After drilling and countersinking, deburr all four rivet holes in both the spar and the nutplates, as well as the two bolt holes in the spar.

Completed: [ ]

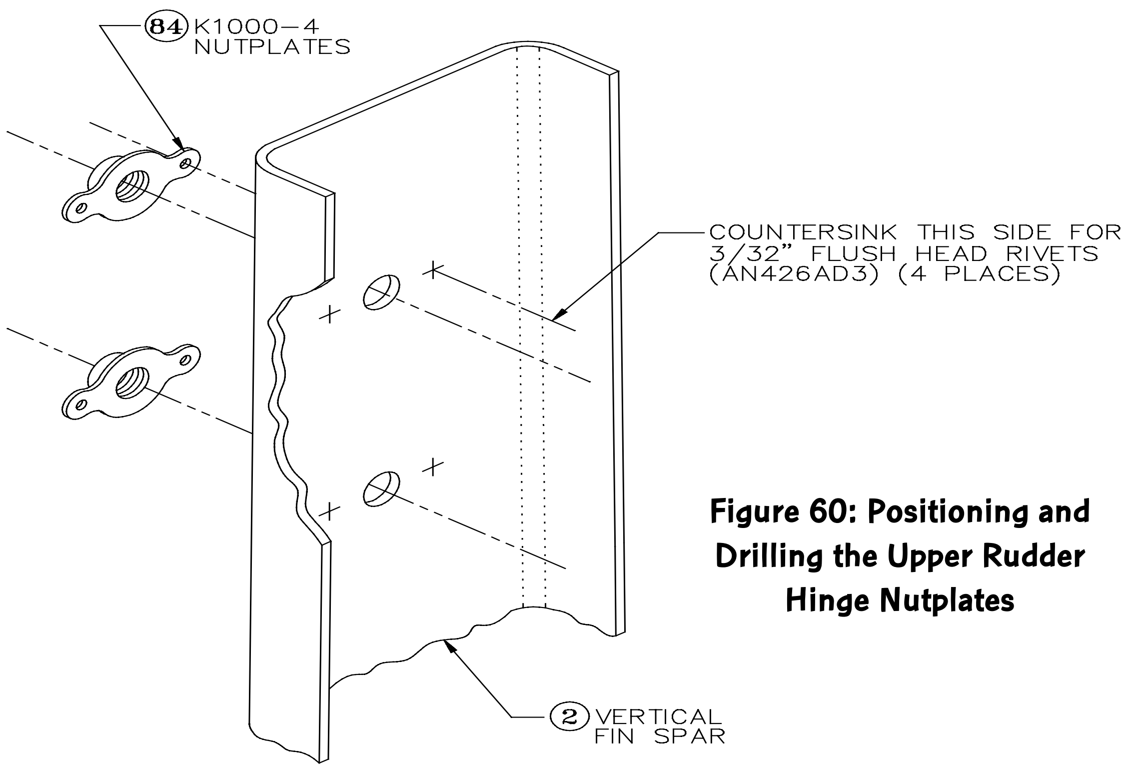


Figure 60: Positioning and Drilling the Upper Rudder Hinge Nutplates

Step 51: Corrosion-Proof the Vertical Fin Spar and the Rudder Hinge Halves

Apply the corrosion protection of your choice to the vertical fin spar and the upper and lower rudder hinge halves. Mask the bronze bushing in the upper rudder hinge half with small circles of masking tape before priming.

> **Caution** Remember, if you plan on float operations, especially on saltwater, the tail is the place that needs corrosion protection most, since it will get a good bath on every takeoff! Etch, alodine and 2-part epoxy primer are the best methods of protection.

Completed: [ ]

Step 52: Rivet the Upper Rudder Hinge Nutplates to the Vertical Fin Spar

Use 3/32" AN426AD3 flush-head rivets to rivet the two K1000-4 nutplates to the **forward face** of the vertical fin spar web. The rivet heads should be on the aft, countersunk face of the web.

Completed: [ ]

Step 53: This Step has been omitted

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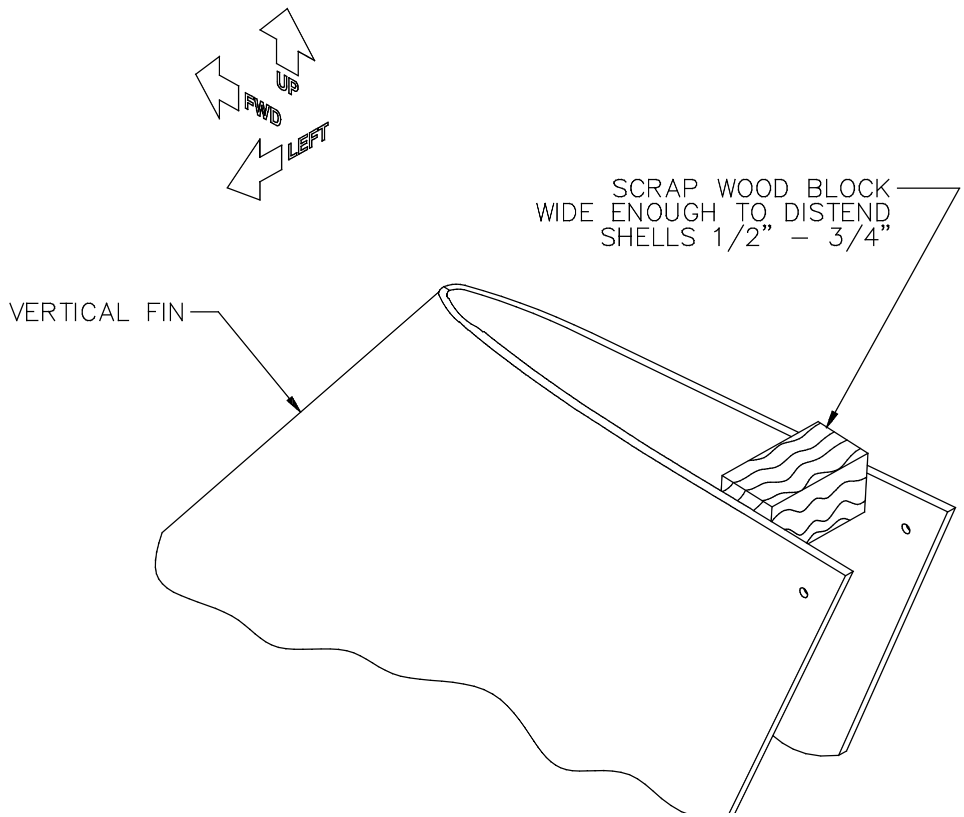


Figure 61: Spreading the Fin Shells

Step 54: Mark and Drill the Vertical Fin Rivet Holes

With the spar bedded in between the fin shells, the next step is to drill the rivet holes through the shells and spar flanges. First, mark a rivet line down the trailing edge of each fin half. This line should be positioned over the spar flange **1/4" forward of the spar flange trailing edge**. Since this distance may or may not bear a fixed relationship to the trailing edges of the fin shells themselves, you'll have to determine the distance to the rivet line from the fin trailing edge **for each flange top and bottom**. This dimension is labeled "x" in Figure 62.

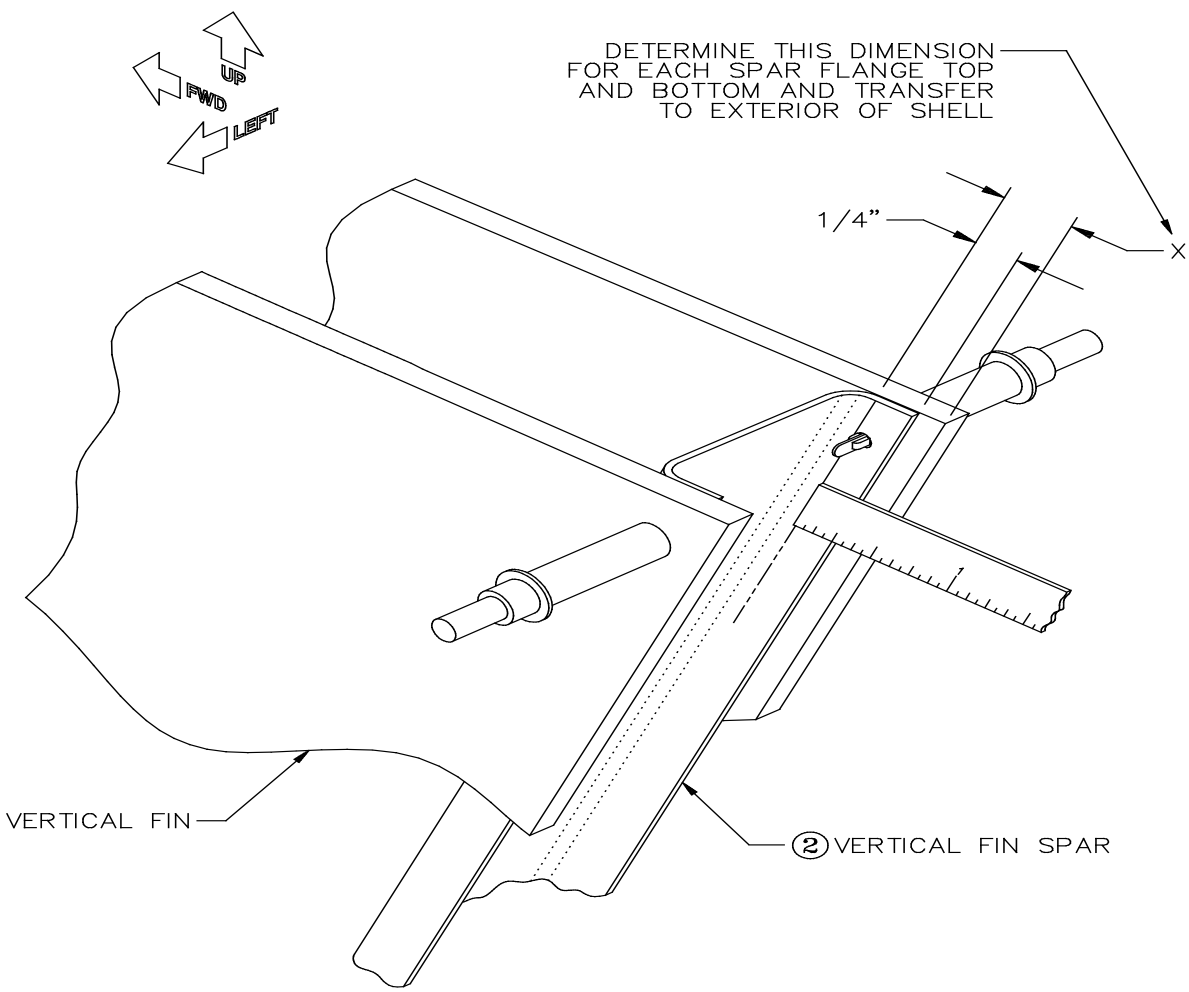


Figure 62: Measuring to Mark the Vertical Fin Rivet Lines

Once you've determined the "x" dimension for each side of the spar both top and bottom, transfer these measurements to the outside of the fin shells and mark lines between them along each side. On these lines, you must lay out and mark rivet hole positions. Space the holes evenly between the upper and lower #40 index holes on each side with **no more than 1-1/4" spacing**. You should wind up with roughly forty holes per side.

Once the hole locations are marked, drill them all through the shell and spar with a **#30** bit. Don't forget to drill the four index holes up to #30 size as well.

The vertical fin spar will be secured to the fin shells with 1/8" flush-head rivets. To accommodate these, you must countersink the holes on the outside of the fin shells.

Be sure to test the depth of your microstop on scrap material before drilling into the shells. Additionally, it would probably be a good idea to squeeze or drive one rivet before countersinking additional holes just to double-check the depth setting.

Hint Fiberglass is just as tough on countersinks as it is on other tools. If you have one, a carbide-tipped cutter will hold up to the abuse much better than standard steel cutters and will produce cleaner results.

Completed: [ ]

Step 55: Bolt the Lower Rudder Hinge and the Fin Spar to Bulkhead C

Slide the vertical fin spar into place between the shells and use AN3-7A **bolts** [42], AN970-3 **large washers** [81], and AN365-1032A **nylon self-locking nuts** [49] to mount the lower rudder hinge to the lower flange of the spar and Bulkhead C. As shown in Figure 64, be sure that the tongues of the hinge point **downward**.

Note The edges of the AN970-3 washers must be relieved so they don't interfere with each other. Use a belt sander or a grinder.

Completed: [ ]

Step 56: Rivet the Vertical Fin Spar to the Fin Shells

Using 1/8" AN426AD4 flush-head rivets, rivet the vertical fin spar into place between the fin shells. Use a rivet squeezer here if you have one.

Completed: [ ]

Step 57: Install the Vertical Fin Rib

You've already cut the vertical fin rib to rough size (Step 32); now it's time to install it. The purpose of this rib is to align and close out the open top of the fin. It is installed with a single layer of cloth on the top side only. Stand behind the vertical fin and sight it to be sure it is in alignment with the centerline of the fuselage. If necessary, pull it straight to eliminate any twist prior to bonding in the rib.

Note VOR antennas are available that fin inside the Sportsman wing tips. However, if you are installing a "cat whisker" VOR antenna, you'll need to apply an **additional** layer of cloth on **top** of the rib and **two** layers of cloth to the **bottom** of the rib to provide sufficient mounting strength. Apply two layers of bi-directional cloth cut on the 45° bias to the bottom side of the fin rib **before** trimming it to final size. Drill whatever mounting holes are necessary, secure nutplates, etc., and then follow the remaining instructions in this step. Be aware, however, that for some antennas, the rib may need to be mounted somewhat lower than the 3/4" below the fin tops called out below in order to provide adequate clearance between the rudder and the antenna.

Trim the rib so that it fits between the fin shells and the web of the fin spar with a firm friction fit **3/4" below the tops of the fins**, as shown in Figure 65.
Secure the rib with a Q-cell fillet followed with one layer of bi-directional cloth cut on the 45° bias. Cut this cloth large enough to extend all the way up to the top of the fin and the spar. Saturate it thoroughly, taking special care to relieve air bubbles at the forward end where the left and right fin shells join. After the laminate has cured, trim off the excess cloth and sand the tops of the fin shells smooth. Also, like the fuselage bulkheads, the fin rib demands a drain hole to prevent water from collecting. In this case, drill a **1/4"** hole through the vertical fin spar web just above where it meets the rib.

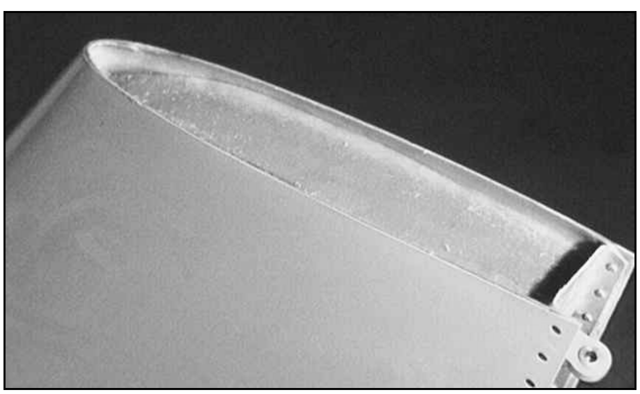


Figure 65: Vertical Fin Rib Installation

Completed: [ ]

Step 58: Bolt the Upper Rudder Hinge to the Vertical Fin

As shown in Figure 66, use AN4-5A bolts and AN960D416L thin aluminum washers to mount the upper rudder hinge to the vertical fin spar. Be sure that the bushing flange is **up**.

Caution Take extra care not to cross-thread the nutplates!

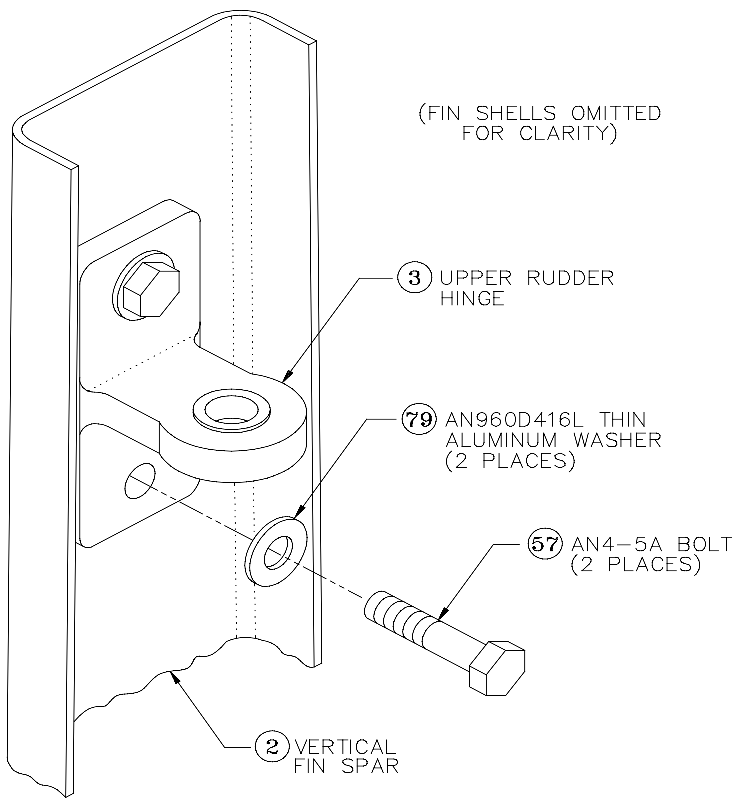


Figure 66: Mounting the Upper Rudder Hinge

Completed: [ ]

Step 59: Finish the Trailing Edges of the Fin and Fit the Rudder

The trailing edges of the fin may still have mold lip, and they almost certainly extend too far aft to allow full rudder travel. In this step, you will sand them to their finished condition. As a first step, use a long sanding block with coarse sandpaper to remove the mold lip and make the two trailing edges parallel with one another, as shown in Figure 67. The vertical fin trailing edge should be sanded to within .2" of the aluminum spar edge on top and to within .4" of the spar on the bottom.

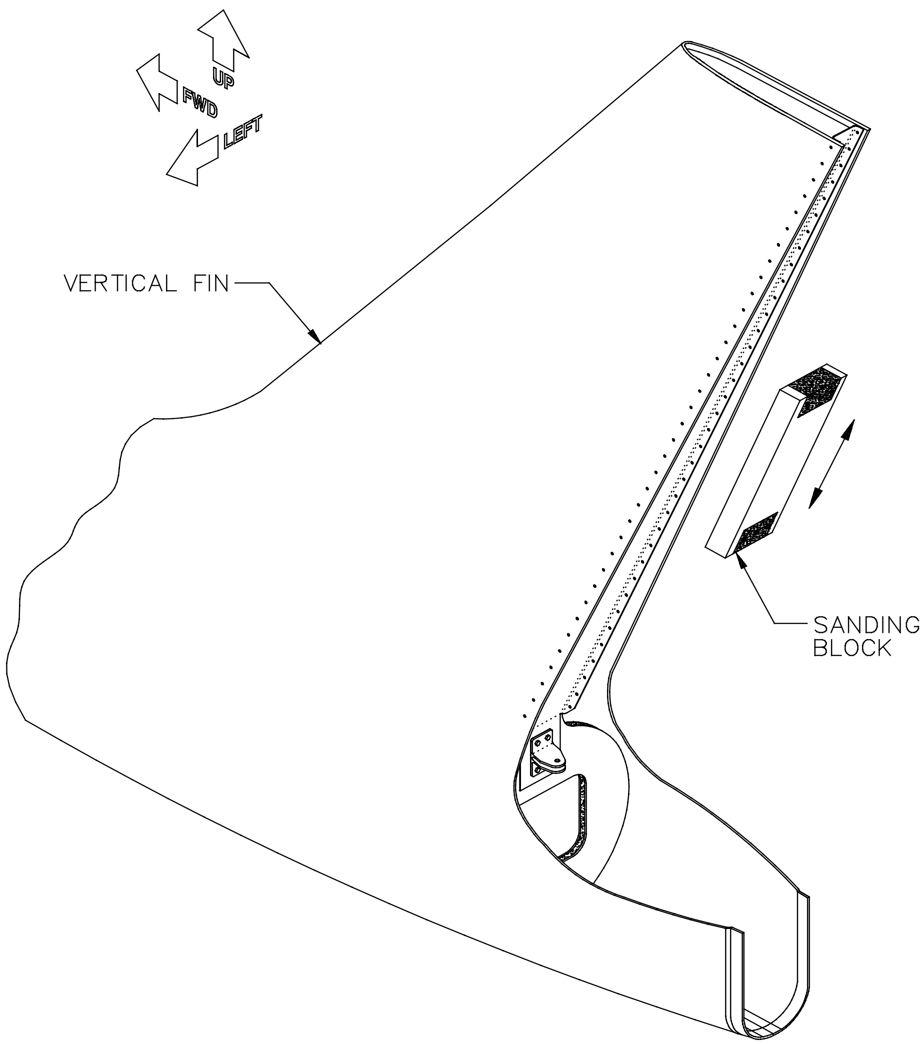
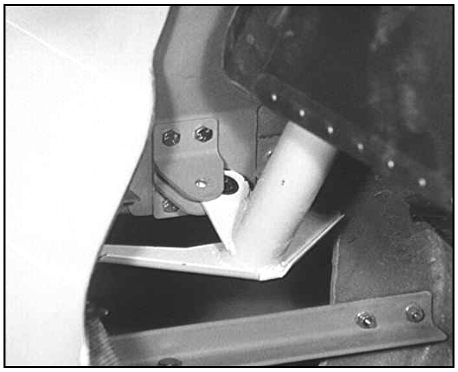
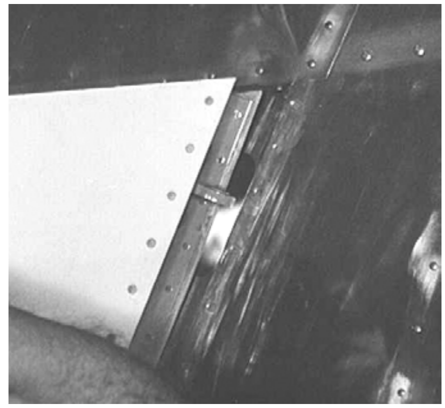


Figure 67: Sanding the Trailing Edges of the Vertical Fin Shells

Next, temporarily hang the rudder. At first glance, this may seem like an insoluble puzzle, since the angle of the hinges prevents sliding the rudder in from behind as seems natural. Instead, the proper technique is to slide the rudder in from one side. Figure 68 illustrates this procedure. Begin by sliding the tongue of the rudder yoke in between the tongues of the lower hinge from one side (Figure 68a). Note that the top of the rudder remains off to one side and angled slightly aft while the yoke tongue slides into the lower hinge (Figure 68b). Next, tilt the rudder forward until the bottom of the rudder counterweight rib comes parallel with and then clears the top of the fin (Figure 68c). Finally, move the top of the rudder sideways until the upper rudder hinge halves mesh. Once the rudder is in place, drop a 1/4" bolt (AN4) into both hinges; the length of this bolt is not important. The lower bolt should go in easily, but the upper one is more of a challenge. Swing the rudder as far to one side as you can, and then use a small pair of needle nose pliers or forceps to maneuver the bolt into place through the access cutout (Figure 68d).

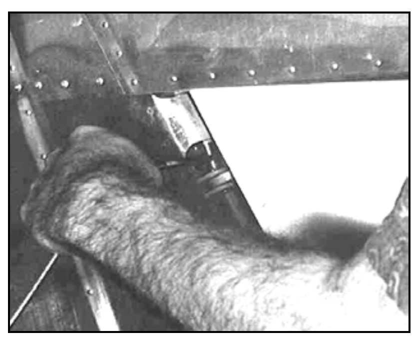


(a)



(b)

(c)



(d)

Figure 68: Hanging the Rudder

It may well be impossible for you to hang your rudder on the first try. You may have to sand more material off the top and/or the trailing edges of the fin. Keep experimenting until you can hang your rudder as shown, but try not to remove any more material than necessary to achieve this.

Once your rudder is hung, you need to determine whether it has the necessary degree of travel, which is **25° each way**. This can most easily be checked by using a bevel gauge set to **155°**, as shown in the Figure.

Hint If you don't have a bevel gauge, a cardboard template cut to 155° will work just as well.

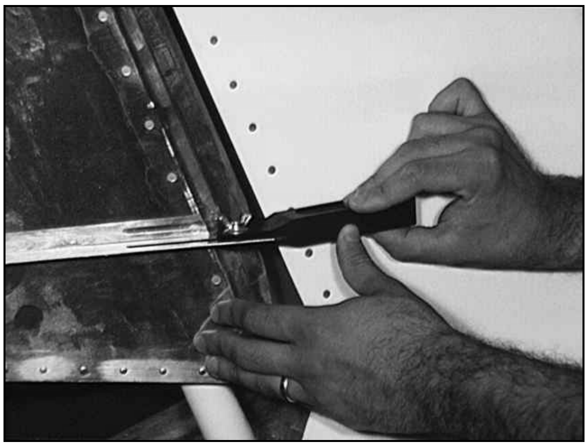


Figure 69: Measuring the rudder travel

You may not have full rudder travel initially. You may have to shave more material off the trailing edges and enlarge the cutout in Bulkhead C so the rudder yoke will clear, as shown the figure. This is simply a trial-and-error process:

Make sure you have positive clearance. You don't want the fin trailing edges scraping your rudder's paint job. The cutout in Bulkhead C, on the other hand, should be enlarged even more. Because there will be cable attach hardware on the ears of the rudder yoke, you should provide at least **1/4"** of clearance all around them when the rudder is at its extreme of travel. Figure 70 shows the extent to which this cutout will typically have to be enlarged. Use a file or a sanding drum in a rotary tool to make this enlargement.

When you're satisfied with your results, remove the rudder assembly and set it aside.

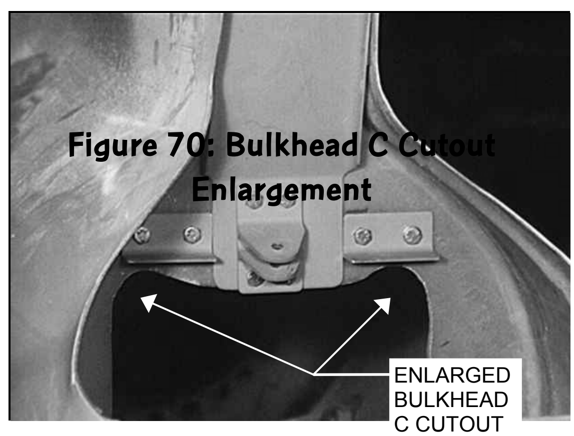


Figure 70: Cutting the rudder yoke clearance

Completed: [ ]

Step 60: Fabricate the Rudder Stop Plate

As mentioned in the previous step, the specified rudder travel is **25° (±1°)** in each direction. To prevent damage to the rudder from traveling too far, a 1/8" thick aluminum **rudder stop plate**, with arms that contact Bulkhead C, will be riveted to the rudder yoke to limit the rudder's travel to no more than the specified value.

Lay out the pattern shown in Figure 72 on the supplied **.125" X 3" X 10" aluminum sheet** [25.1]. Use a bandsaw to cut out the stop plate.

> **Note** The template is slightly oversized. Since the stop plate will be trimmed to its final size during installation, there is no need to smooth and deburr the cut edges at this time

Bend the outboard ends of the stop plate **down** about **15°–20°** along the dashed bend lines shown on the template, as shown in Figure 71. (This puts the ends of the arms roughly horizontal at full left and right rudder deflection, as shown in Figure 75.) To do this, clamp the plate in a vise between two scrap aluminum angles (to prevent the vise jaws from marring the plate) and use a hammer to bend the arms. The aluminum angle on the lower side of the plate should have a **1/8"** radius to avoid a sharp corner in the bend.

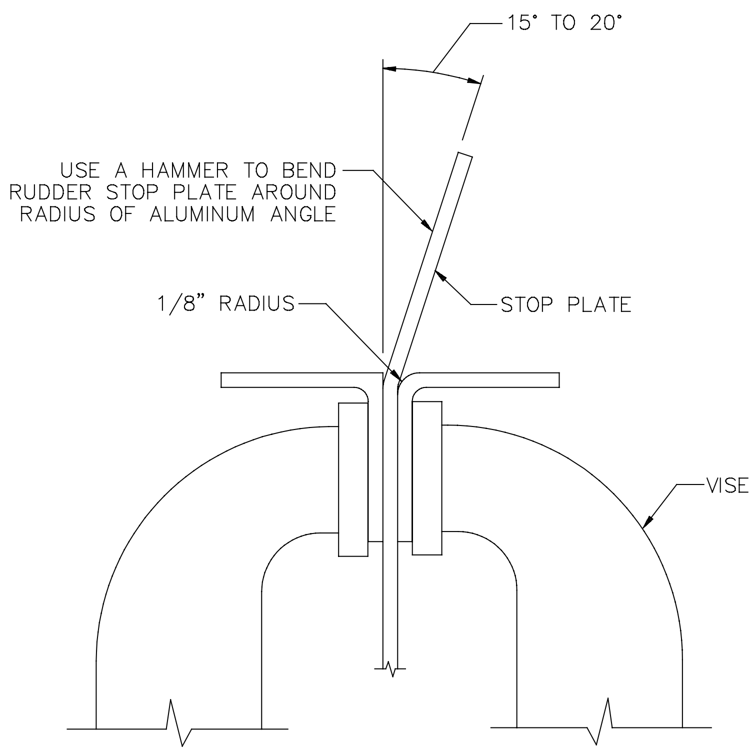


Figure 71: Bending the Stop Plate Arms

Completed: [ ]

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sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

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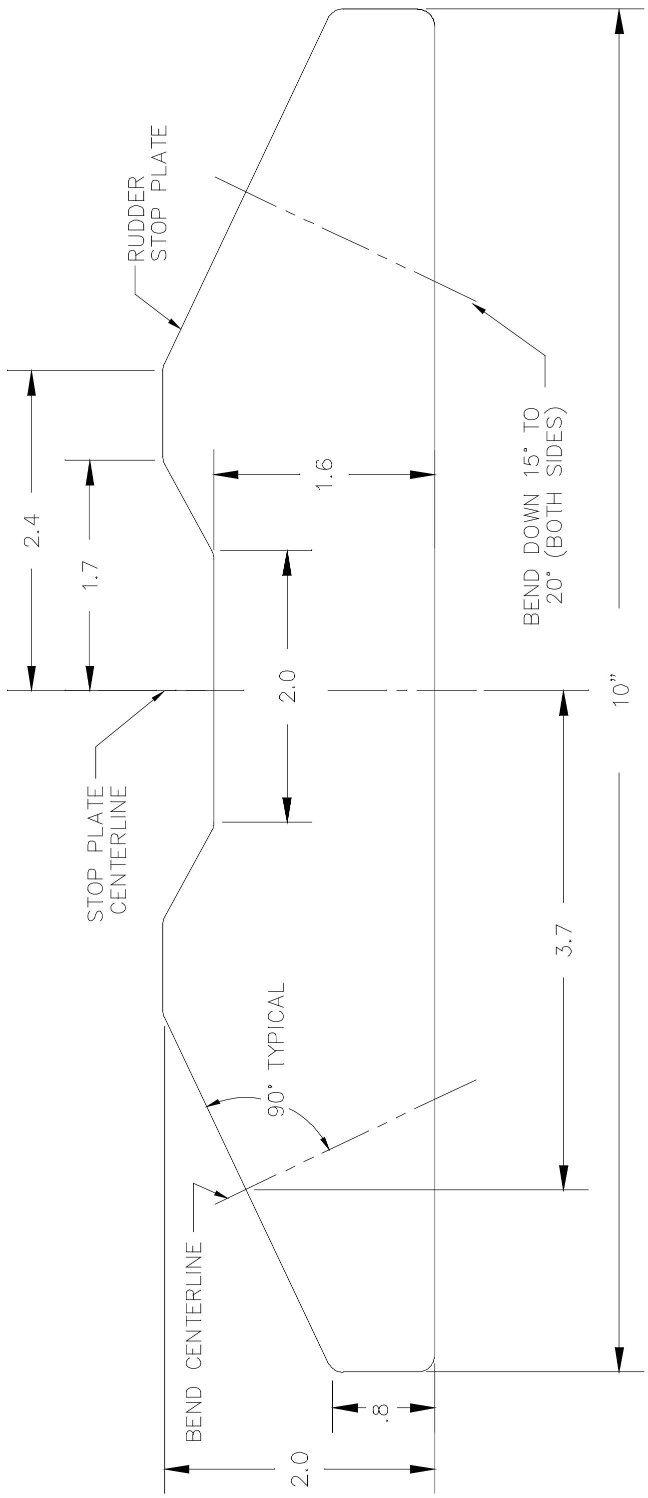

Figure 72: Rudder Stop Plate Template (Full Size)

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

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Step 61: Fasten the Stop Plate to the Rudder Yoke

Clamp the stop plate to the bottom of the rudder yoke, as shown in Figure 73, with the forward edge of the stop plate aligned with the shape of the rudder yoke and with the bent arms of the plate angled **downwards**.

Lay out and center punch the rivet pattern shown in Figure 73 onto the underside of the rudder stop, being careful to maintain a minimum **1/4"** edge distance from the centers of the rivet holes to the edges of both parts. Also maintain a 1/4" edge distance to the bent-up flange and other parts of the rudder yoke to provide access for bucking the rivets.

Use a **#30** bit to drill the ten rivet holes through the assembly. Cleco the first couple of holes to maintain alignment while drilling the rest. When finished, deburr the holes in both parts.

Install the rudder and use two Clecos to fasten the stop plate to the underside of the rudder yoke. Insert the Clecos from the bottom so they won't contact Bulkhead C when the rudder swings.

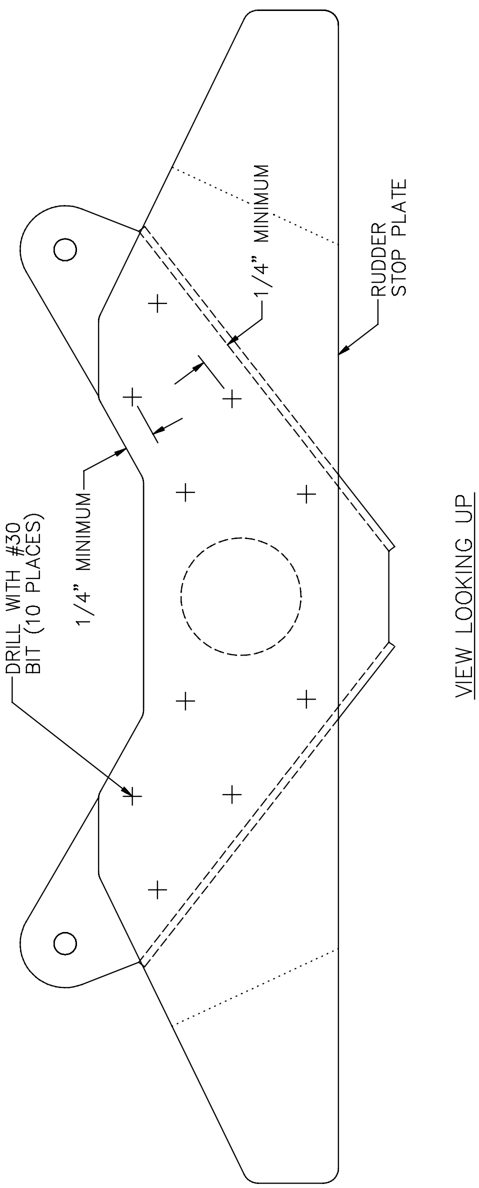

Figure 73: Drilling the Rudder Stop Plate Rivet Holes

Completed:

Step 62: Adjust the Rudder Travel

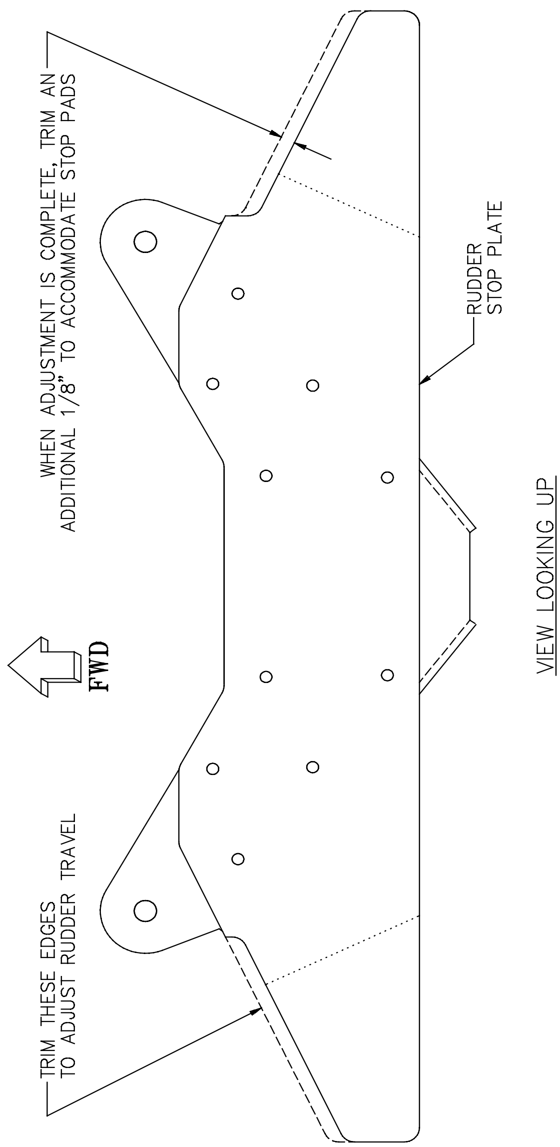

Figure 74: Adjusting the Rudder Stop

Set a bevel gauge to **155°** to use for checking the rudder travel, as described in Step 60, or make a rudder travel gauge by cutting a 155° angle on the edge of an 8" long piece of 1/4" plywood.

As shown in Figure 74, trim the **forward** edges of the stop plate arms until they contact the aft side of Bulkhead C just as the rudder reaches its 25° travel limit. This will require several cycles of checking the rudder travel, removing the stop plate for trimming, reinstalling the plate and rechecking the travel. When satisfied with the adjustment, check that the outboard ends of the stop plate arms are roughly horizontal when they contact the bulkhead; adjust the angles of the bends, if necessary, to accomplish this.

Remove the stop plate and trim an **additional 1/8"** from the forward edges of both arms, as shown. This will provide space for the 1/8" thick polyethylene stop plate pads that will be fastened to the aft side of Bulkhead C in the next step.

Smooth the saw-cut edges of the stop plate and thoroughly deburr them.

Completed: [ ]

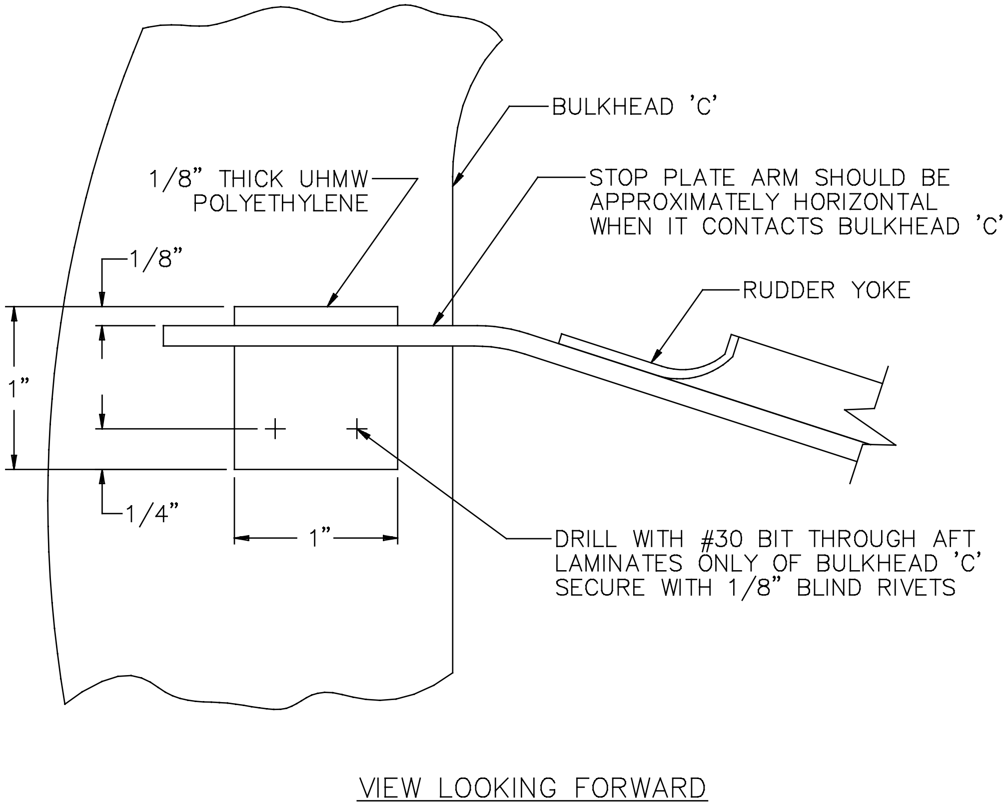

Figure 75: Installing the Stop Plate Pads

Step 63: Install the Stop Plate Pads

Cut two **1" square** pieces from the supplied **1/8" X 2" X 2" UHMW polyethylene sheet** [15.1]. Drill two **#30** rivet holes in each piece **1/4"** from one edge, as shown in Figure 75. These pieces will pad the aft side of Bulkhead C to prevent wear where the stop plate arms contact.

Note Later, in "SECTION X: FINAL ASSEMBLY," you will have to cut another pair of wear pads for a similar stop plate to be installed on the elevator bellcrank. Since all four of these pads must be cut from the 2" X 2" stock supplied, each will obviously end up slightly smaller than 1" X 1"; don't worry about this, but be sure not to lose the piece that remains after you cut out your rudder stop pads.

Mark the stop pads "left" and "right" to keep them straight. Hold each pad in place on Bulkhead C under its proper arm with the two rivet holes down and the top of the pad about **1/8"** above the top of the arm. To provide clearance for the inter-bulkhead shearweb attach angles that will be installed later, the pads must be positioned as low as possible while still providing full contact for the arms. Check that the rudder still reaches its 25° travel limit with the pads in place; trim the stop plate arms further if necessary. When satisfied, use a fine-point pen to mark around each pad onto Bulkhead C and then remove the rudder from the airplane.

Hold each stop plate pad in its marked position on Bulkhead C and use the holes in the pad as guides to drill **#30** holes through the **aft laminates only** of Bulkhead C. Use **1/8" aluminum blind rivets** [40.1] to secure the pads to Bulkhead C.

Completed: [ ]

Step 64: Drill Holes for the Tailwheel Steering Cable Bushings (Taildragger Only)

For the Sportsman taildragger, the tailwheel steering cables will fasten to the rudder stop plate. Drill **5/16"**-diameter holes through the stop plate in the locations shown in Figure 76. For best results, start with smaller holes (about 1/8") and gradually enlarge the holes in steps. Bushings will be installed in these holes for the steering cable fasteners.

> **Note** If, after trimming to adjust the rudder travel, there isn't enough material in the locations shown in Figure 76 to drill the holes for the bushings, drill the holes just **inboard** of the bends in the arms.

Completed: [ ]

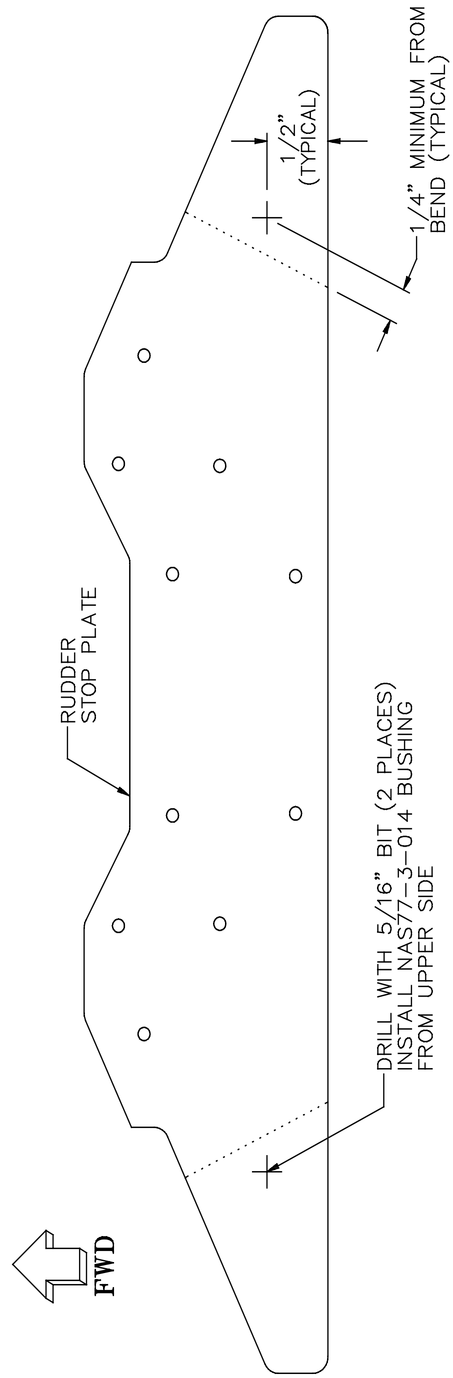

Figure 76: Drilling Holes for the Tailwheel Steering Cable Bushings (Taildragger Only)

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Step 65: Rivet the Rudder Stop to the Rudder Yoke

Apply the corrosion-protection of your choice to both the stop plate and the holes drilled in the rudder yoke. When the corrosion protection has cured, Cleco the rudder stop to the rudder yoke. Make sure the stop plate is right-side-up (with the arms angled downward) before riveting.

Rivet the rudder stop to the rudder yoke with 1/8" AN470AD4 **universal-head rivets**. Because of limited access for your rivet gun, you'll have to install the rivets with the heads down.

If you are building a taildragger, proceed to the next step; otherwise, set the rudder assembly aside.

Completed: [ ]

Step 66: Install the Tailwheel Steering Bushings (Taildragger Only)

Use a small C-clamp to press the NAS77-3-014 **flanged steel bushings** [91] into the 5/16"-diameter holes drilled through the stop plate arms in Step 67. Place the bushing flanges on the **top** side of the stop plate.

Set the rudder assembly aside.

Completed: [ ]

Step 67: Cut an Inspection Hole in the Lower Aft Fuselage

Both to provide construction access and to facilitate inspection of control linkages in your completed Sportsman, it's useful to cut an inspection hole in the bottom of the aft fuselage. As Figure 77 shows, this hole should be centered **4-3/4" aft** of Bulkhead C. Mark this location and drill a **#30** pilot hole from **inside** the fuselage. Then drill from **outside** with a hole saw. The diameter of the hole is not critical, but **3-5/8"** is ideal and you should keep it smaller than 5".

Hint If you don't have a hole saw this size, use a saber saw to cut the opening and finish the cut with a rotary sanding drum. Save the plug of the inspection hole. In "SECTION X: FINAL ASSEMBLY" we'll suggest a way to use it as an inspection hole cover.

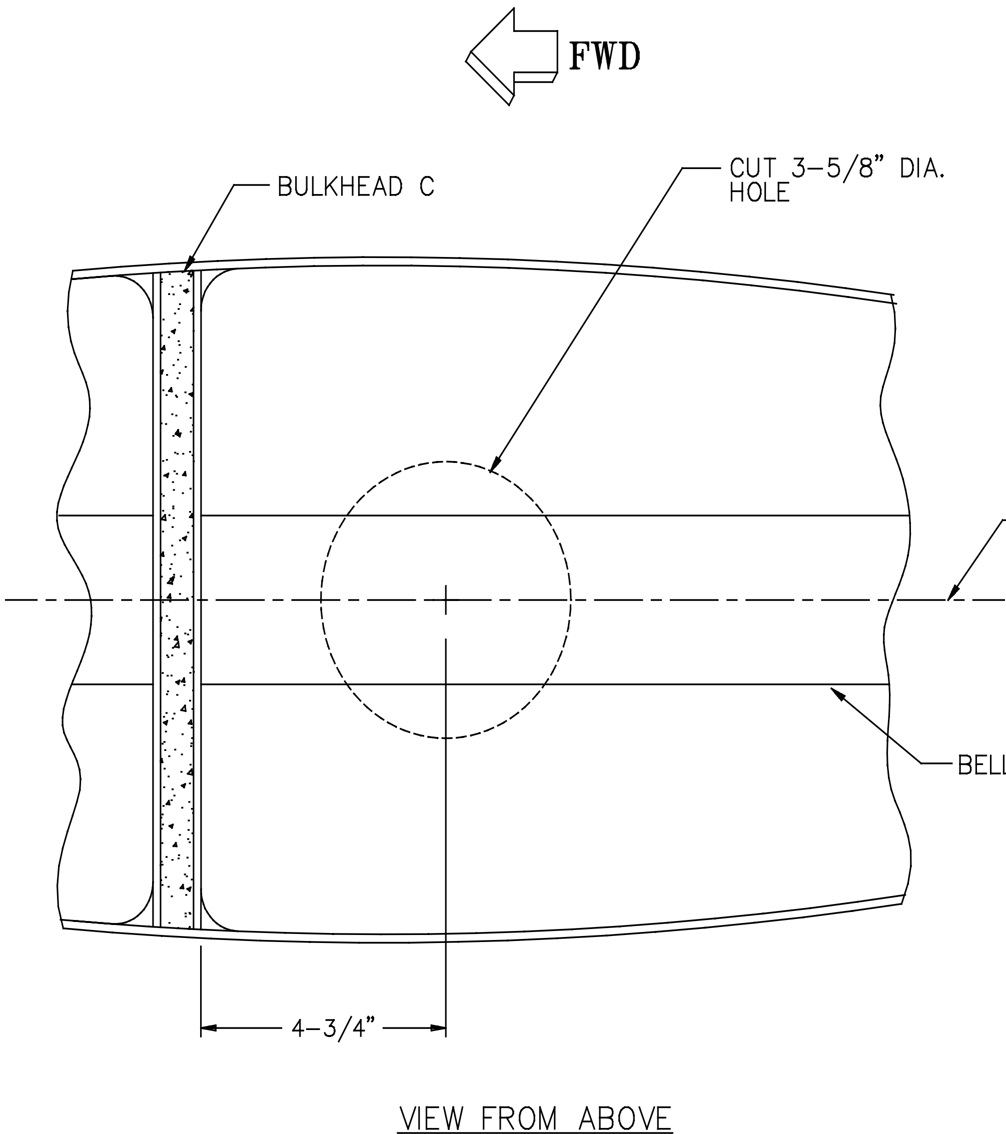

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Figure 77: Cutting the Aft Fuselage Inspection Hole

Step 68: Trim, Position and Drill the Elevator Bellcrank Brackets

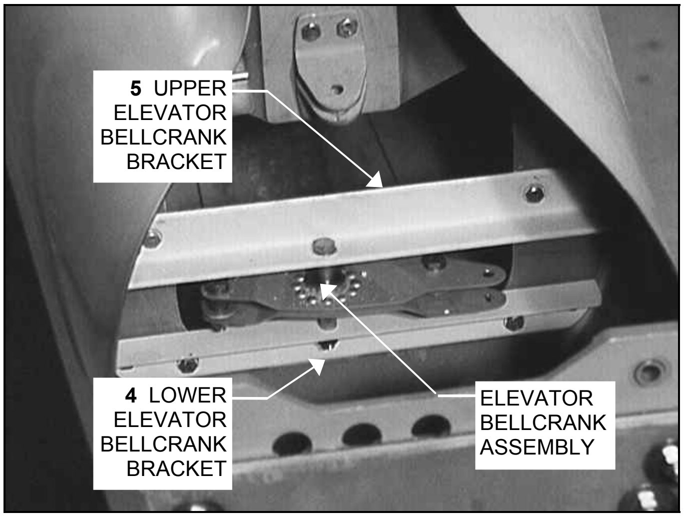

Figure 78: Elevator Bellcrank Assembly and Brackets

Pitch control in the Sportsman is transmitted from the control sticks via cables to a bellcrank mounted between two aluminum angles bolted to Bulkhead C. A rigid pushrod runs from this bellcrank aft to the elevator. Figure 78 shows the completed bellcrank and its brackets.

Note Figure 78 shows a later stage of assembly; for the moment, ignore the parts in the foreground.

The **upper** [5] and **lower** [4] **elevator bellcrank brackets** can be distinguished from one another by the location of the pre-drilled bellcrank pivot hole—as can be seen in Figure 78, the bellcrank center is to the left of the aircraft centerline, which allows room for the pushrod which is positioned to the right of aircraft centerline. Mark four bolt hole locations according to the dimensions shown in the right-hand end of Figure 79. Do the same on the upper bracket.

Next, temporarily assemble the main components of the bellcrank assembly to set the vertical distance between the upper and lower brackets. As shown in Figure 80, insert the bellcrank bearing [31], NAS43DD4-32 and NAS43DD4-50 aluminum spacers [85.1, 85.2], an AN960D416 aluminum washer and an AN960D416L thin aluminum washer between the brackets on an AN4-25 drilled-shank bolt [56]. Secure this bolt with AN960D416 aluminum washers under the bolt head and an AN310-4 castle nut. For now, just tighten the assembly finger tight. The vertical distance between the angles should be approximately 1.85"

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

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Use two small C-clamps to clamp the bracket to the aft face of Bulkhead C in the position shown in Figure 78. The bracket should be visually centered between the left and right fuselage shells and leveled. The top of the lower bracket's horizontal flange (i.e., the flange with the pivot hole in it) should be approximately **5-1/2" above the lower joggle seam**.

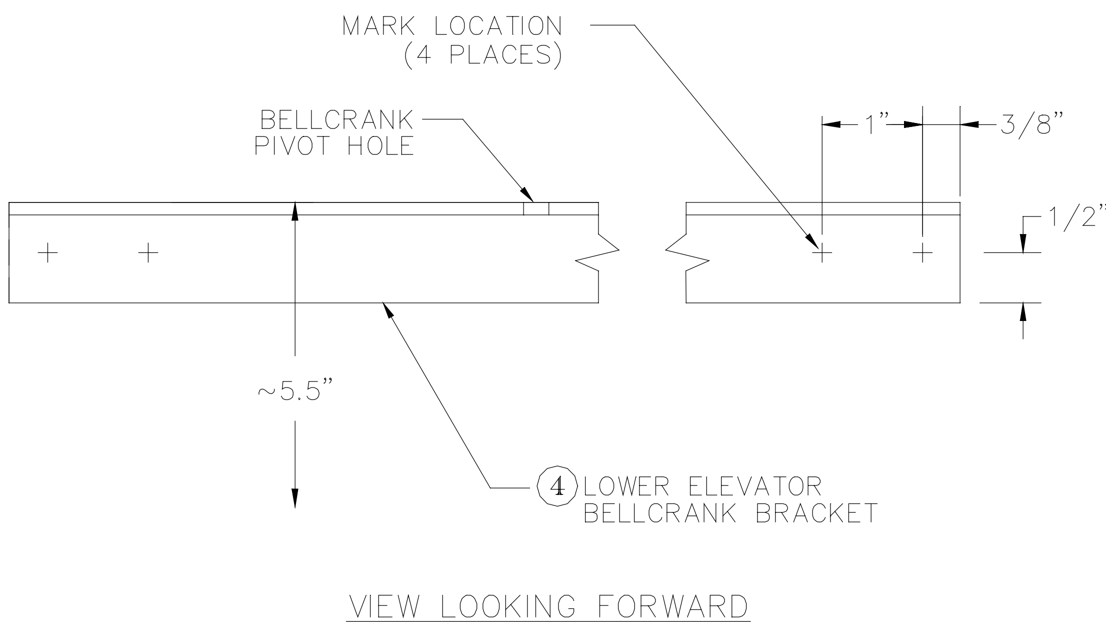

Figure 79: Trimming and Marking Hole Locations on the Lower Elevator Bellcrank Bracket

With the bracket in place, verify that the marked positions of the two **inboard** bolt holes will provide at least **3/8" edge margin** to the edges of the cutout in Bulkhead C and the edge of the angle. Shift the hole position marks as necessary to satisfy this condition. The 1" dimension is not critical. When satisfied, drill each of these locations with a **#30** bit and then follow it through with a #10.

Remove the bracket and deburr the holes.

Completed: [ ]

Note Although the hardware sets the vertical position of the upper bracket, you still need to adjust it to make sure it's parallel to the lower bracket.

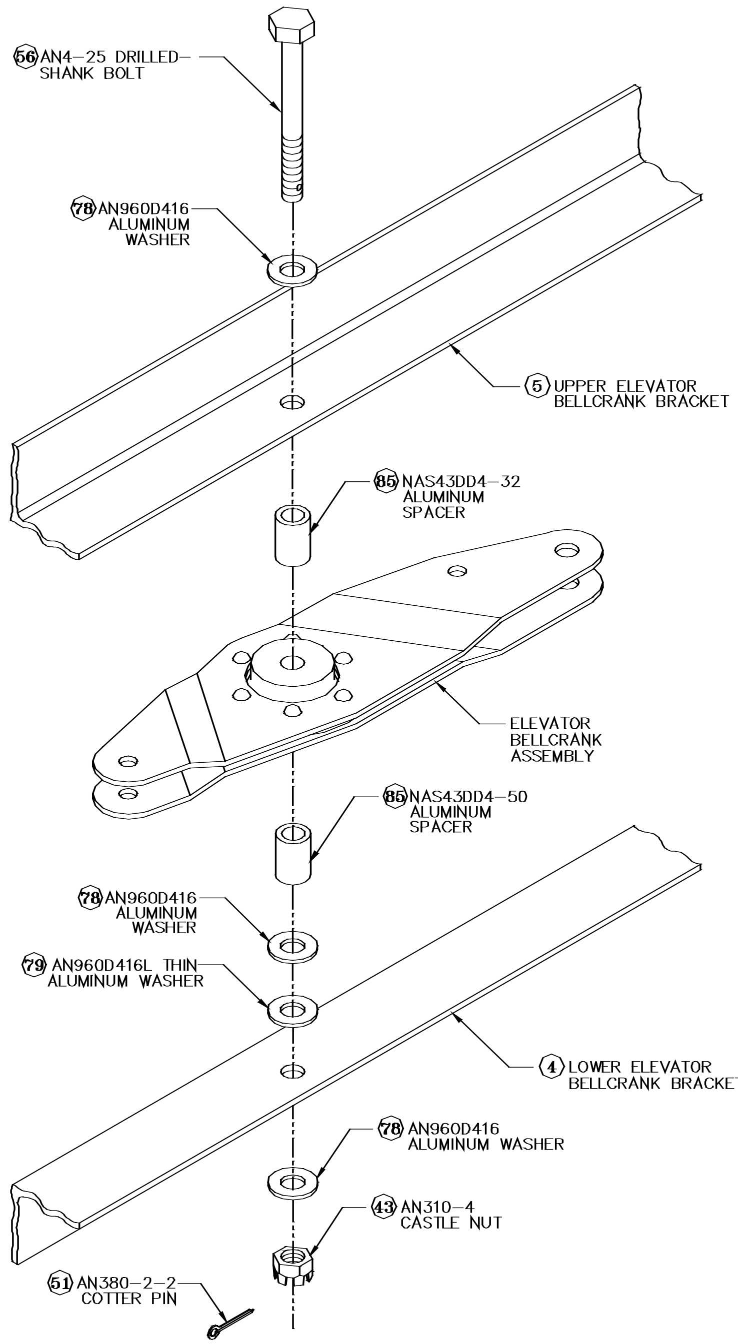

Figure 80: Elevator Bellcrank Hardware Stack-Up

Step 69: Drill the Elevator Bellcrank Assembly

The elevator bellcrank assembly goes together just like the aileron bellcranks—with the bearing sandwiched between an upper and a lower bellcrank half. As shown in Figure 81, the **upper elevator bellcrank half** [15] is the one on which the ends bend upward when you hold it with the longer arm on the right and the 3/16" hole away from you; the **lower half** [14] is opposite.

Stack the bellcrank bearing on top of the two halves as shown in the figure and Cleco them together through the 1/8" holes in the two halves. After centering the bearing in the large center hole in each half and making sure the halves are aligned with one another, drill through the bearing and both halves at **every other** one of the twelve bearing pilot holes with a **#30** bit. Insert a second Cleco after drilling the first hole and then juggle the Clecos as necessary to complete the drilling.

Note Don't forget to remove the initial Cleco and drill that hole up to final size, because it's slightly undersized to begin with.

After all six holes have been drilled, disassemble and deburr the parts.

Completed: [ ]

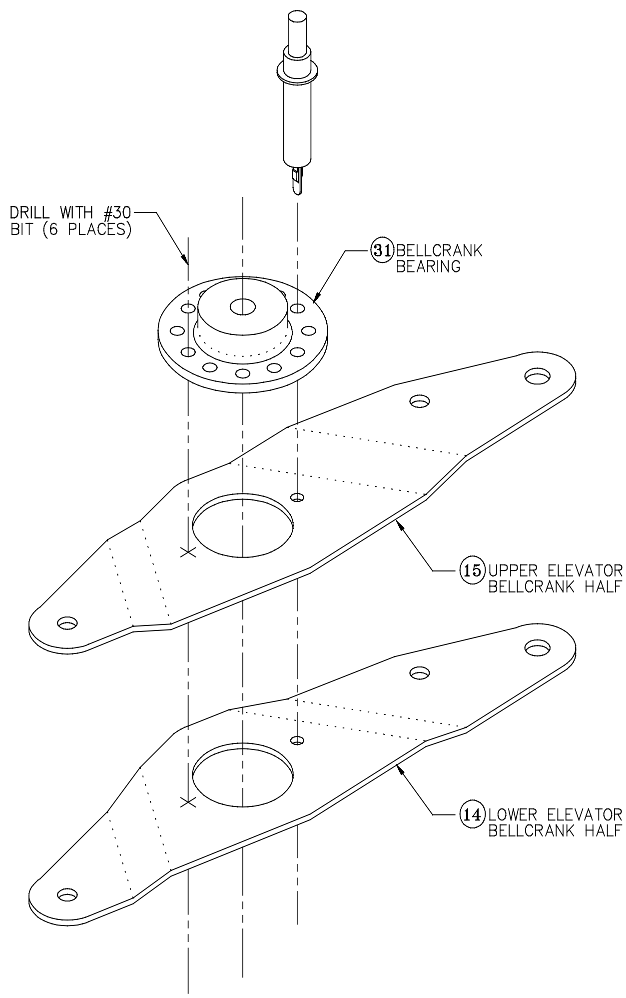

Figure 81: Drilling the Elevator Bellcrank Assembly

Step 70: Corrosion-Proof the Elevator Bellcrank Assembly and Brackets

Inspect both bellcrank brackets, bellcrank halves and the bearing for proper deburring and surface finishing, and then apply corrosion protection.

Caution The bellcrank bearing itself should be well protected against contamination with any of the chemicals used in prepping or priming the bearing flange. You may wish to prime the flange with a small brush rather than risk spraying.

Completed: [ ]

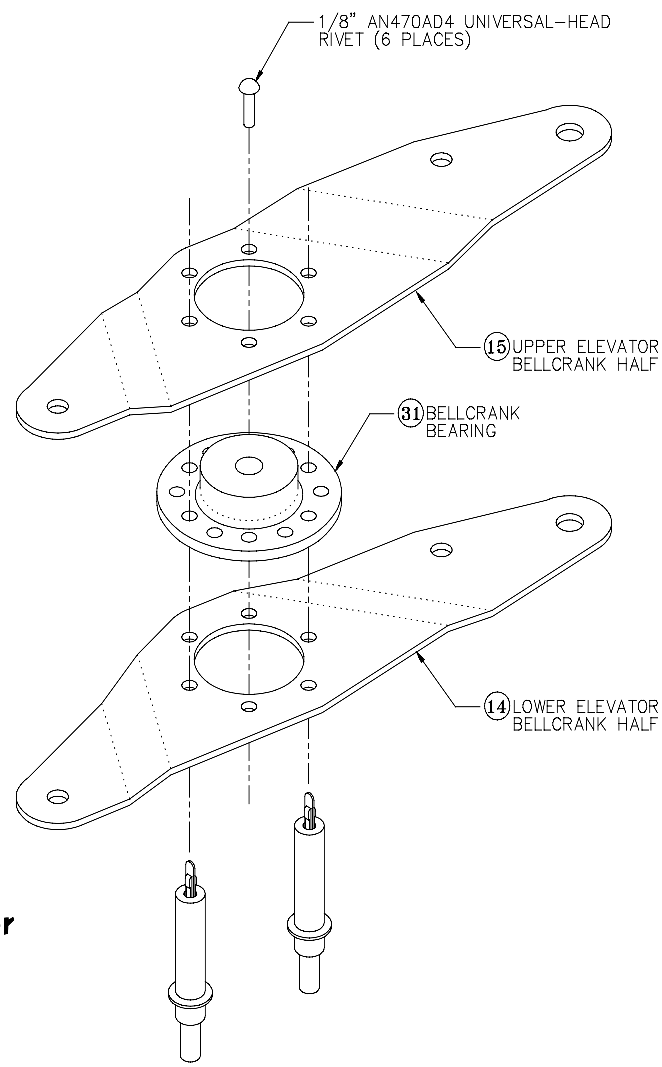

Figure 82: Riveting the Elevator Bellcrank Assembly

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

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Step 71: Rivet the Bellcrank

As shown in Figure 82, use 1/8" AN470AD4 universal-head rivets to rivet the bellcrank assembly together with the bearing sandwiched between the halves. The manufactured heads of the rivets should be on the upper half.

Completed: [ ]

Step 72: Install the Elevator Bellcrank/Bracket Assembly

Before assembling, you may want to review Step 174 in Final Assembly regarding the elevator control stop. Assemble the bellcrank/bracket assembly as shown in Figure 80. Tighten the nut until the spacers are clamped firmly against the bearing, and then secure it with an AN380-2-2 cotter pin.

Bolt the entire assembly to Bulkhead C through the holes drilled previously. Use AN3-6A **bolts** [41.1], AN970-3 large washers and AN364-1032A nylon self-locking nuts, with the washers and nuts forward.

Completed: [ ]

Step 73: Position and Install Bulkhead D

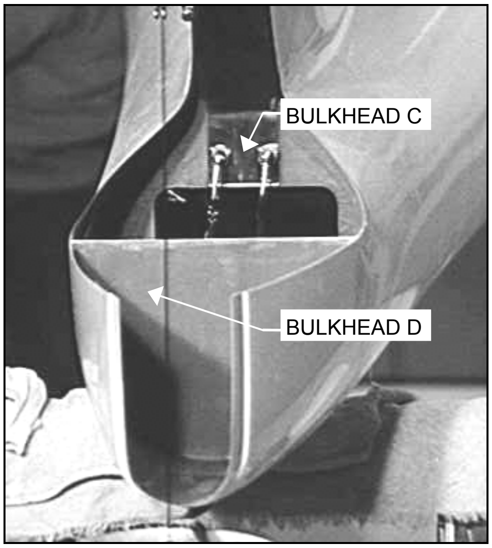


Figure 83: Bulkhead D

Figure 83 shows that Bulkhead D is positioned aft of Bulkhead C in the wide, flared portion of the aft fuselage. The precise dimension from the tailcone joggle to the aft face of the bulkhead (prior to lamination) should be **11-9/16"**, as shown in Figure 84. Measure this distance straight forward along the centerline, not along the shells.

Bulkhead D must be positioned perpendicular to both the waterline and centerline with as much precision as possible, since it bears the **horizontal stabilizer forward attach bracket** [13], which in turn determines the alignment of the stabilizer. You can check for perpendicularity to the waterline by holding a level (preferably a digital one) against the face of the bulkhead. Perpendicularity to the centerline can be checked with a a try square, as shown in Figure 85: hold the body of the square against the bulkhead and sight along the blade down to the centerline. Or the most accurate method is to measure from the wing strut attach lugs to the bulkhead on each side, in a similar manner as shown in Figure 104. A long straight edge attached to bulkhead D will aid in making measurements.

When the bulkhead is as square as you can make it in both directions, tack it in place with hot-melt glue.

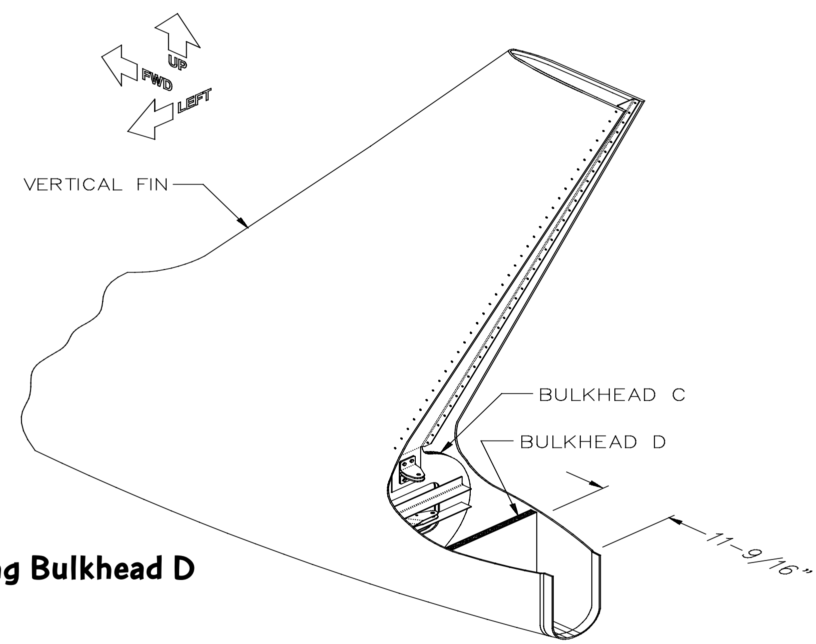


Figure 84: Positioning Bulkhead D

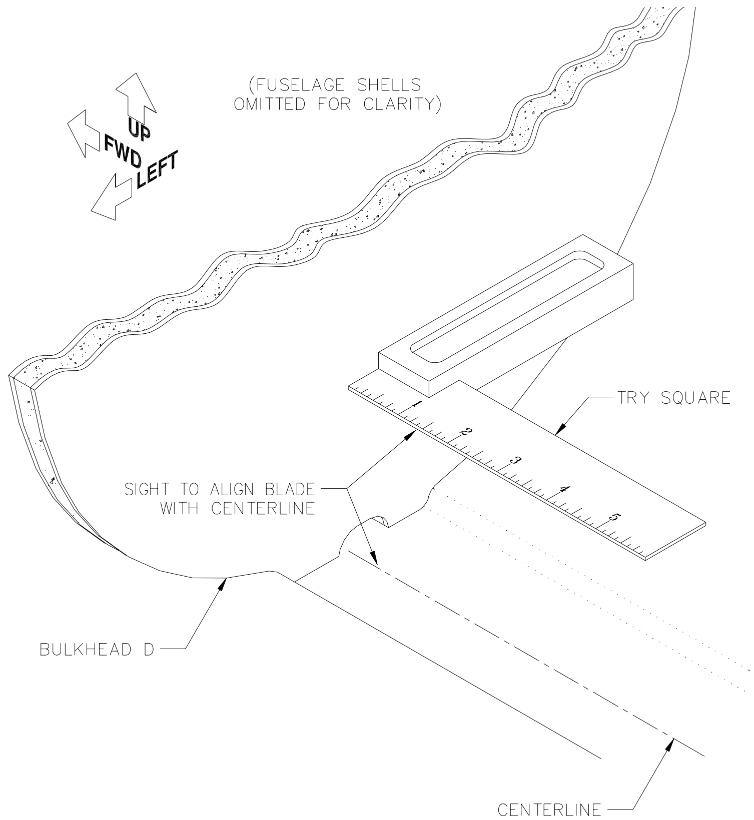


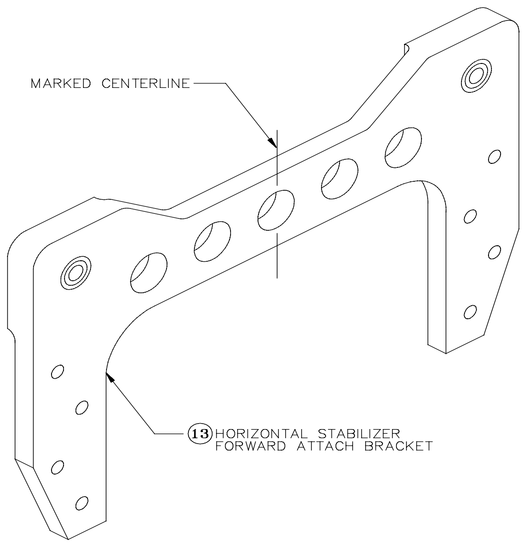
Figure 85: Squaring the Bulkhead Relative to the Aircraft Centerline

After positioning, apply a 3/16" Q-cell fillet all around the forward and aft edges. When the Q-cell has cured, add **four** laminates of bi-directional cloth cut on the 45° bias—two layers on the forward face and two on the aft—all of which should cover the **entire face of the bulkhead** and lap approximately **1"** over onto the shell all the way around. Keep the drain hole clear of Q-cell and laminates.

Use the Bulkhead D template that you saved earlier as a guide to cut out these four pieces, leaving a generous margin around all the edges except the top. Since the horizontal stabilizer attach bracket mounts to the forward face of D, take special care to keep these laminates flat and free of bubbles. After the laminates have cured, trim them even with the top of the bulkhead.

Completed: [ ]

Step 74: Position and Drill the Horizontal Stabilizer Forward Attach Bracket



You used the horizontal stabilizer forward attach bracket in "SECTION IV: HORIZONTAL STABILIZER ASSEMBLY." You'll probably find it underneath all that scrap metal and those back issues of *Sport Aviation* under your bench—dig it out and dust it off for installation!

The first step is to mark a centerline on the **aft** face of the bracket and on bulkhead D. As shown in Figure 86, the aft face is the flat face without the machined, raised areas around the bearings.

Figure 86: Marking a Centerline on the Stabilizer Attach Bracket

The bracket is positioned by aligning the centerline mark on the bracket with the one on the bulkhead, and then setting the height of the bracket relative to the waterline, as shown in Figure 87.

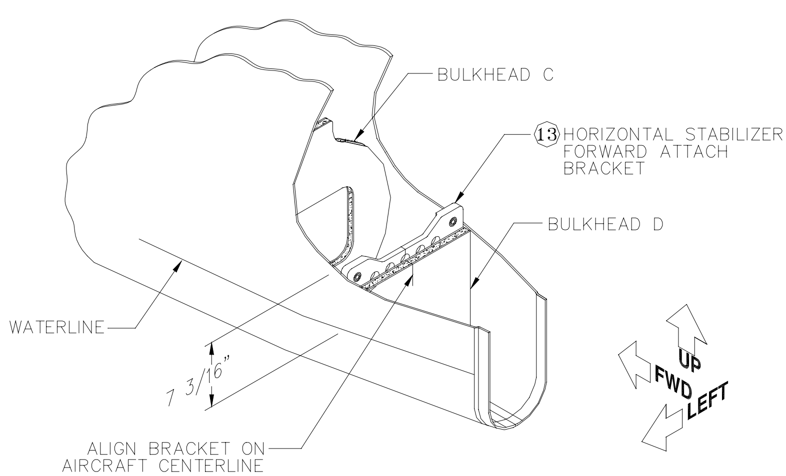


Figure 87: Positioning the Stabilizer Attach Bracket

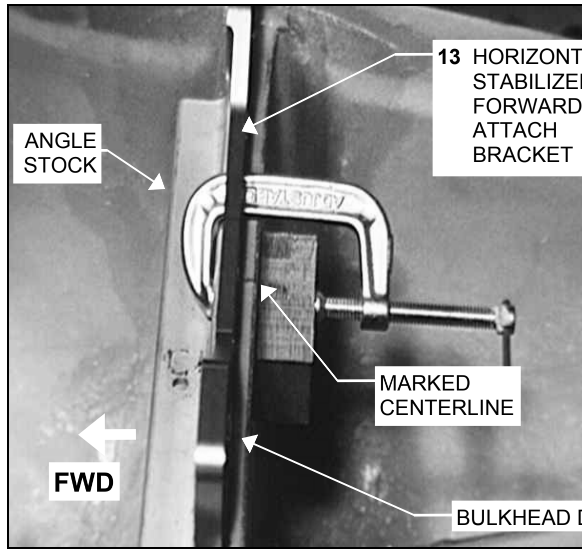


Figure 88 Clamping the Stabilizer Attach Bracket to Bulkhead D

Begin by clamping the bracket to the **forward** face of Bulkhead D using the method shown in Figure 88. The small C-clamp shown passes through one of the lightening holes in the bracket; this is necessary to keep the clamp out of the way during the subsequent measuring and leveling procedures. Be sure to use one of the holes to either side of the center hole, since the clamp would obscure the marked centerline if the center hole were used. Use a strip of wood or a piece of angle stock to bridge the legs of the bracket on the forward side, and use a block of wood on the aft side to prevent crushing the foam core of Bulkhead D.

Note In order for the bracket to be properly positioned, it's essential that the fuselage be level laterally. You may wish to check this again before proceeding.

Next, adjust the height of the bracket relative to the waterline, as shown in Figure 89. This distance should be **7 3/16"** and should be measured as precisely as possible. To get an accurate measurement, be sure to read the ruler from eye level. With the height set, you next need to level the bracket, as shown in Figure 90. Obviously, moving the bracket to make it level may change its distance from the waterline as well, so you'll probably have to run through several iterations of measuring and leveling until both conditions are met.

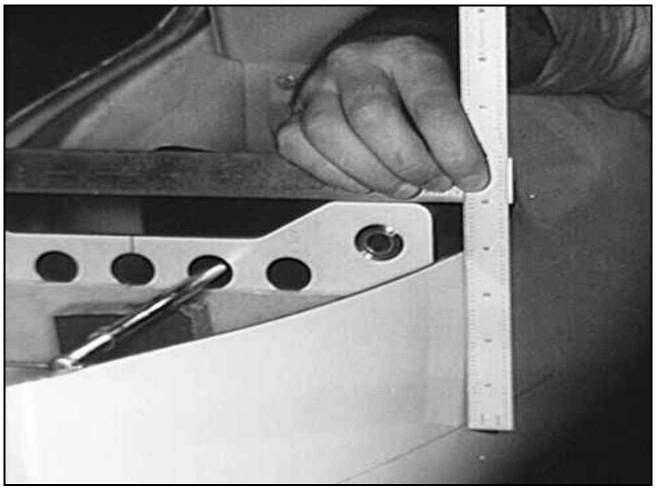


Figure 89: Measuring the Height of the Stabilizer Attach Bracket from the Waterline

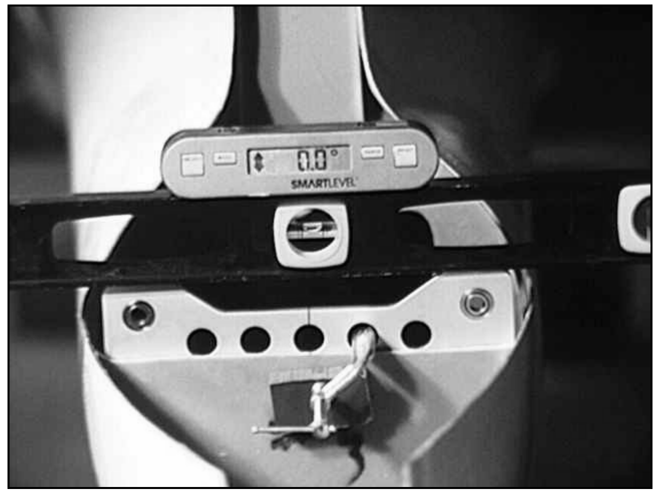


Figure 90: Leveling the Stabilizer Attach Bracket

Hint Although your waterline marks on each side of the fuselage are theoretically parallel with one another when the fuselage is level laterally, in the real world there's likely to be some small discrepancy from side to side. For this reason, it would be a good idea to measure the height of the bracket on both sides. If the distance doesn't measure 7-3/16" when the bracket is level, then split the difference and readjust the height of the bracket. In any case, the bracket should **always** be leveled according to the technique shown in Figure 90 rather than according to the waterlines.

Note Don't worry if your stabilizer attach bracket doesn't protrude as far above the top of Bulkhead D as shown in Figures 89 & 90. The fuselage sides (and the top of Bulkhead D, if necessary) will be trimmed later.

Once the bracket is positioned to your satisfaction, use a 90° drill motor to drill the eight bolt holes with a **1/4"** bit from the forward side of the bracket. Be careful to hold the drill perpendicular to the bracket to avoid enlarging the pre-drilled holes. Insert 1/4" (AN4) bolts in the first couple holes to help maintain alignment.

Finally, remove the clamp, wood block and angle stock, but keep the bracket pinned to the bulkhead with a pair of bolts. Use a marking pen to trace the inner outline of the bracket onto the forward face of the bulkhead, as shown in Figure 91. You will make use of this line in the next step. When you're done, remove the bracket and set it aside.

Completed: [ ]

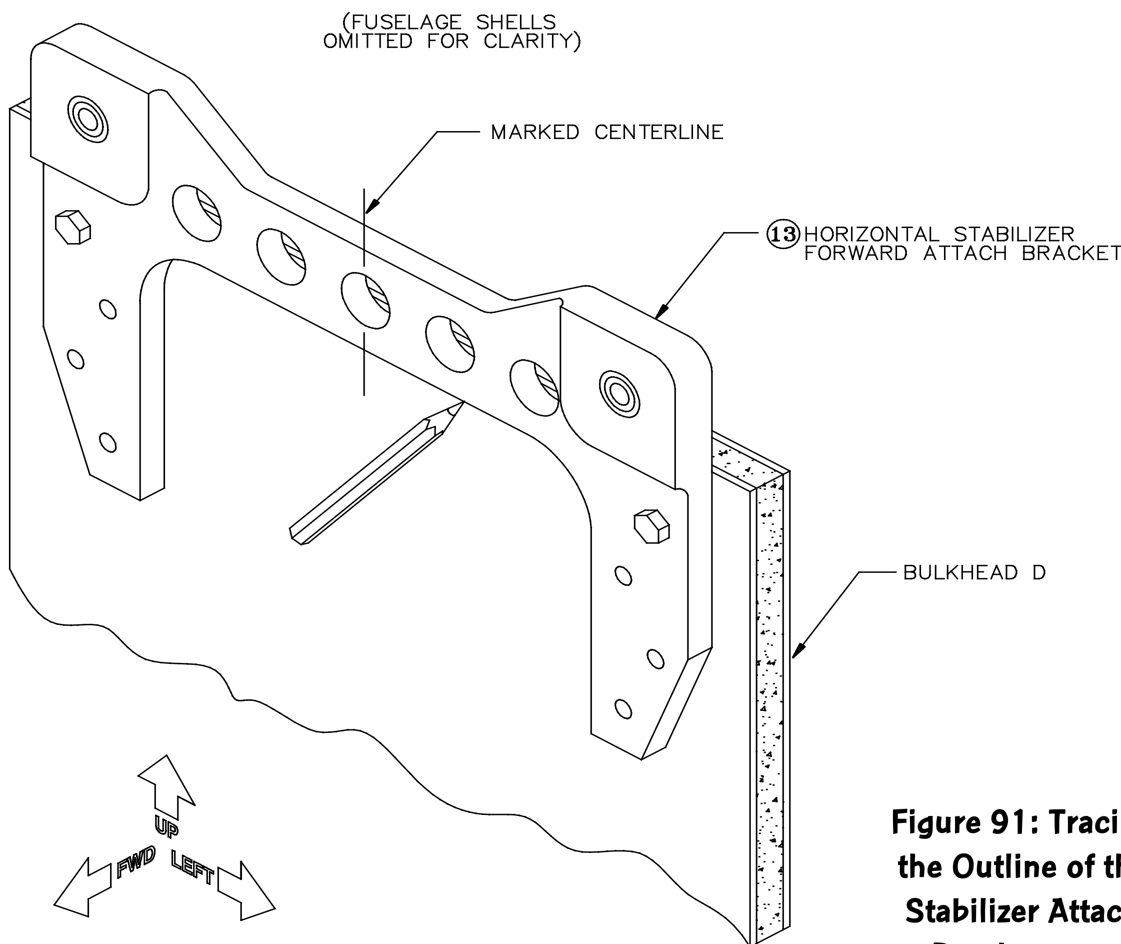


Figure 91: Tracing the Outline of the Stabilizer Attach Bracket onto Bulkhead D

Step 75: Laminate the Aft Attach Flange for the Forward Inter-Bulkhead Shearweb

Torsional strength is added to the aft fuselage by a .050"-thick aluminum shearweb installed horizontally between Bulkheads C and D and the two fuselage shells. Figure 92 shows the completed web. In this and the next two steps, you will install the attach angles and flanges to which this shearweb is bolted. The forward angles will be cut from aluminum stock, but the side and aft flanges are laminated in place. Figure 93 shows the position and appearance of the completed aft flange.

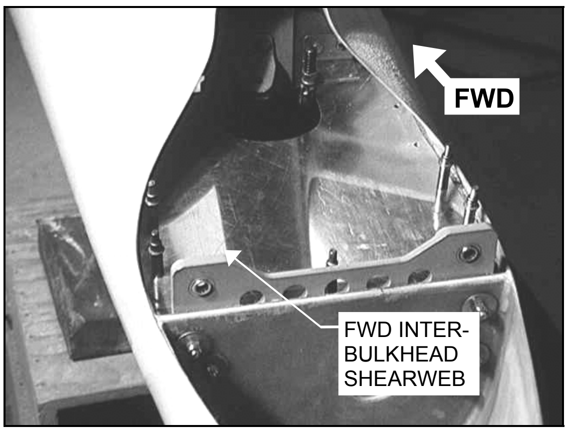


Figure 92: Forward Inter-Bulkhead Shearweb

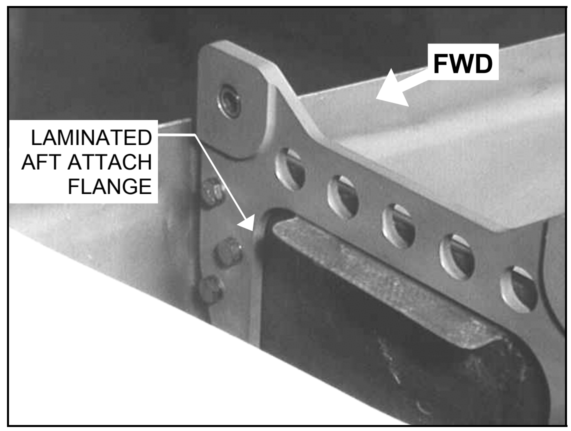
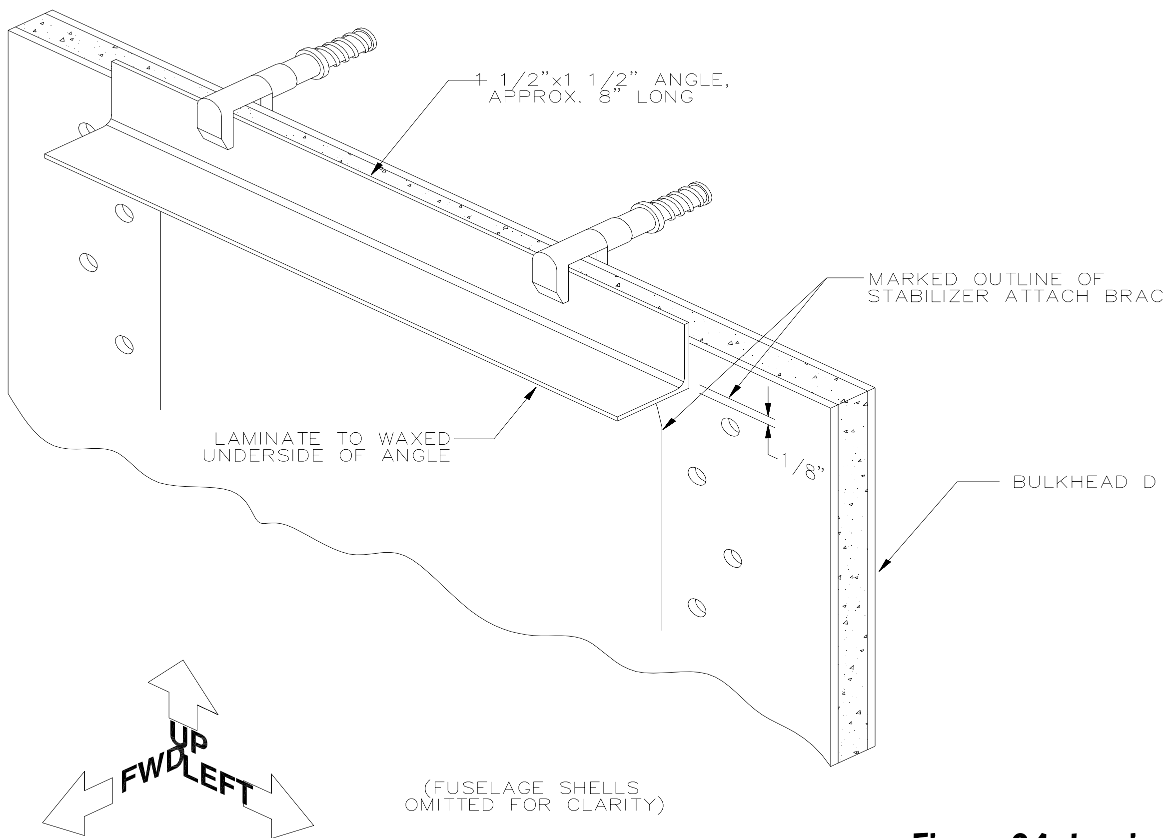


Figure 93: Aft Attach Flange for the Shearweb

The flange consists of a two-layer DBM laminate made against the underside of a scrap 1-1/2" X 1-1/2" angle stock form. First, clean the forward face of Bulkhead D with acetone. Then, as shown in the upper panel of Figure 94, cut a piece of angle about **8"** long and apply mold-release wax to one flange. Clamp this angle centered across the top of Bulkhead D with the waxed flange down. The waxed surface should be about **1/8" below** the marked outline of the stabilizer attach bracket. This provides clearance for the shearweb between the bracket and the attach angle.

With the angle clamped in place, two layers of DBM cloth, each of which should overlap equally onto the angle and the bulkhead. These pieces of cloth should be about **6-1/2"** long and centered between the lines you marked indicating the inside edges of the bracket legs.

Hint Laying a small mirror on the fuselage floor will make this laminating task easier.



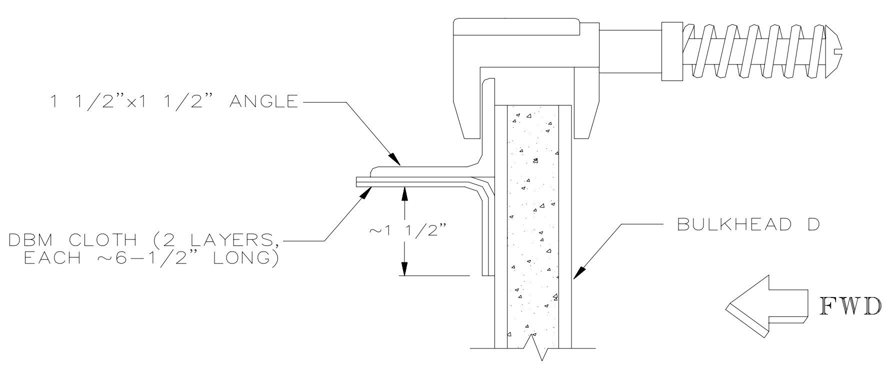


Figure 94: Laminating the Aft Attach Flange for the Forward Shearweb

Note Don't worry if the DBM cloth extends a bit beyond the angle flange in the forward direction or a bit beyond the bracket leg lines in an outboard direction. You will be trimming this laminate after it cures in any case.

After the laminate has reached at least green cure, with a new sharp utility knife trim its forward edge even with the angle flange. Then remove the angle. If you don't catch it at the green cure, it can later be ground or sanded to the desired width. After the laminate has cured completely, grind the ends down as necessary to provide clearance for the stabilizer attach bracket, and then round the corners of the flange (as shown in Figure 93).

Completed: [ ]

Step 76: Position and Drill the Forward Attach Angles for the Forward Shearweb

The forward attach angles are cut from aluminum stock rather than being laminated in place. From the 6" length of **.063" X 1" X 1" aluminum angle stock** [30], cut two 2"-long pieces; smooth the ends and round the corners as usual.

As shown in the upper panel of Figure 95, mark, center punch and drill four **#10** holes in each angle. Note that the two pairs of holes are **not** equidistant from the edges of the angle flanges: the two holes in the **vertical** flange should be **1/2" below** the upper edge of the flange, and the holes in the **horizontal** flange should be **3/8" forward** of the aft edge of the flange.

Figure 95 illustrates the placement of these angles on Bulkhead C: each should be **1/4" outboard** of the edges of the vertical fin spar and **5/8" below** the top edge of the lower rudder hinge. Clamp or hold the angles in position and use the holes in the angles as guides to drill **#10** bolt holes through Bulkhead C.

After both angles have been drilled, temporarily bolt them in place with 3/16" (AN3) bolts.

Completed: [ ]

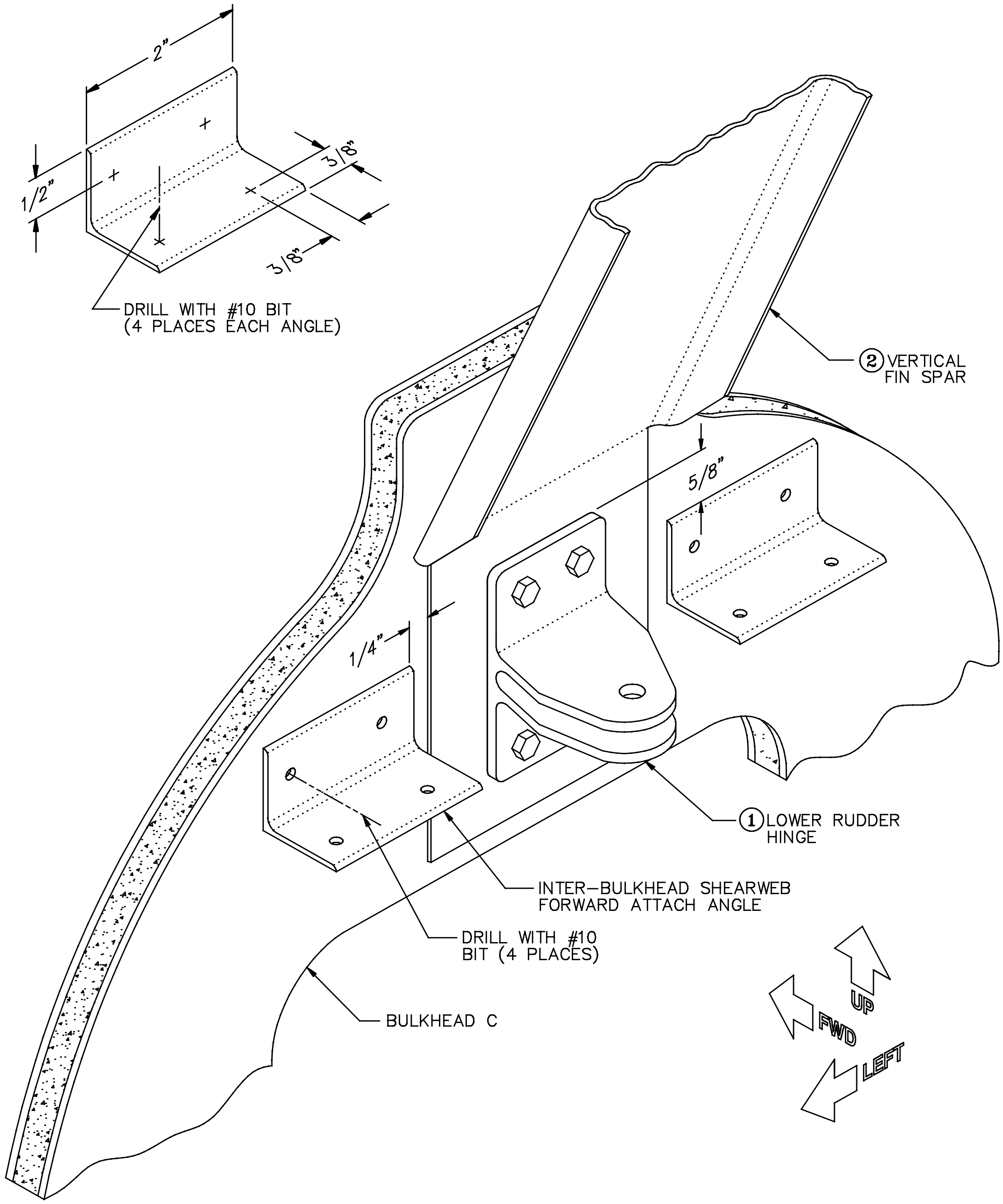


Figure 95: Positioning and Drilling the Forward Attach Angles for the Forward Shearweb

Step 77: Cut Out the Forward Shearweb

The forward inter-bulkhead shearweb must be cut from the **.050" X 12" X 12" aluminum sheet** [25]. A pattern for the shearweb is given on the **inter-bulkhead shearweb template** [22].

By this point in the assembly process, every Sportsman is going to be a little bit different, and this is particularly true in the aft fuselage area, where precise measurements are difficult and typical fiberglass work produces variation in results. Therefore, it's best to use the template only as a general guide to size and shape and to fit your shearweb precisely to your Sportsman through a process of trial and error. To minimize the cost of errors, we recommend fitting a dummy shearweb of stiff cardboard first before cutting the real one from the aluminum sheet. Begin by tacking the template to your cardboard piece and cutting it out a good bit oversized—say, **1/4"** extra all the way around.

The upper panel of Figure 96 is a cross-sectional side view of the aft fuselage that shows how the forward shearweb should ultimately fit relative to Bulkheads C and D, the forward attach angles and the aft attach flange. Note that the web lies on **top** of the aft flange but slides **below** the forward angles.

The first step in fitting the dummy shearweb is to trim it to width. Try sliding the web between the shells from the aft end and trim one or both side as necessary to get a good fit. When finished, the web should slide easily in and out from between the shells (i.e., it should **not** be a friction fit), but it should also follow the contours of the left and right shells as closely as possible, since it also will be attached to fiberglass angles. It should **not** be necessary to bend the shearweb to get it into place.

Once the left and right sides are close to being correct, begin trimming to length. As the upper panel of Figure 96 shows, both the forward and aft ends of the shearweb will be bent at a slight angle to keep them flat against their respective attach angles/flanges. This bending will effectively shorten the shearweb a bit, but this amount is so slight that you can achieve good results by simply trimming the shearweb to fit flat between the bulkheads, as shown in the lower panel of Figure 96.

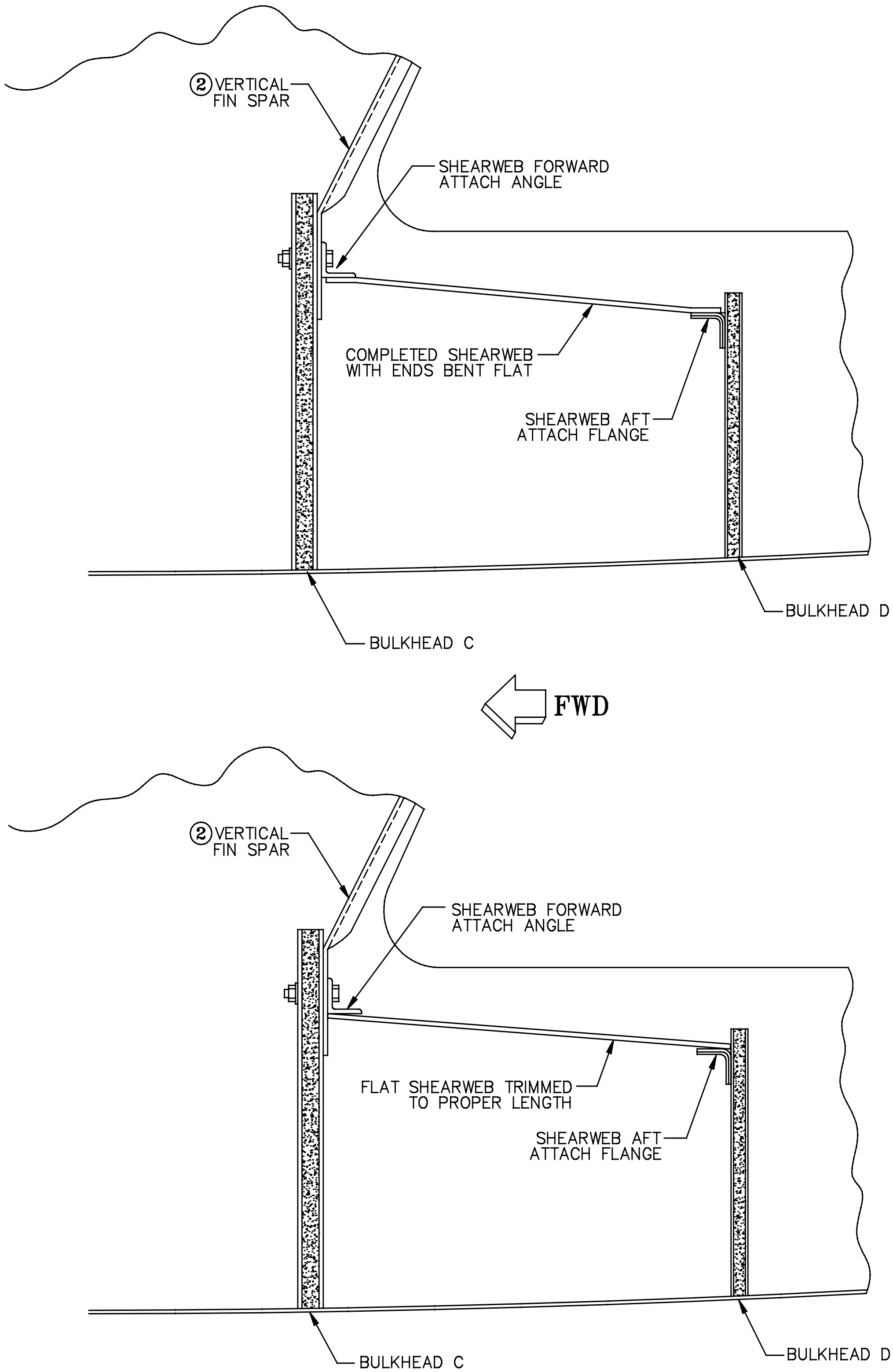


Figure 96: Fitting the Forward Shearweb

With the dummy shearweb fit to your satisfaction, transfer its outline to the aluminum and cut out the shearweb. A scroll saw is really the ideal tool for this job, although a bandsaw will also work reasonably well. In dire emergency (i.e., an exhausted tool budget!), the shearweb can also be roughed out with heavy-duty snips and filed to final shape.

When the shearweb is cut out, mark, center punch and pilot drill the bolt hole locations around the perimeter of the shearweb as shown on the template. Use a **#30** bit. Next, bend the ends of the shearweb to match the forward attach angles and aft attach flange. These bends should be equal in size and will probably turn out to be around **5°** apiece. However, as with the overall size of the shearweb, you'll have to use trial and error to determine the exact bend appropriate to your Sportsman.

Mark bend lines **1"** in from each end, as shown on the template. Mark the **forward** line on the **top** of the web and the **aft** line on the **bottom**. Because these bends are so slight, you don't need to worry much about establishing a proper bend radius. Simply clamp the web flat with the line on the edge of your bench, and apply pressure on the overhanging part with a scrap of 2 X 4 to make the bend.

Caution Try to avoid bending the ends **beyond** the required angle. It's much better to have to increase the bend three or four times before getting it right than to go too far initially and then have to bend the ends back.

After the shearweb is bent to final shape, slide it into place under the forward attach angles and on top of the aft attach flange. Holding the web tightly against the forward angles, drill through each of the four pilot holes in the angles with a **#10** bit, as shown at the left-hand end of Figure 97. Insert a 3/16" Cleco in each newly drilled hole. Finally, as shown at the right-hand end of Figure 98, drill through the shearweb and the aft attach flange at each of the three pilot-drilled locations along the aft edge of the shearweb, again using a **#10** bit. After drilling, remove the shearweb from the fuselage.

Completed: [ ]

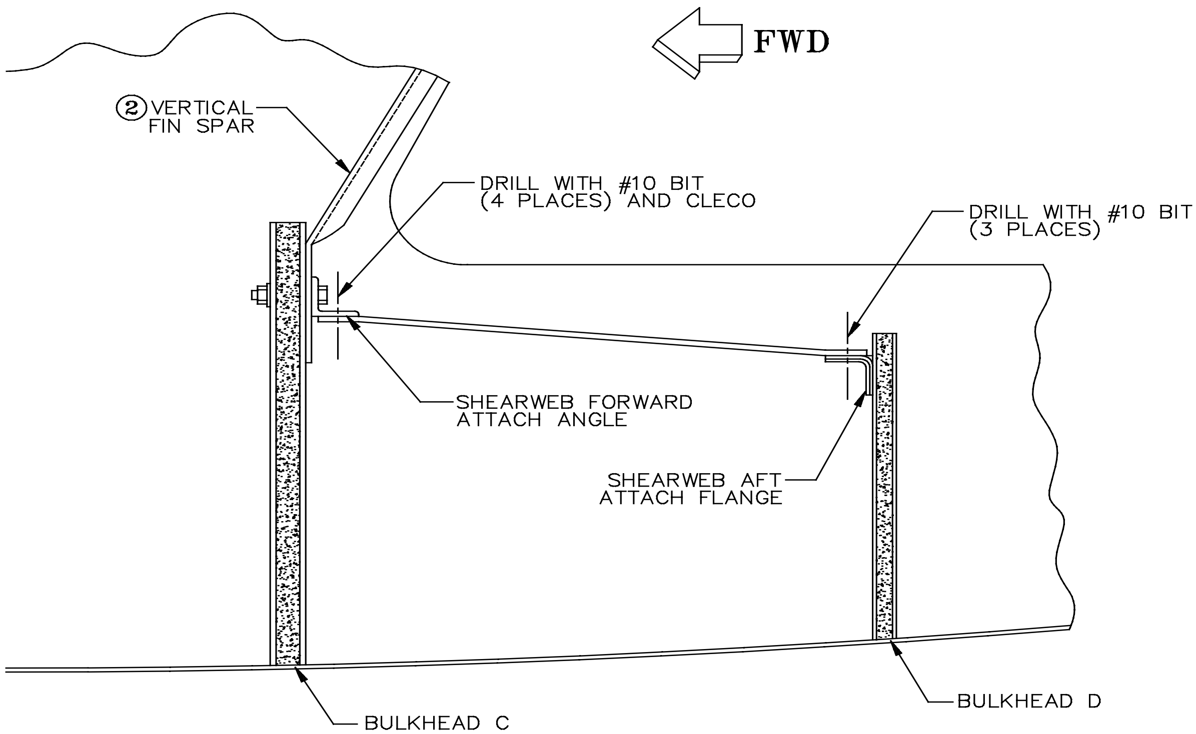


Figure 97: Drilling the Forward Attach Angles and Aft Attach Flange

Step 78: Laminate the Side Attach Flanges for the Forward Shearweb

The side attach flanges are laminated with two layers of DBM cloth just like the aft flange was. However, because of the curvature of the fuselage shells, it's impossible to use a piece of angle as a form for these laminates as you did before. Instead, you will use the shearweb itself as the form.

Begin by waxing the **entire underside** of the shearweb. You'll only be laminating purposely on the first 2" or so on each side, but count on being messy, since you'll be working by feel through the inspection hole in the bottom of the fuselage. Also, wipe down the sides of the fuselage shells between Bulkheads C and D with acetone. Replace the shearweb in the fuselage and Cleco it securely fore and aft.

The attach flanges are laminated exactly as the aft flange was: with two layers of DBM overlapped equally onto the fuselage shell and the shearweb. The strips of DBM should be about **1" shorter** than the distance between Bulkheads C and D.

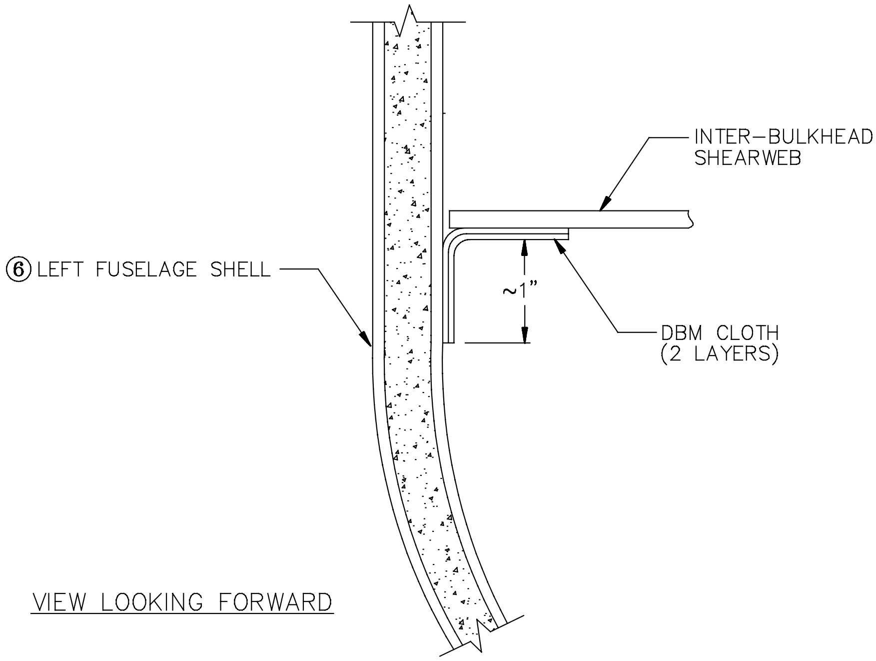


Figure 98: Laminating the Side Attach Flanges for the Forward Shearweb

Hint Obviously, the tricky aspect of doing the side flanges is having to work from underneath the fuselage through the inspection hole. You'll find it much easier to lay up the DBM strips if you pre-saturate them with resin before placing them under the shearweb. Double them up and install both together.

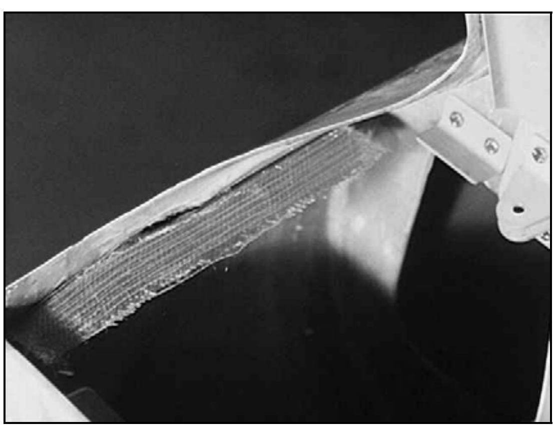


Figure 99: Left-Hand Attach Flange

When completed, the side attach flanges should be **1"** wide and should end **1"** aft of Bulkhead C and **1"** forward of Bulkhead D. Remove the shearweb and trim and grind the side angles to final size after they've cured. Figure 99 shows the finished left-hand flange laminate just prior to trimming.

Completed: [ ]

Step 79: Drill the Bolt Holes Along the Sides of the Forward Shearweb

Replace the forward shearweb and Cleco it in place with several Clecos through the forward attach angles and aft flange. Use a **#10** bit to drill through the shearweb and side attach flanges at the two aft pilot holes along the sides of the shearweb.

Two more #10 holes must be drilled along the each side of the shearweb forward of the holes you just drilled. However, because of the way the fuselage shells fair into the vertical fin, there is no way to get either a straight drill or even a 90° motor in from above. Therefore, you'll have to drill these holes from below.

Remove the shearweb and mark two additional hole locations on the **top** of each side attach flange. As shown in Figure 100, space these holes about **2-1/4"** apart fore and aft and the same distance from the inboard edges of the flanges as the two aft-most holes. Then use a 90° drill motor to drill **up** through the flanges with a **#10** bit at each of the marked locations. Since the flanges are narrow and translucent, you should be able to eyeball the position of the drill bit quite accurately.

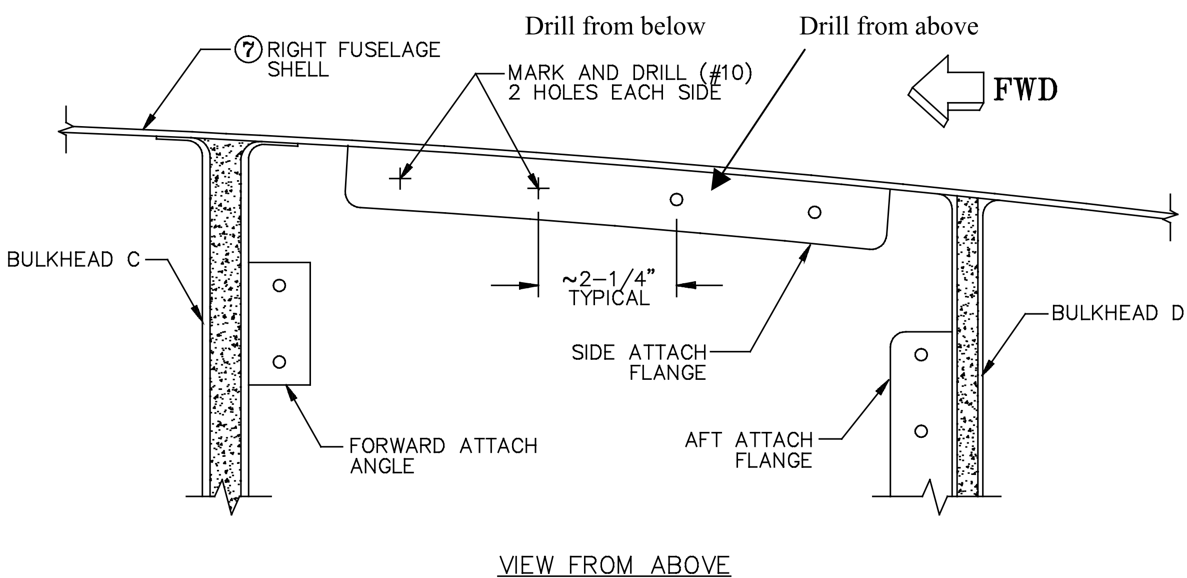


Figure 100: Marking and Drilling the Forward Bolt Hole Locations in the Side Attach Flanges

Finally, once these holes are drilled through the flanges, replace the shearweb, mark the four new holes from underneath, remove the shearweb, center punch the marked locations, and drill them with a **#10** bit.

Completed: [ ]

Step 80: Deburr and Corrosion-Proof the Forward Shearweb and Attach Angles

Remove the shearweb and the forward attach angles from the fuselage. Thoroughly deburr the holes, smooth the cut edges and remove all traces of wax and apply corrosion protection. Set the shearweb aside; it will be installed in "SECTION X: FINAL ASSEMBLY."

Note The horizontal stabilizer forward attach bracket is anodized and thus requires no further corrosion protection.

Completed: [ ]

Step 81: Install the Forward Shearweb Forward Attach Angles

Install the forward attach angles for the inter-bulkhead shearweb using the hardware shown in Figure 101: AN3-7A bolts, AN970-3 large washers, AN960D10 washers and AN364-1032A nylon self-locking nuts. Do not over tighten these bolts.

Completed: [ ]

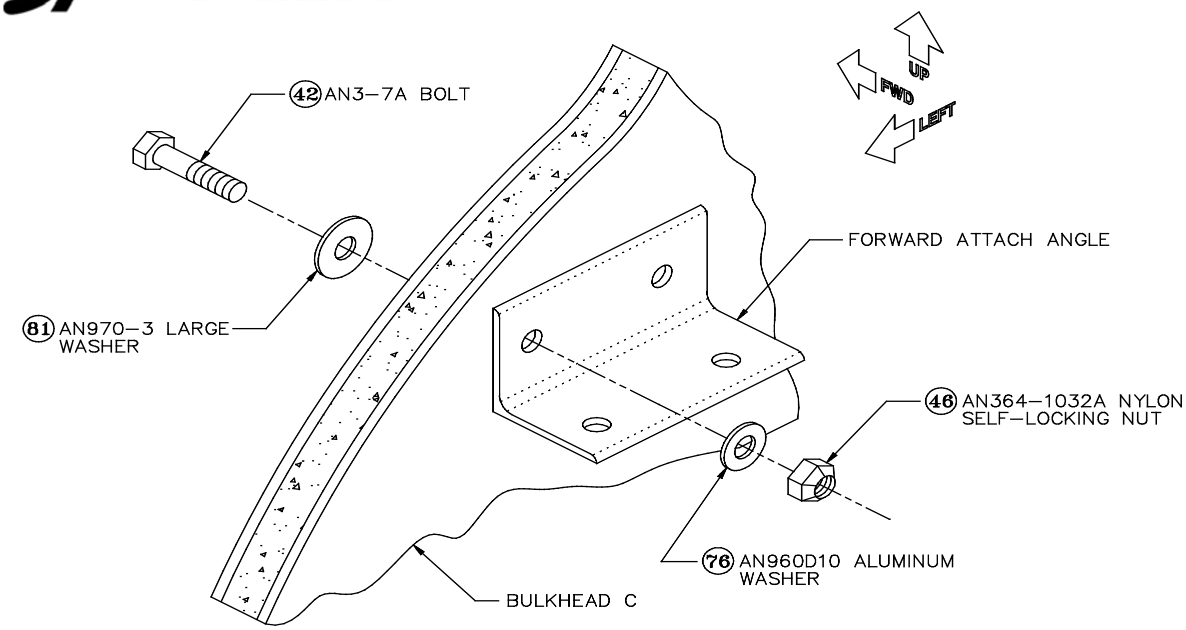


Figure 101: Installing the Forward Attach Angles

Step 82: Install the Horizontal Stabilizer Forward Attach Bracket

Install the horizontal stabilizer attach bracket. Insert AN4-11A **bolts** [55] from the forward side of Bulkhead D, with AN960D416 aluminum washers under the heads. On the aft side of the bulkhead, secure the bolts with AN970-4 **large washers** [82] and AN364-428A nylon self-locking nuts, as shown in Figure 102. If the large washers interfere with each other or the Q-cell radius around the aft side of Bulkhead D, grind their edges as necessary to allow them to lie tightly against the bulkhead.

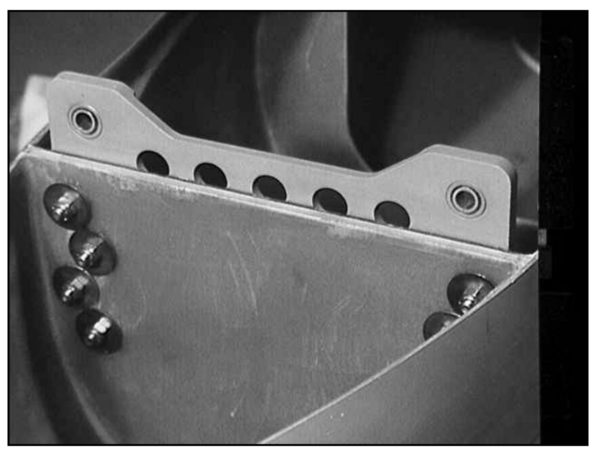


Figure 102: Installing the Horizontal Stabilizer Forward Attach Bracket

Completed: [ ]

Step 83: Trim the Fuselage Shells to Fit the Horizontal Stabilizer

In the next step, you'll mount the horizontal stabilizer and use it to position Bulkhead E. First make a trial installation to test fit the stabilizer. Begin by wiping a small amount of grease on the alignment pins. Lower it over the forward attach bracket and try to insert the alignment pins into the bushings in the bracket. Note where the fiberglass shells may interfere with the leading edge and grind away material as necessary.

If necessary, cut away some material from the fuselage shells to provide clearance for the stabilizer. The ideal tool for this job is a pneumatic die grinder with a small sanding drum, but files and a hacksaw or saber saw will work as well.

Relieve the fiberglass until you can insert the stabilizer pins in the bracket without any contact between the stabilizer and the shells. Also trim the top of Bulkhead D as necessary to match the fuselage sides.

Do not grind any more material than necessary at this point to allow the pins to engage. One the final incidence angle is set and the aft attach bracket are drilled, a uniform gap of 1/16 to 1/8 will be set between the stabilizer and the fuselage sides.

Completed: [ ]

Step 84: Position Bulkhead E

Bulkhead E is located at the very aft end of the fuselage, where it provides the aft attach point for the horizontal stabilizer. Because it's very important to have a precise fit between the bulkhead and the aft attach bracket of the stabilizer, you will use the stabilizer as a "jig" to set the position of the bulkhead.

The horizontal stabilizer is set to a minus 1.4° (leading edge down) angle of incidence relative to aircraft waterline. Since you use the horizontal stabilizer to set bulkhead E, you need to make sure the stabilizer is square with aircraft centerline, level and set to the correct angle of incidence.

Slide the horizontal stabilizer into place, inserting the alignment pins into the bushings in the forward attach bracket. Push the stabilizer forward as far as possible. This may take a bit of force, so don't be too timid. It's a strong stabilizer!

You can work it in one of two ways. The preferred method is to use a smart level and align the centerline to the correct setting (it is a symmetrical airfoil). Check the angle at both of the tips. If you have a slight twist, just take the average if necessary. When you have the setting, clamp the bulkhead to the forward side of the two attach arms on the stabilizer.

Alternatively, if you do not have a smart level you can work to the dimensions shown in Figure 103 measuring off the waterline marked on your fuselage. The top

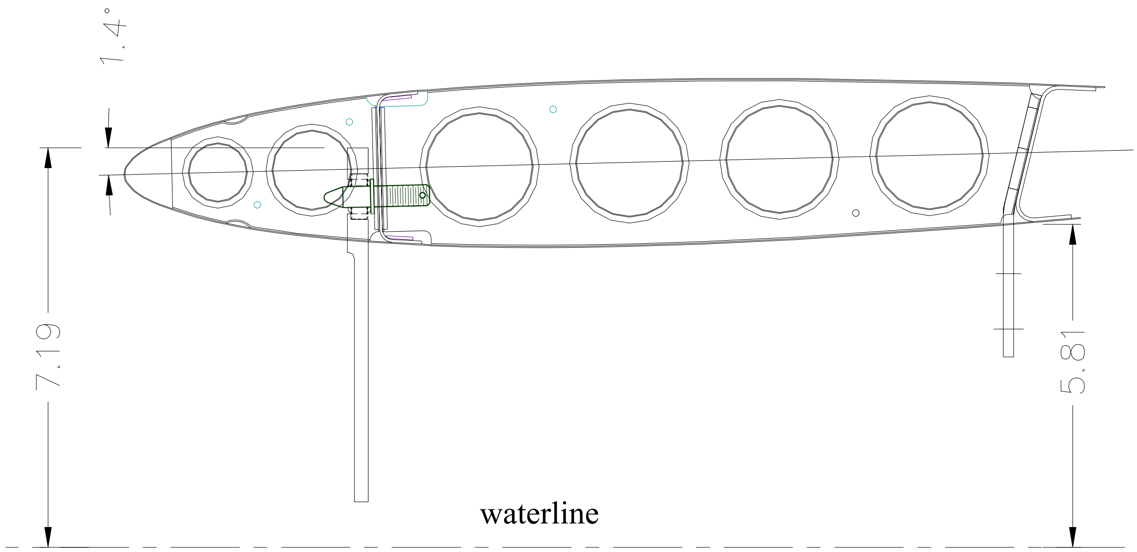


Figure 103 Setting the horizontal stabilizer

of the forward attach bracket should be 7-3/16". Where the skin and the aft attach bracket intersect each other, the dimension should be 5-13/16. If your forward dimension is different from the 7.19, simply subtract 1.38 [7.19 - 5.81=1.38] from your actual forward dimension to obtain your aft attach bracket skin dimension.

The bulkhead is located immediately **forward** of the downward-projecting ears of the stabilizer aft attach bracket. When set correctly, it is nearly perpendicular to aircraft waterline. In order to get it positioned tightly against these ears, you'll have to insert it into the fuselage on edge, passing it between the ears, and then turn it perpendicular to the centerline and pull it back into place.

To facilitate maneuvering Bulkhead E back against the stabilizer aft attach bracket, trim the elevator pushrod cutout outlined on the paper bulkhead template if you have not already done so.

Note A 'U'-shaped notch will be cut in the upper surface of the tailcone during its final installation; this will make the tailcone more flexible to fit the joggle at the aft end of the fuselage more easily. Take this into account when fitting Bulkhead E.

You're almost ready to install Bulkhead E at this point, but one more check needs to be made first. Earlier, you squared Bulkhead D relative to the aircraft centerline, and in theory, this should guarantee that the stabilizer forward attach bracket is square, which in turn should keep the stabilizer itself perpendicular to the centerline. In practice, however, it's possible that the stabilizer might be slightly skewed, and if not corrected now, the placement of Bulkhead E will make this permanent. At this time, therefore, check the stabilizer for perpendicularity by running a tape measure from the wing strut attach lugs on each side of the fuselage cage back to the outboard, leading-edge corners of the stabilizer, as shown in Figure 104.

Hint To get the most accurate measurement possible, place the end of the tape measure inside the wing strut attach holes and have an assistant hold the tape so that you can pull it good and taut. See the detail view in Figure 104.

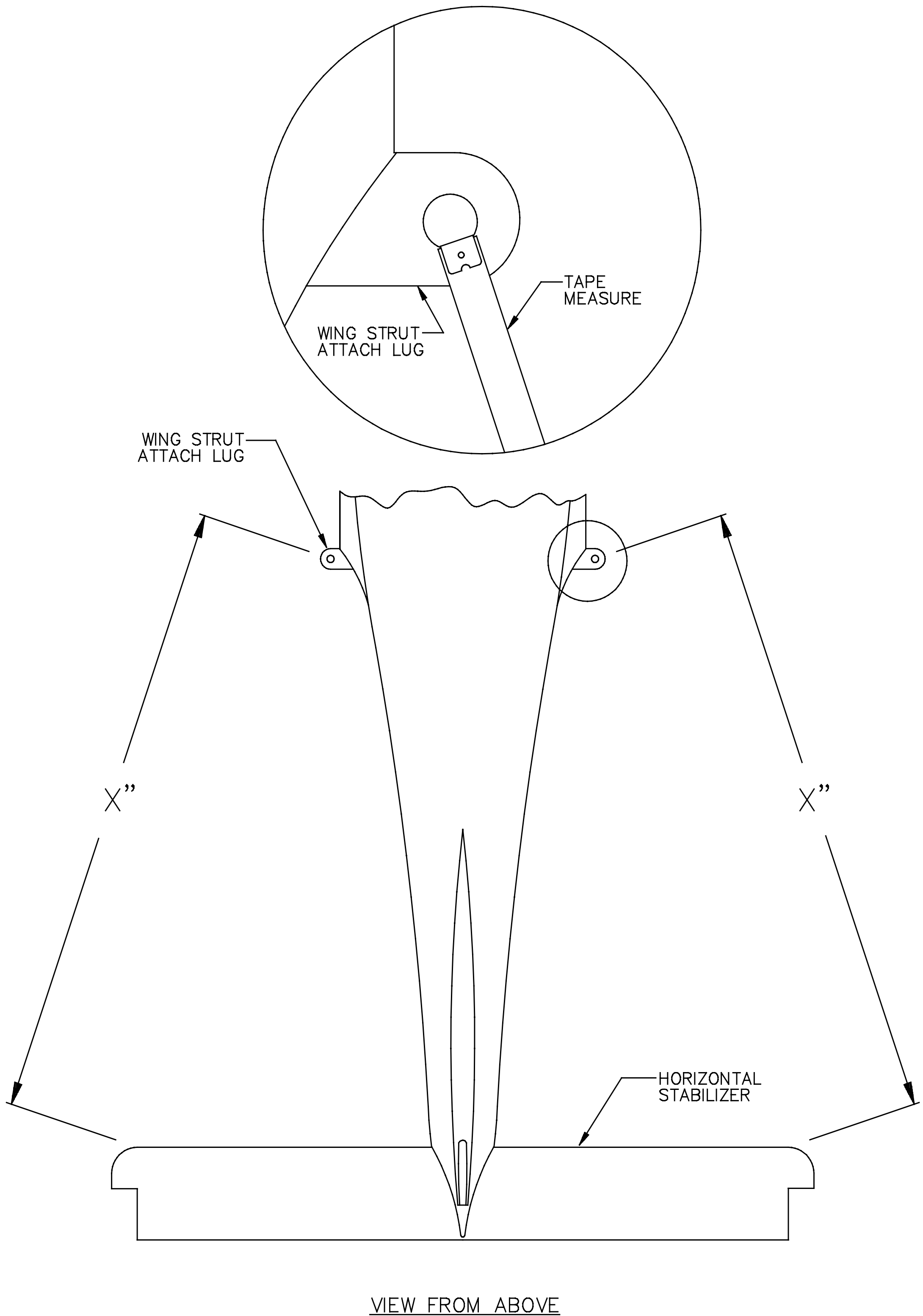


Figure 104: Checking the Horizontal Stabilizer for Squareness to the Centerline

It's unlikely that your stabilizer will be off the perpendicular by much, but it's also unlikely that it will be perfect. A misalignment of less than 1° at Bulkhead D translates into an inch of displacement at the tips. If you find a misalignment of more than 1", check to make sure that your stabilizer alignment pins are fully inserted into the forward attach bracket. If they are and the misalignment persists, remove the stabilizer and check to see if the forward attach bracket is seated squarely against Bulkhead D. Chips of fiberglass or blobs of Q-cell between the bracket and the bulkhead can skew the stabilizer. Remove any such material, reinstall the bracket and recheck the stabilizer.

If the stabilizer is still out of alignment but **by less than 1"**, go ahead and adjust its position, and then reposition Bulkhead E to bring it once again tightly against the ears of the aft attach bracket. Because of the small size of the misalignment, the position of the stabilizer can be corrected by repositioning Bulkhead E alone, and the alignment pins will still penetrate the forward attach bracket bushings far enough to provide a secure mounting of the stabilizer.

However, if the misalignment is **greater than 1"**, you should realign the forward attach bracket by laminating one or more extra shim layers of cloth under one or the other of the bracket legs, as shown in Figure 105. After this laminate has cured and the forward attach bracket has been reinstalled, check the stabilizer again and adjust further as necessary.

Note As a rough approximation, one layer of 7781bi-directional cloth (~.012 thick) under a leg of the ***forward*** attach bracket will move each tip of the stabilizer, one moving forward and the other aft about .25" each.

When the stabilizer is finally perpendicular to the aircraft centerline and Bulkhead E is positioned firmly against the attach bracket ears, mark the bulkhead's location on the fuselage shells and remove the stabilizer. Chances are the bulkhead will remain in position due to the pressure of the shells, but if necessary, tack it in place with some hot-melt glue.

Completed: [ ]

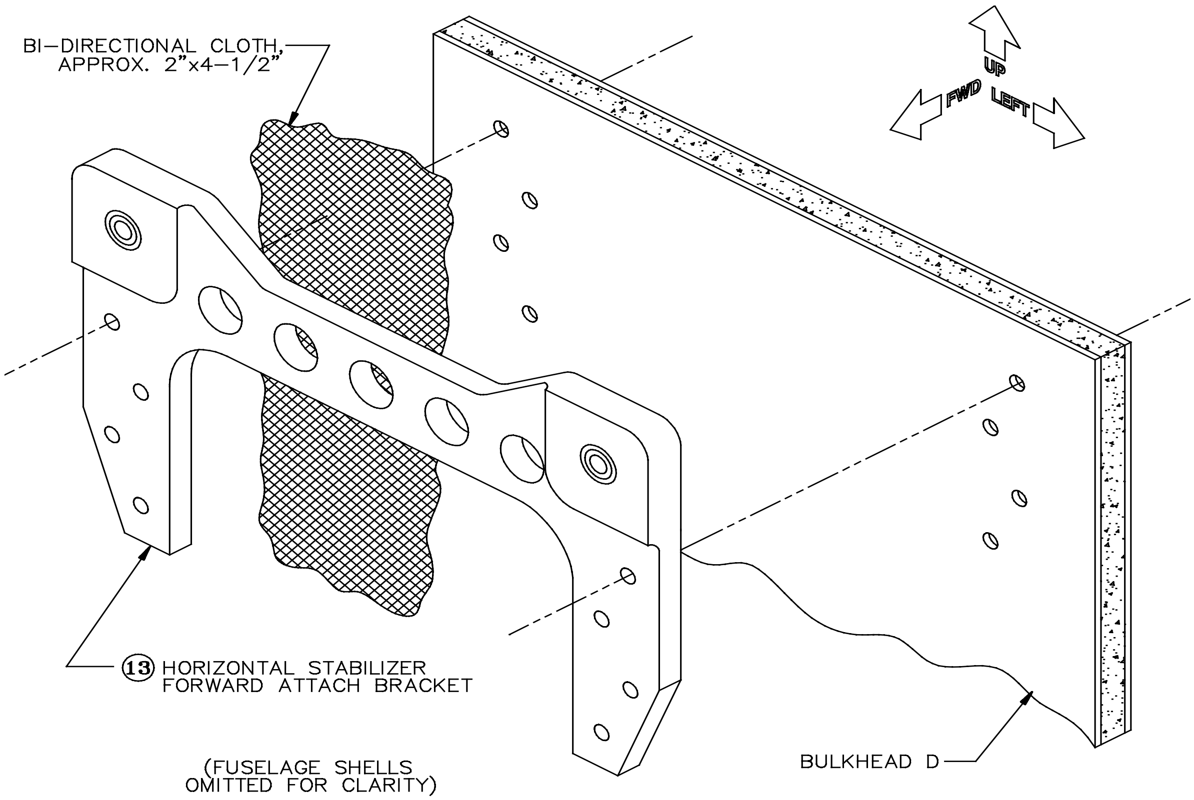


Figure 105: Adjusting the Horizontal Stabilizer Forward Attach Bracket

Step 85: Install Bulkhead E

Bulkhead E is a solid laminate and is installed with a 3/16" Q-cell fillet followed by two complete layers of bi-directional cloth on the **aft side only**. On the **forward** side, laminates of bi-directional and DBM cloth will then be applied to provide a solid, durable mounting point for the horizontal stabilizer aft attach bracket.

So, with Bulkhead E in the position that was determined in the previous step, begin by applying a **3/16"** Q-cell fillet around the perimeter of Bulkhead E on the **aft side.** Then apply a two-layer, 45° bi-directional laminate on the **aft side only** of Bulkhead E. The laminate should cover the entire aft surface of the bulkhead, be as flat and void free as possible and extend all the way to the aft end of the tail cone joggle flanges. Let the laminate cure.

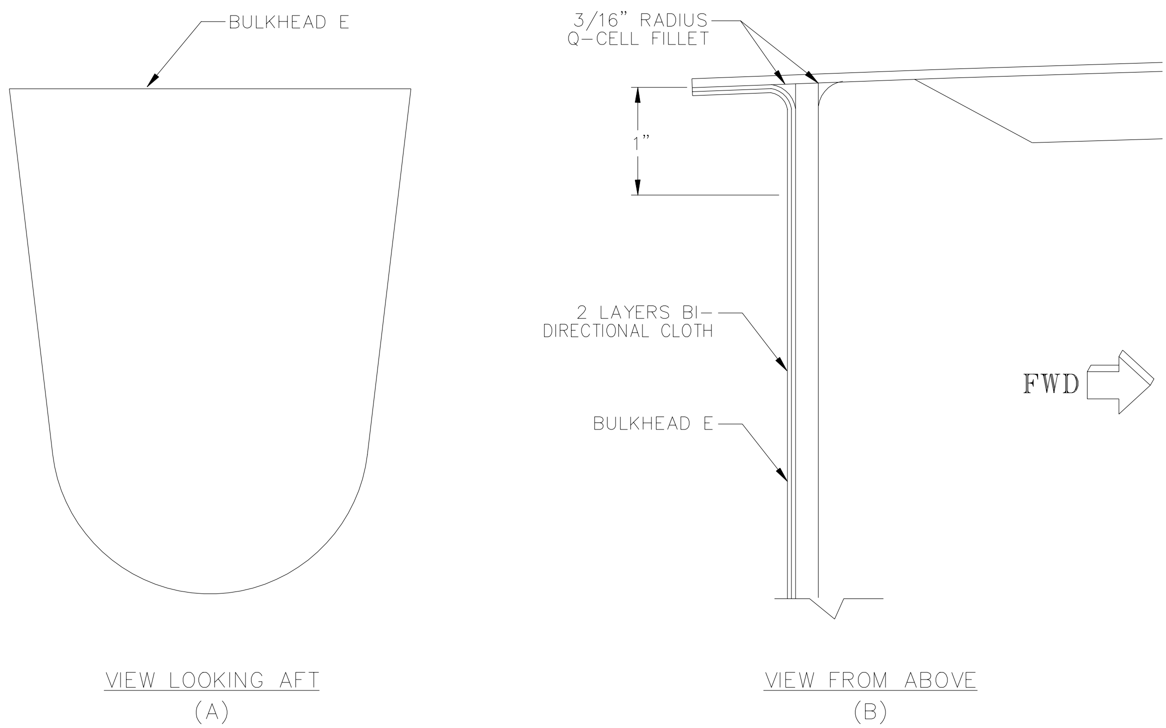


Figure 106: Laminating the Aft Side of Bulkhead E

Next, apply a 3/16"-radius Q-cell fillet around the perimeter of the bulkhead on the forward side. Figure 107 and 108 illustrate the schedule of laminates to be applied on the forward face of Bulkhead E. These layers can all be applied in a single laminating session, or you can let the resin cure between layers or groups of layers at your discretion. All told, the laminates will bring the thickness of the solid fiberglass upper half of the bulkhead to something over **1/4"**. The two layers of 7781 bidirectional cloth are applied to the lower, formed face of Bulkhead E overlapping 1-1.5" onto the fuselage sides.

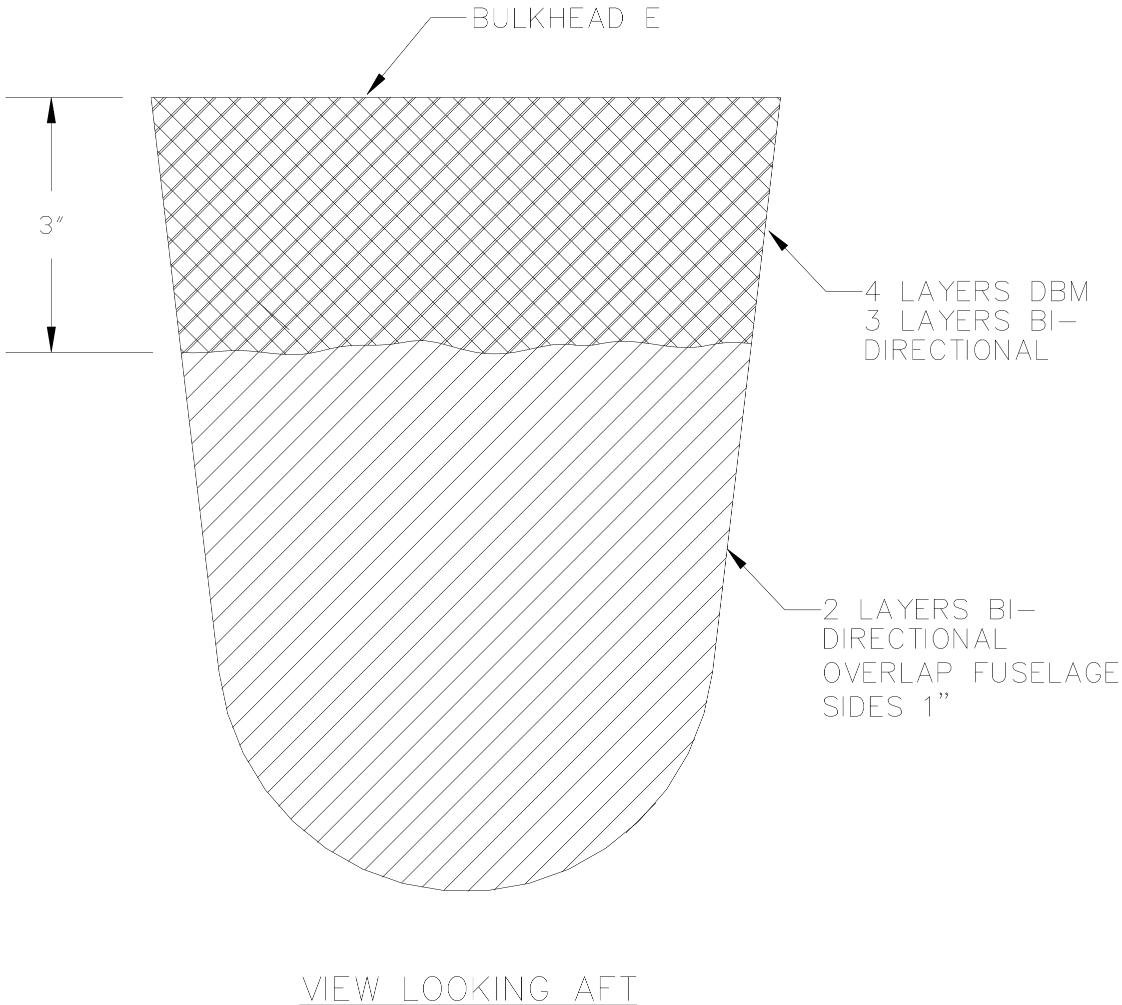


Figure 107: Bulkhead E Forward Laminates

Note that the layers of DBM cloth called out in Figure 108 are 3" wide and cover the upper portion of the bulkhead but do **not** lap over onto the fuselage shells. By contrast, the layers of bi-directional cloth do lap over, and each succeeding layer of bi-directional cloth laps over **3/4" further** than the preceding layer. All the bi-directional cloth should be cut on the 45° bias.

After the laminates have cured, drill a **1/4"**-diameter drain hole through the fuselage belly on the centerline just forward of Bulkhead E.

Note You may note that the two layers of cloth on the aft face of Bulkhead E will effectively change the position of the ears of the stabilizer aft attach bracket. However, the thickness of the double-layer laminate amounts to only about thirty thousandths of an inch, which is a negligible amount.

Completed: [ ]

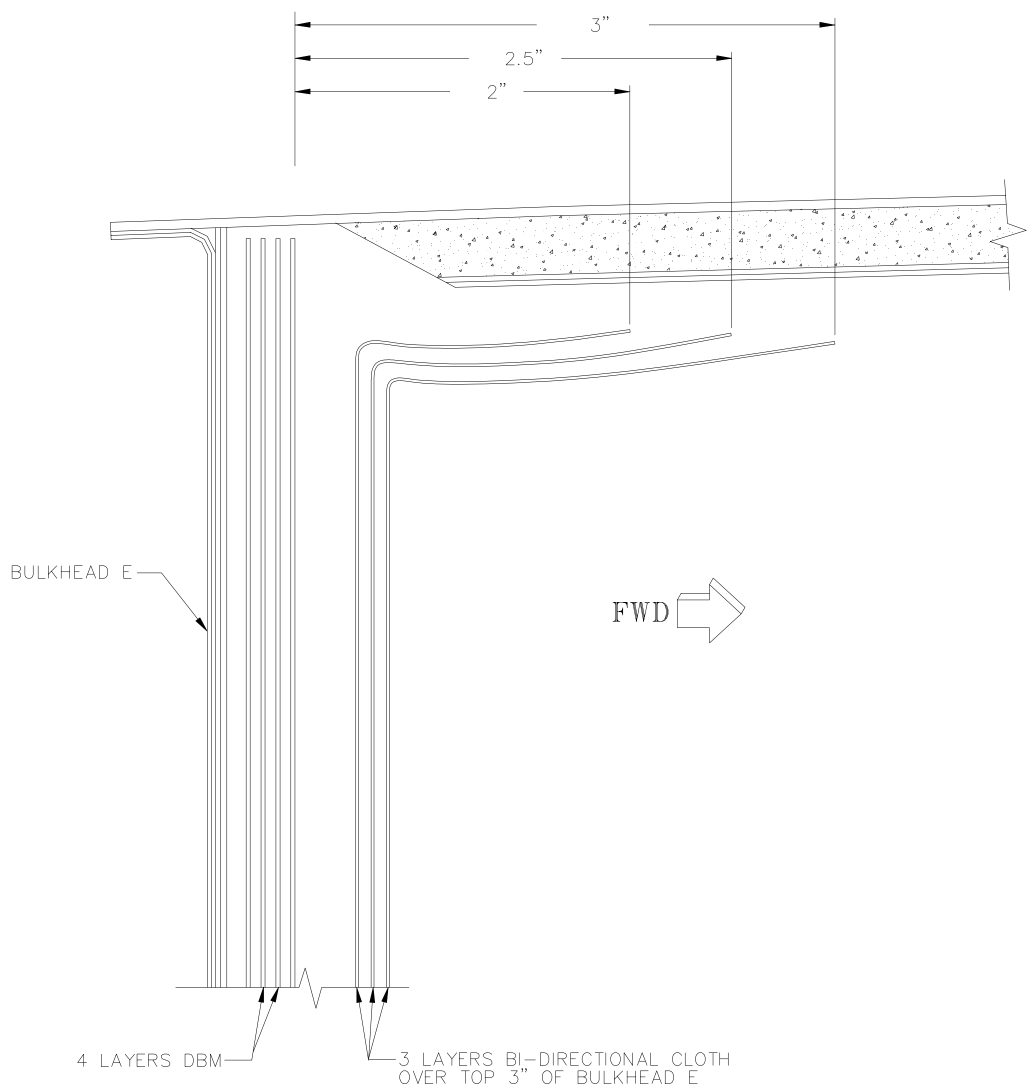


Figure 108: Reinforcement Laminates for the Upper Portion of Bulkhead E

Step 86: Drill the Horizontal Stabilizer Aft Attach Bracket Bolt Holes

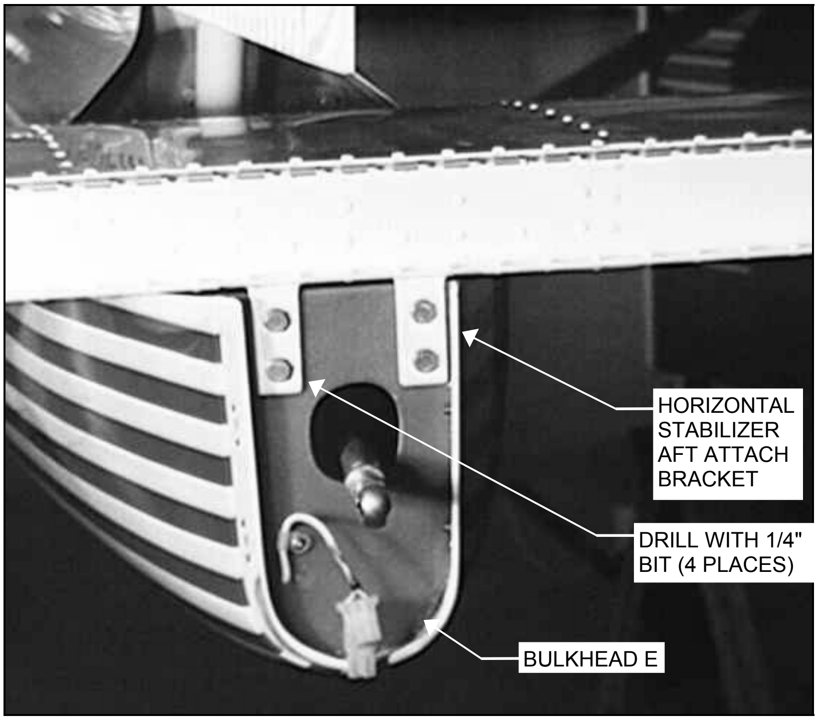


Figure 109: Drilling the Horizontal Stabilizer Aft Attach

After Bulkhead E has cured, remount the stabilizer. As before, shim the stabilizer until the distance from the waterline to the lower skin is about **5-13/16"**. With your fuselage completely level, use a digital level to confirm that the angle of incidence is **1.4° nose down**. Check this at both ends of the stabilizer by holding the level on the chord line of the stabilizer—i.e., on the line that bisects the airfoil shape. With the angle of incidence thus set, you're ready to drill the four bolt holes through the aft attach bracket and Bulkhead E. Use a **1/4"** bit to drill these holes, as indicated in Figure 109. After the drilling is complete, set the final gap between the stabilizer skins and the fuselage sides between 1/16 – 1/8" wide. Remove the stabilizer and set it aside.

Completed: [ ]

> **Caution** Fiberglass is extremely abrasive to aluminum. If allowed to remain in contact with the stabilizer in a flying Sportsman, the shell edges could abrade through the thin aluminum skins in a matter of hours! Shoot for a uniform gap between the shells and the stabilizer of **between 1/16" and 1/8"**.

Step 87: Install the Stabilizer Mounting Nutplates

The four bolts holding the stabilizer aft attach bracket to Bulkhead E are secured by nutplates riveted to the forward side of the bulkhead. Position and drill four F5000-4 **floating nutplates** [83] now, using a **#40** bit to drill the rivet holes. Countersink the holes on the **aft** side for 3/32" flush-head rivets. After the holes have been drilled and countersunk, use 3/32" AN426AD3-7 universal-head rivets to secure the nutplates.

> **Note** The stabilizer will ultimately be secured with four AN4-10A bolts. Mounting the stabilizer to the fuselage with these bolts will be described in "SECTION IX: SYSTEMS INSTALLATION." Until then, store the stabilizer in a safe place.

Completed: [ ]

Step 88: Laminate Attach Flanges for the Aft Inter-Bulkhead Shearweb

A second aluminum shearweb—the **aft inter-bulkhead shearweb**—is installed between Bulkheads D and E in a similar manner to the forward shearweb already installed between Bulkheads C and D. The aft shearweb requires attach flanges on both bulkheads and on the fuselage sides. All four of these flanges will be laminated, as were the side flanges for the forward shearweb.

Use the shearweb template provided to cut the shape of the shearweb out of the second .063" X 12" X 12" aluminum sheet. You may wish to check the template with a piece of cardboard first. Trim the template to fit snugly about **3/4"** below the top edges of the fuselage shells and bulkheads. Make relief cutouts in the corners of the template as necessary to clear the forward stabilizer attach bracket bolts and the aft stabilizer attach nutplates.

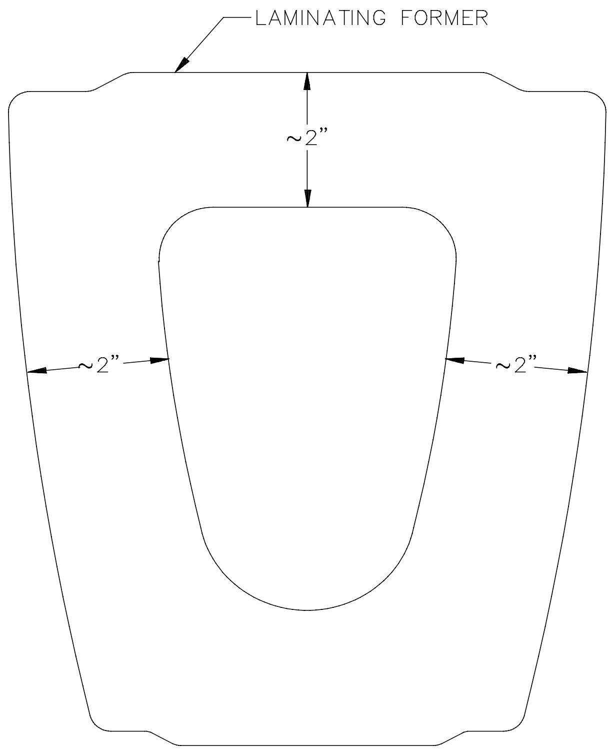


Figure 110: Laminating Former

Transfer the final shape of the template to a scrap piece of .032"–.063" sheet metal or Formica and cut the shape out of that material. Then, cut a hole in the middle of the piece about **2"** inside the perimeter. This piece will serve as a former against which to laminate the attach flanges.

Using 60–80-grit sandpaper, thoroughly roughen the insides of the fuselage shells, the aft face of Bulkhead D and the forward face of Bulkhead E from the tops down about **2"**. Clean the sanded fiberglass with acetone. Then apply mold-release wax to the entire underside of the former and use hot-melt glue and/or tape to position it between the bulkheads, about **3/4"** below the tops of the bulkheads and shells.

For **each of the four sides** of the laminating former, cut **two** strips of DBM cloth, each just a bit shorter than the side of the former it's intended for in order to clear the bolts and nutplates in the corners. Laminate these strips against the underside of the former just as you did the side attach flanges for the forward inter-bulkhead shearweb in Step 82.

When the flanges have cured, remove (but do not discard) the former. Trim the flanges to an even width of **1"** and slightly round the corners.

Completed: [ ]

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Step 89: Cut and Install the Aft Inter-Bulkhead Shearweb

Use files and/or a belt sander to reduce the outside dimensions of the shearweb by **1/16"–1/8"** all the way around so that the shearweb will slip easily into place between the fuselage shells and Bulkheads D and E. Twelve AN3-4A bolts will be used to secure the shearweb to the underlying attach flanges. Figure 111 shows the suggested layout of these holes. Mark the locations on the shearweb, position it and drill through the shearweb and the attach flanges with a **#10** bit, Clecoing as you go.

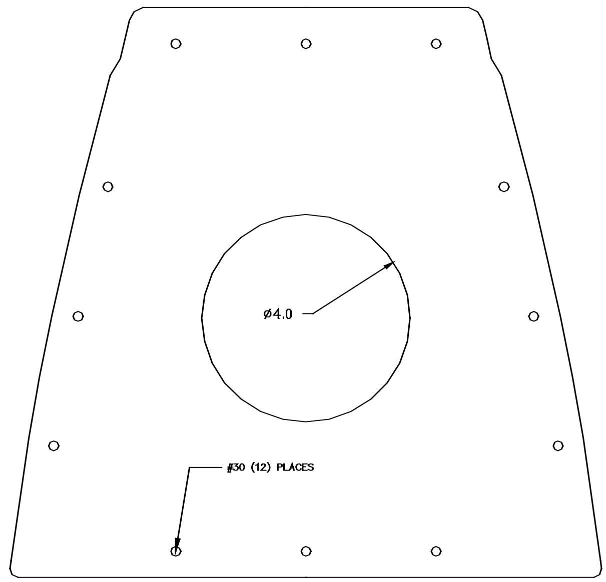


Figure 111: Aft Shearweb Bolt Hole Pattern

Thoroughly deburr the shearweb and corrosion-proof it as you see fit.

Because there is a large inspection hole in the fuselage bottom between Bulkheads C and D, you were able to use regular nylon self-locking nuts on the bolts securing the forward shearweb. For this aft one, however, nutplates are required. Use standard procedures to position, drill and install MF5000-3 **floating nutplates** [84.1] under the attach flanges at each hole location.

The aft shearweb will ultimately be installed after the final government airworthiness inspection prior to first flight. Set it aside for now.

Completed: [ ]

Step 90: Lay Up and Trim the Bulkhead A Laminate

Bulkhead A forms the aft end of the baggage compartment and is laid up without a foam core. In order to make the laminate, you will need a flat, very smooth surface **30" square**. A large piece of sheet metal, Formica or Masonite is ideal.

Begin by marking both the inner and outer perimeters onto the surface with a marking pen. Then remove the template, setting it aside for later use. Wax the laminating surface thoroughly with mold-release wax.

As shown in Figure 112, the Bulkhead A laminate is a hybrid—it consists of three layers of bi-directional cloth sandwiched between two layers of DBM. Cut two strips of DBM, each about **90"** long. Cut the three layers of bi-directional cloth on the 45° bias to match the shape of the lower part of the bulkhead, as shown in Figure 107, but make them each about **1" oversized** all around.

Hint The DBM is used to form the outer ring of the bulkhead because, it builds up thickness faster than multiple layer of 7781 cloth. You may find it easier to apply if you cut the 90" strips into 3—5 shorter segments and overlap them end to end by an inch or so. Another method is to bend the 90" strip into the circular shape and cut the pleats or puckers with scissors approximately 3/4 of the way through the width. Overlap the pleats, but try to avoid stacking them when applying he 2nd layer. Either of these methods are acceptable.

Saturate the cloth and lay it up using standard laminating procedures. You may lay up all five layers at once or do them individually, at your convenience, but the strongest, lightest bulkhead will result if you do them all at once. Regardless, be sure that all five layers of cloth exceed the margins of the pattern marked on the laminating surface.

After the laminate has cured hard, remove it from the laminating surface and spray-glue the template to the laminate. Then use a sabersaw or a bandsaw to cut it to final size and thoroughly sand the surfaces t remove high spots and traces of the shiny, waxed surface.

Completed: [ ]

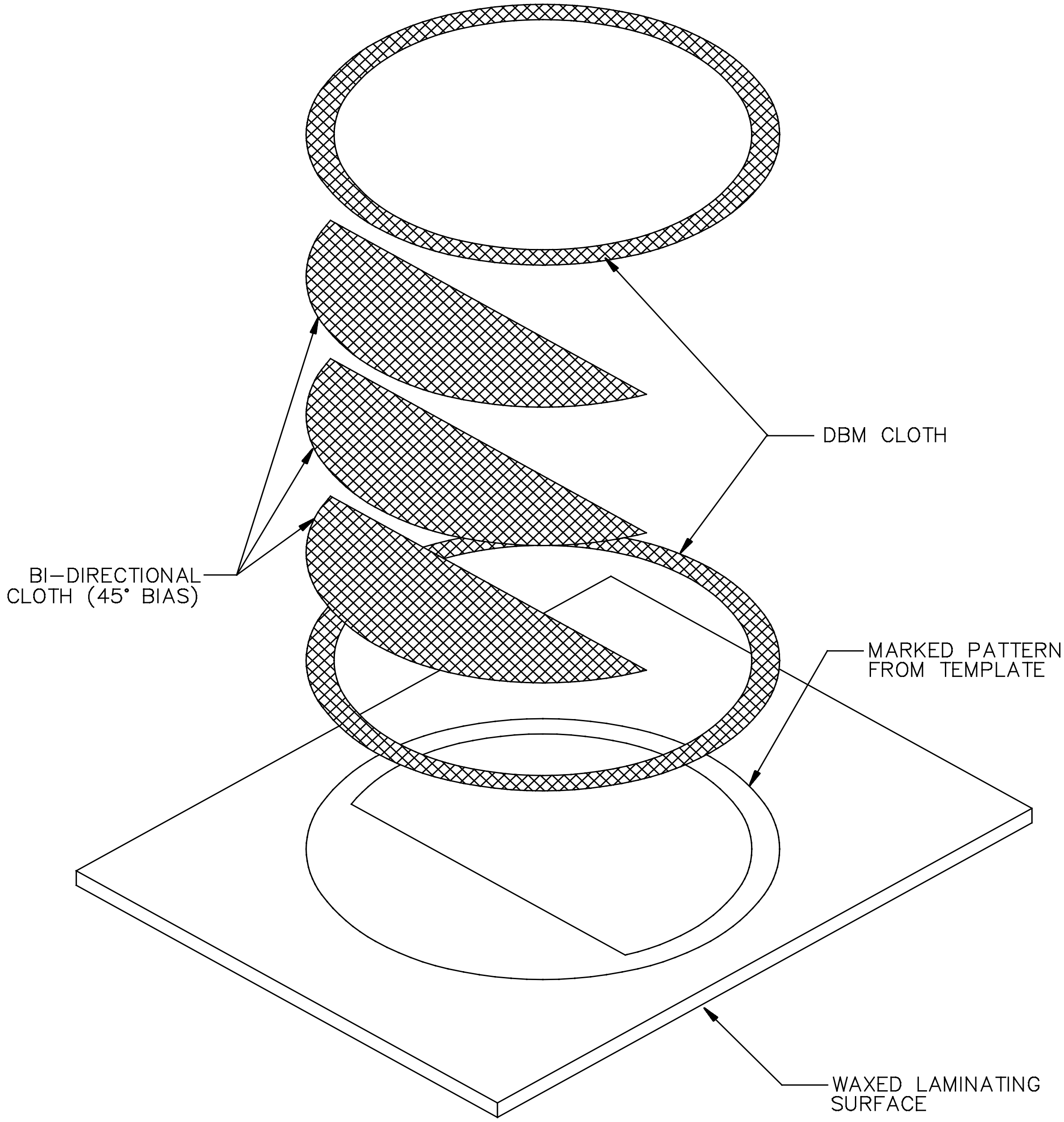


Figure 112: Laminating Bulkhead A

Figure 113: Bulkhead A

Step 91: Install Bulkhead A

As shown in Figure 113, Bulkhead A is installed 52" aft of the aft gear truss (lower tube) perpendicular to waterline.

Because the Bulkhead A laminate is so flexible, it would be difficult to position it in the fuselage by itself. An easier solution is to cut a wooden former the same shape and size as the bulkhead, temporarily attach the bulkhead to the former, and then use the former to hold the bulkhead in position until it has been bonded in. This procedure is shown in Figure 114.

Cut the plywood (or paneling, chipboard, Masonite, etc.) to match the inside and outside dimensions of Bulkhead A, using the trimmed laminate as a template. Then use large loops of wide masking tape or duct tape to fasten the bulkhead to the former, with the **smooth** face of the bulkhead against the former.

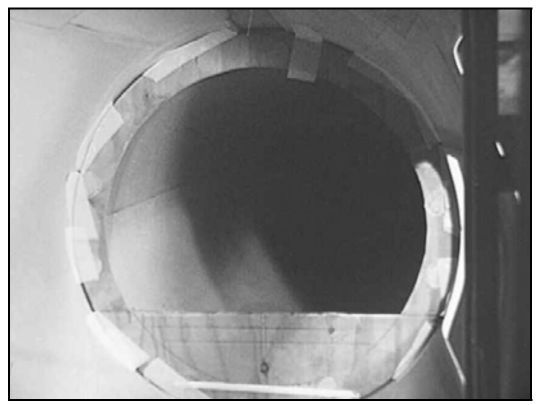


Figure 114: Bulkhead A Former

Place the former in the fuselage with the bulkhead aft and slide it back until it fits at the measured location and then lock it in place with tape, as shown in Figure 114. Use enough tape (or hot glue) to hold the former fairly securely, as you will be applying a laminate to the aft side of the bulkhead.

Bulkhead A is installed with Q-cell fillets forward and aft and a single layer of DBM cloth on the aft side, overlapping a minimum of 1" onto the fuselage shells. Begin with the aft fillet, followed by the DBM. After these have cured, remove the former and apply the forward fillet. Finally, drill **1/4"** drain holes through the bottom of the fuselage on the centerline just **forward** and **aft** of Bulkhead A.

Completed: [ ]

Step 92: Install the Aft Fuselage Struts

The fuselage struts must be installed prior to hanging the engine and going on the gear. As Figure 115 shows, **left** [11] and **right fuselage struts** [12] extend back from the upper aft corners of the cage into the aft fuselage, where they are tied into the shells via pairs of shell attach fittings. These struts and fittings are vital in transferring flight loads from the fuselage shells to the cage assembly.

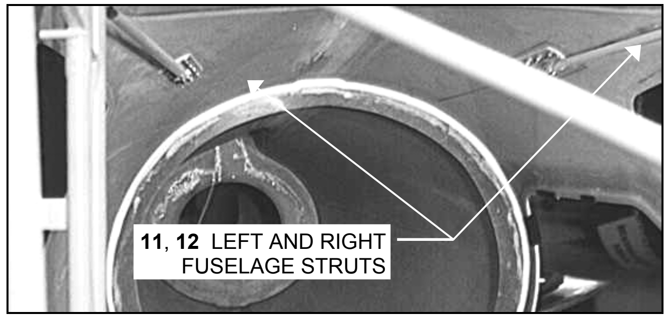
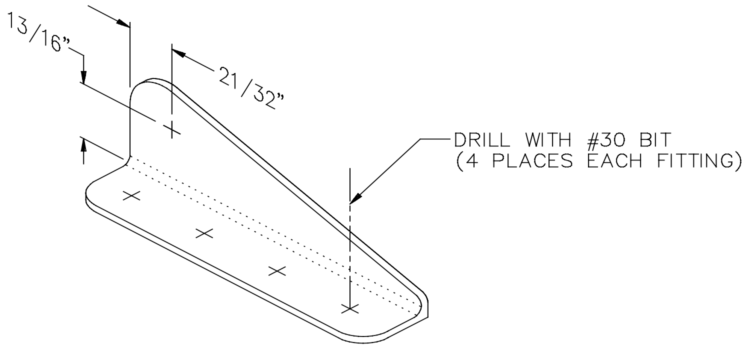
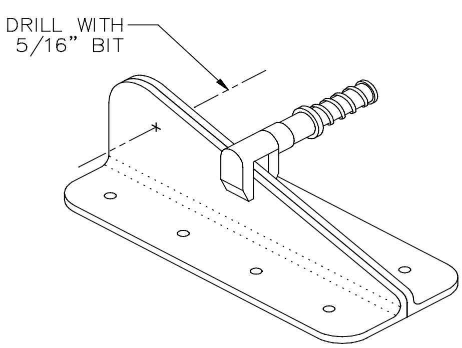


Figure 115: Fuselage Struts

The first step in installing the struts is to mark hole locations in two pairs of the triangular aft shell attach fittings you fabricated way back in Step 11. Begin by





marking and center punching the bolt hole location on the triangular flange of one fitting from each pair according to the dimensions shown in figure 116. The 21/32"

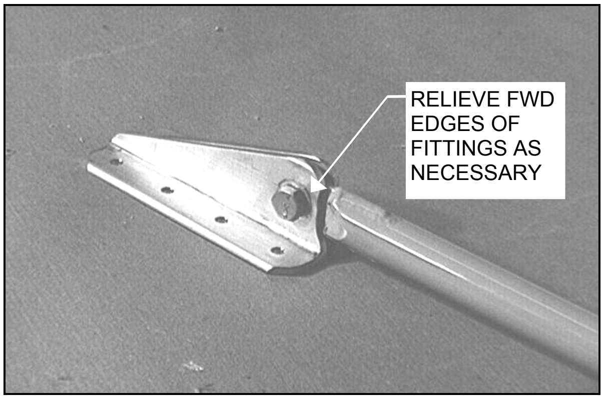


Figure 117: Mounting the Shell Attach Fittings on the Fuselage Strut

dimension may have to be adjusted in order to clear the weld on the lug. Verify the weld on the strut lug will clear the edge of the angle bracket and make any adjustments necessary. Finally, clamp the two fittings from each pair together back to back as shown and drill at the marked location with a **5/16"** bit. Deburr all the holes.

Then fasten a pair of fittings to one end of each strut using an AN5-6A **bolt** [61], AN960D516 **aluminum washers** [80] (under both bolt and nut) and an AN364-524A **nylon self-locking nut** [48]. Don't tighten the hardware down at this point.

With the fittings mounted on the struts, they can now be mounted to the cage. The tab at the free end of each strut must be inserted between the double tabs on the cage assembly at the locations shown in Figure 118. Use trial and error to distinguish between the left and right struts at this time: with the strut tab inserted between the cage tabs, the rectangular flanges of the fittings should lie nearly flat against the inside surface of the fuselage shell. If they don't, then you have the strut on the wrong side. When you have the left- and right-hand struts distinguished, mount them to their respective cage tabs with AN5-6A bolts, AN960-516 **washers** [74] (under the nuts only) and AN364-524A nylon self-locking nuts. As with the fitting hardware, don't tighten these down yet.

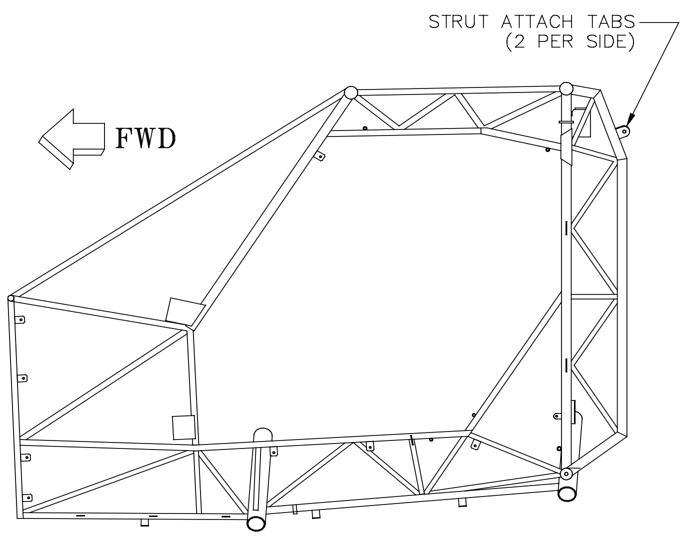


Figure 118: Fuselage Strut Cage Tabs

Because of the curvature of the shells, there is obviously no way the fittings will lie perfectly flat against the shells, but the bolts going through the shells should be fairly perpendicular to the outer shell contour. For this reason, a Q-cell shim must be provided under each pair of fittings. (Actually, the shim goes **above** the fittings, relative to the aircraft.)

There is high density foam insert and multiple reinforcement plies of cloth on both the external and internal side of the fuselage at the location of the strut fittings. The location of the insert is shown in Figure 119. The inner corner of the 20# foam insert is located on the aft edge near the center of the flap track recess. (This is that oval recess that can be seen on the outside of the fuselage skin, aft of the hatch cover cutouts.)

Verify that your strut attach point is positioned over the 20# foam insert. A very bright flashlight placed against the outer skin will reveal where the insert is. A little light will pass through the 5# density foam, whereas no light will pass through the denser 20# foam. There will be a fair amount of lateral give to your strut arm , so center it over the pad. Protect the Zolatone finish with masking tape and then mix a thick batch of Q-cell and spread it liberally on the shell under each pair. Try to keep the fittings parallel with one another and with the inner surface of the shell. Hold the fittings in place until the Q-cell cures by strapping the struts to the shell with duct tape.

After the Q-cell has cured, drill through the fitting and shell at each of the four #30 pilot holes in each fitting with a **#10** bit. Be certain to drill these holes perpendicular to the exterior surface. Countersink the outside surface of the shell to accommodate AN509-10R14 screws (or the appropriate length), and then secure these screws with AN960D10 aluminum washers and AN364-1032A nylon self-locking nuts.

After the fittings have been screwed tightly to the shells, tighten all the other strut hardware.

Completed: [ ]

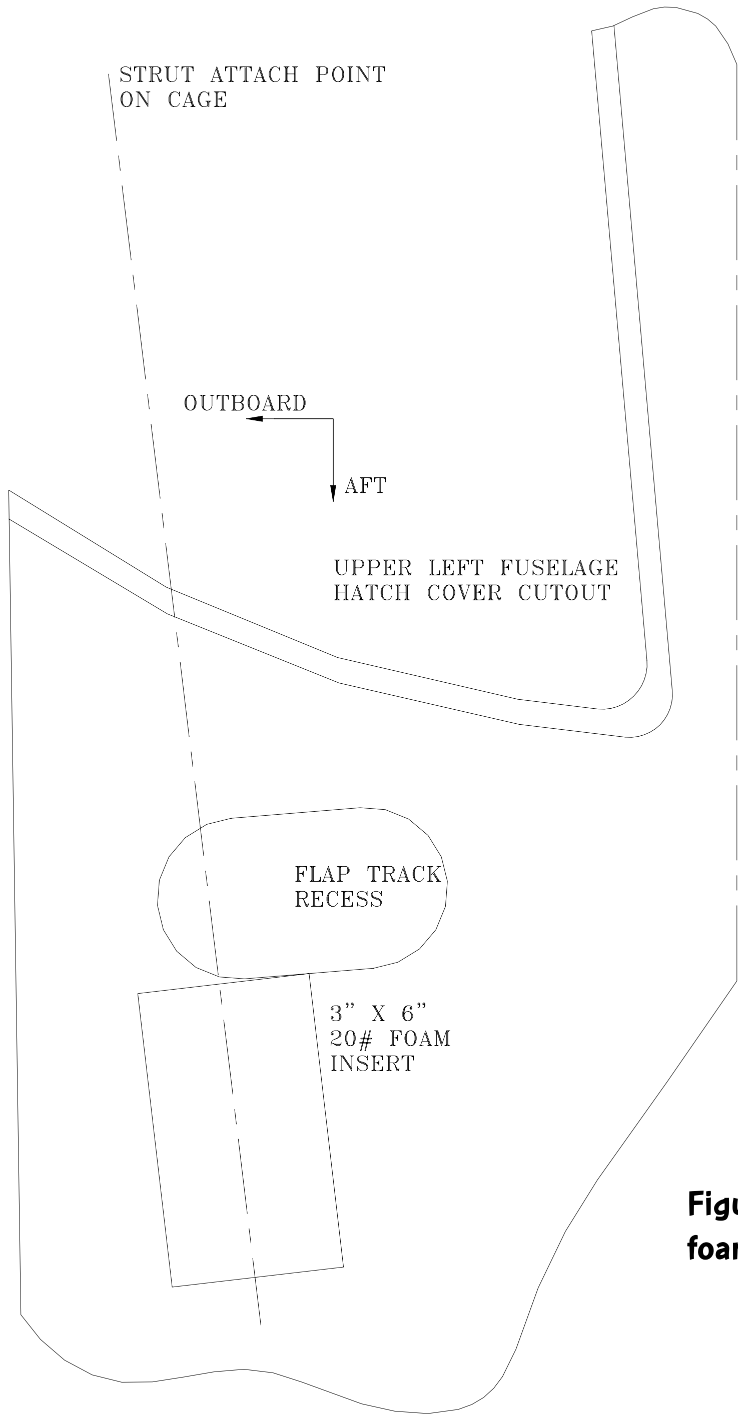


Figure 119: Location of hard foam for aft strut attachment.

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point.

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165:

Step 93: Secure the Upper Center Shell Attach Tab

The procedure for installing the upper center shell attach fittings are exactly the same as those used for the shell attach fittings at the bottom of the cage, with one exception: you'll use an AN4-10A **bolt** instead of an AN4-6A bolt to fasten the fittings to the cage tab. (The extra length allows the bolt to be also used to secure a guide for the aileron crossover cables.

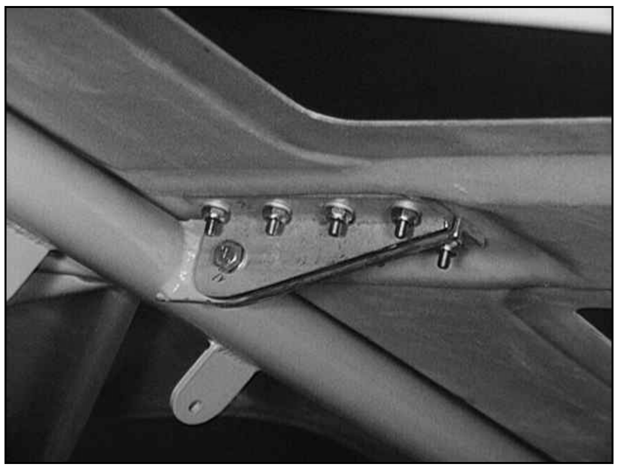


Figure 120: Upper Center Shell Attach Tab

Note The AN4-10A bolt takes an AN364-428A nylon self-locking nut with AN960D416 washers under both the bolt head and the nut. Until the cable guide is installed, just finger-tighten this nut. The eight holes through the fittings and the top deck take AN507-10R16 flush-head screws, AN960D10 washers and AN364-1032A nylon self-locking nuts.

Completed: [ ]

Step 94: Laminate the Aft Center Portion of the Top Deck

Your final task will be to laminate the aft portion of the top deck to the fuselage shell. You have already trimmed and drilled two index holes in the aft end, which locate the top deck relative to the fuselage. Now you will laminate three layers on the external surface and three layers on the internal surface across the seam. Sand the external and internal surfaces and clean both surfaces in preparation for laminating.

The external plies are illustrated in lower portion of Figure 121. These laminates should overlap each other by 1/2" starting with the smallest laminate first. Cut your 7781 cloth on the 45 degree bias. By feathering the laminates like this, you will minimize the amount of finish body work you do later. They should not lap over the flange for the hatch covers, but rather are flush with the joggled edge. You should trim to this edge when the laminates have reached a green cure state.

To laminate the internal plies, you will find it helpful to turn the fuselage upside down and let gravity work with you instead of against you. The internal plies butt right up to the edge of the joggle as shown in the upper portion of Figure 121. The first laminate (again the smallest) should extend 1" beyond the 45 degree trim line and then the others are staggered 1/2" out from that point. The last laminate can ride right up the bevel of the foam core. This should approximately be where the factory applied Zolatone finish stops on the top deck.

Completed: [ ]

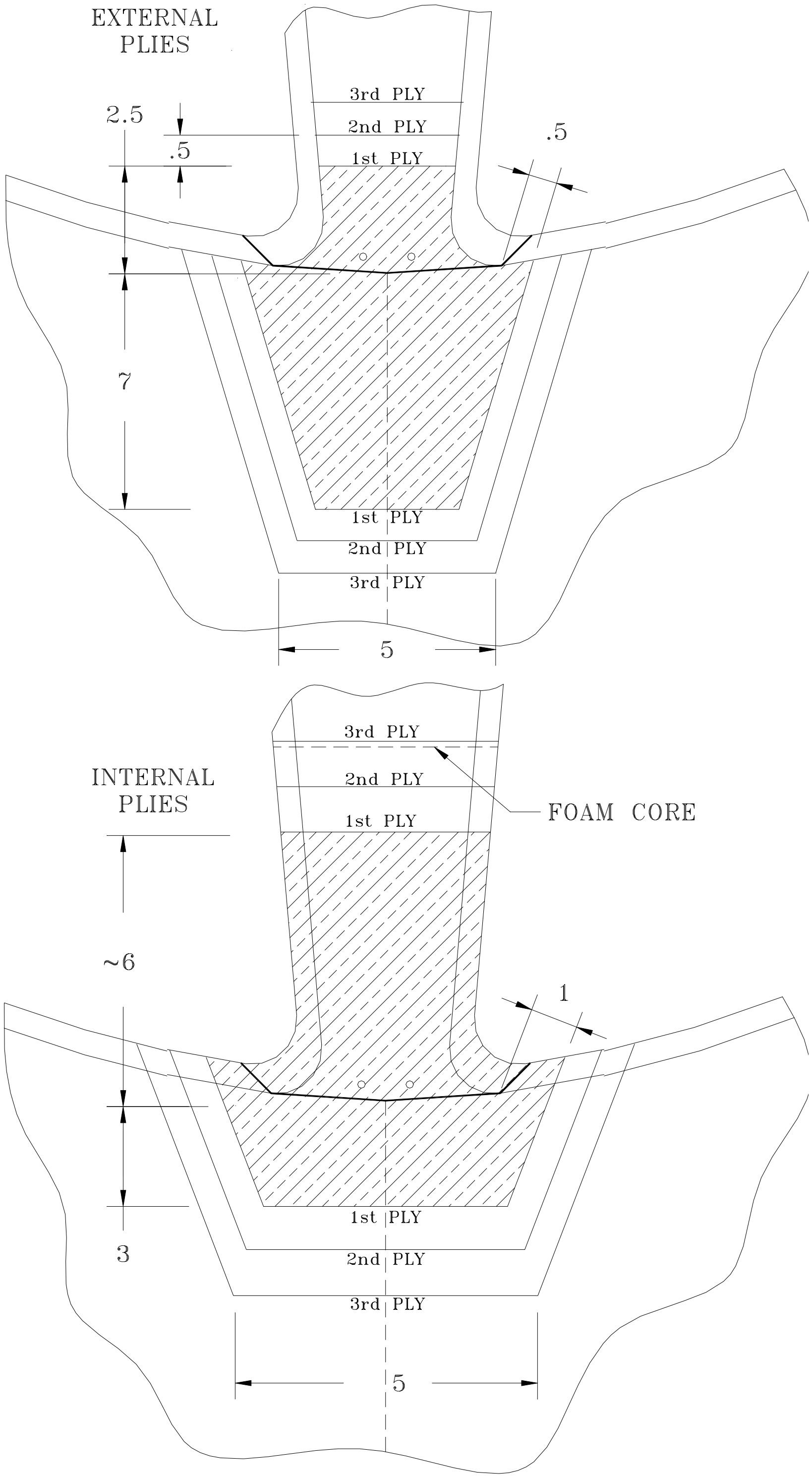
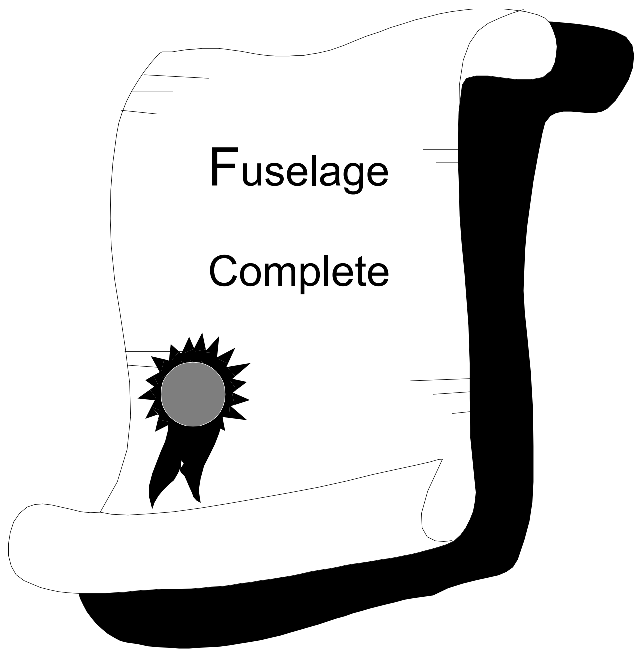


Figure 121: Laminating the aft portion of the top deck

CONGRATULATIONS!

Your Sportsman fuselage is complete! Now it's time to give it wings (and wheels and brakes and control cables and pulleys and pedals and sticks and pitot tubes and fuel tanks and nav lights and . . . you get the picture). On to systems installation!



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SECTION IX: SYSTEMS INSTALLATION

MAIN PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	Roller bearing	8	017-00002-01
2	Rod end bearing, 1/4"	2	017-00003-01
3	Brass elbow	6	032-00401-01
4	Swagelok union tee	1	032-00601-01
5	Swagelok female branch tee	1	032-00602-01
6	Fuel shut-off valve	1	033-00601-01
7	Push nut	4	064-00002-01
8	Fairlead	4	067-00001-01
9	Polyethylene block, 5/16" X 1" X 24-1/2"	1	067-00375-01
10	Blind rivet, 1/8"	12	070-00003-01
11	Aluminum sheet, .040" X 6" X 6"	2	075-01004-01
12	Aluminum sheet, .063" X approx. 6" X 12" (left over from Section VIII [40])	1	075-01011-01
13	Nylon flap track bushing	16	201-10059-01
14	Steel sheet, .090" X 3/4" X 6"	1	075-02010-01
15	Rubber tubing, 5/8"	42 in.	083-00001-01
16	Nylon washer, .032" [from Sect. VIII]	16+	085-00003-01
17	Nylon washer, .064" [from Sect. VIII]	16+	085-00004-01
18	Master cylinder	2	090-00001-01
19	Brake reservoir	1	090-00005-02
20	Rudder pedal support bracket	2	601-01106-01
21	Forward spar attach pin [from Sect. VIII]	2	101-03000-01
22	Rod end bearing	6	170-3414-002
23	Rod end bearing	2	170-4519-001
24	Cable retainer clip	4	201-05504-01
25	Clamp-up bushing	8	201-10008-01
26	Wing strut	2	201-25001-01
27	Fuselage wing strut attach fitting	2	201-25002-01
28	Inspection hole doubler, 4.45"	4	201-33002-01

Section IX: Systems Installation

Page 2:

Page 23: In the third paragraph, you should drill #10 diameter holes and not 1/4" diameter for the control bracket hardware.

Page 36: The last sentence in Step 7 will be revised to: This pivot tube centerline should be approximately 5" aft of the aft face of the 5/8" diameter firewall tubes.

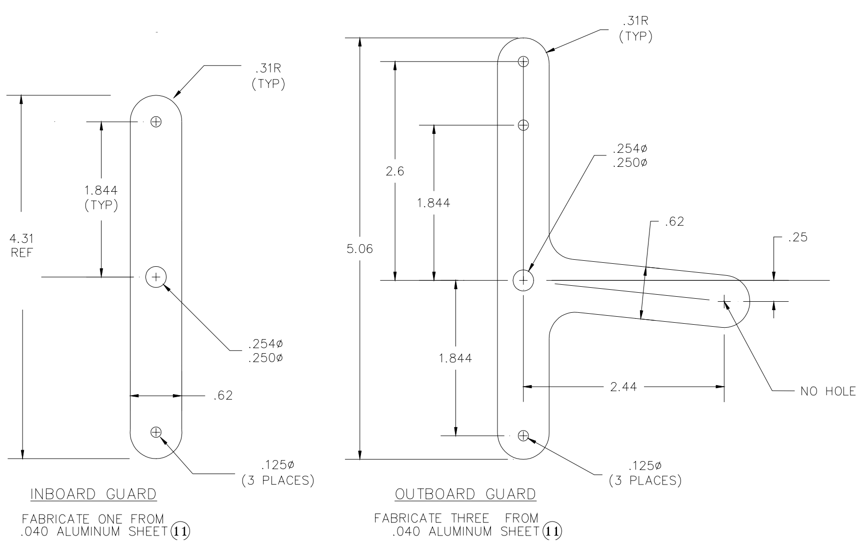
Page 42: The reference to a #10 bit in the first sentence will be changed to a #12 bit, which is slightly smaller in diameter.

Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

Page 54: The first sentence will change to make (3) outboard pulley guards. The sentence 'The second hole at 2.60" on the third pulley guard can be trimmed off as shown in the left side of Figure 23' will be added to the first paragraph.



The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

29	Inspection hole doubler, 6.2" X 4.7"	2	201-34002-01
30	Inspection hole doubler, 5.75"	10	201-35002-01
31	Left fuel tank	1	201-40000-01
32	Right fuel tank	1	201-40000-02
33	Fuel tank filler neck	2	201-40002-01
34	Cable tie, 4"	25	210-0018-001
35	Nylon male tubing connector	2	320-0250-001
36	Nylon tubing connector insert	2	320-0259-001
37	Drain valve	1	320-0334-001
38	Axle spacer	2	401-01501-01
39	Main gear leg	2	401-00001-04
40	Axle washer	2	401-01503-01
41	NicoPress sleeve	12	450-0002-004
42	Roll pin, 3/16" X 1/2"	1	450-0012-001
43	Rod end insert	2	521-0490-001
44	Cable retainer strap stock	8	600-00001-01
45	Rudder pedal pivot angle	1	601-01102-03
46	Rudder pedal brake actuator angle	1	601-01103-03
47	Left rudder control weldment	1	601-01290-01
48	Right rudder control weldment	1	601-01290-02
49	Elevator/aileron control yoke	1	601-01300-09
50	Control stick pivot bracket	2	601-01470-01
51	1/2" x 1/2" x .05 Aluminum tube	1	820-0639-001
52	Control stick interconnect rod	1	601-01600-03
53	Control yoke bearing block	2	601-02000-03
54	Item deleted		
55	Flap handle ratchet plate	1	602-02051-01
56	Flap handle plunger extension	1	602-02002-01
57	Flap handle plunger	1	602-02003-01
58	Flap handle	1	602-02010-03
59	Flap pushrod	2	602-03000-01
60	Formed alum. angle, .063" X .88" X 2.5"	1	602-04101-03
61	Control cable attach tab	6	602-06002-01
62	Aileron pushrod	2	602-07000-01

63	Forward rudder cable	2	618-01001-01
64	Empennage cable, 132"	4	618-01002-02
65	Elevator down cable	1	618-01003-01
66	Elevator up cable	1	618-01004-01
67	Flap primary cable	3	618-01006-01
68	Flap primary retraction cable	1	618-01007-01
69	Flap final deployment cable	2	618-01010-01
70	Flap final retraction cable	2	618-01011-01
71	Aileron primary actuation cable	2	618-01012-01
72	Aileron secondary actuation cable	2	618-01013-01
73	Aileron left crossover cable	1	618-01014-01
74	Aileron right crossover cable	1	618-01015-01
75	Flap handle button	1	620-1321-218
76	Monel blind rivet	12	700-0042-001
77	Rudder control spring	2	771-0525-001
78	Flap handle spring	1	772-0310-001
79	Aluminum tubing, 3/8"	180 in.	820-0524-001
80	Aluminum tubing, 3/4"	2 ft.	820-0638-004
81	Nylon tubing, 3/16"	30 ft.	830-0370-001
82	Spiral wrap, 3/8"	18 in.	830-0598-002
83	Nylon tubing, 1/4"	25 ft.	830-0600-001
84	Cable thimble	10	AN100C-4
85	Shackle	6	AN115-21
86	Pulley	5	AN210-3A
87	Pulley	18	AN210-4A
88	Drilled-shank bolt	7	AN3-10
89	Drilled-shank bolt	3	AN3-11
90	Drilled-shank bolt	9	AN3-12
91	Bolt	1	AN3-17A
92	Bolt	4	AN3-24A
93	Drilled-shank bolt	2	AN3-35
94	Drilled-shank bolt	3	AN3-5
95	Bolt	4	AN3-4A
96	Drilled-shank bolt	2	AN3-6
97	Bolt	6	AN3-6A

98	Bolt	1	AN3-22A
99	Bolt	4	AN3-7A
100	Castle nut	27	AN310-3
101	Castle nut	17	AN310-4
102	Castle nut	2	AN320-5
103	Castle nut	2	AN310-7
104	Castle nut	4	AN310-8
105	Jam nut	10	AN316-4R
106	Jam nut	2	AN316-5R
107	High-temperature self-locking nut	2	AN363-524
108	Nylon self-locking nut	31	AN364-1032A
109	Nylon self-locking nut	1	AN364-428A
110	Nylon self-locking nut	8	AN364-624A
111	Nylon self-locking nut	4	AN365-1032A
112	Nylon self-locking nut	2	AN365-524A
113	Cotter pin	67	AN380-2-2
114	Cotter pin	2	AN380-3-3
115	Cotter pin	2	AN380-3-4
116	Cotter pin	6	AN380-4-6
117	Cotter pin	2	AN380-4-8
118	Clevis pin	5	AN392-17
119	Clevis pin	8	AN393-11
119.1	Clevis pin	4	AN393-13
120	Clevis pin	2	AN393-17
121	Clevis pin	1	AN393-19
121.1	Bolt	4	AN4-10A
121.2	Drilled-shank bolt	2	AN4-24
122	Drilled-shank bolt	1	AN4-12
123	Drilled-shank bolt	6	AN4-14
124	Bolt	1	AN4-14A
125	Drilled-shank bolt	3	AN4-17
126	Drilled-shank bolt	1	AN4-53
127	Drilled-shank bolt	2	AN4-21
128	Drilled-shank bolt	1	AN4-45
129	Lock pin	2	AN415-2

130	Clevis fork	2	AN486-4P
131	Drilled-head bolt	2	AN4H14A
132	Drilled-head bolt	4	AN4H20A
133	Drilled-shank bolt	2	AN5-20
134	Bolt	2	AN5-22A
135	Bolt	8	AN6-24A
136	Drilled-shank bolt [from Sect. VIII]	2	AN8-15
137	Drilled-shank bolt	2	AN8-22
138	Reducer bushing	1	AN912-1D
139	Plug	2	AN913-2D
140	Washer	8	AN960-10
141	Thin washer	45	AN960-10L
142	Washer	6	AN960-416
143	Thin washer	14	AN960-416L
144	Washer	6	AN960-516
145	Thin washer	2	AN960-516L
146	Thin washer	2	AN960-716L
147	Washer	4	AN960-816
148	Thin washer	4	AN960-816L
149	Aluminum washer	31	AN960D10
150	Thin aluminum washer	28	AN960D10L
151	Aluminum washer	14	AN960D416
152	Aluminum washer	10	AN960D616
153	Thin aluminum washer	1	AN960D616L
154	Large washer	12	AN970-3
155	Large washer	2	AN970-5
156	Nutplate	2	K1000-3
157	Dowel pin	1	045-16555-01
158	Pulley	2	MS20220-3
159	Turnbuckle barrel	11	MS21251-B5S
160	Cable eye	4	MS21255-5LS
161	Rubber grommet, 7/16"	6	MS35489-6
162	Strap shackle	4	NAS1435K4
163	Aluminum spacer	3	NAS42DD6-15
164	Aluminum spacer	2	NAS42DD8-19

165	Aluminum spacer	2	NAS42DD8-27
166	Aluminum spacer	2	NAS42DD8-31
167	Aluminum spacer	2	NAS42DD8-43
168	Clamp-up bushing	1	NAS73-4-14
169	Plain steel bushing	4	NAS75-8-016
170	Plain steel bushing	2	NAS75-8-018
171	Flanged steel bushing	6	NAS77-3-006
172	Flanged steel bushing	2	NAS77-4-009
173	Flanged steel bushing	6	NAS77-4-012
174	Flanged steel bushing	4	NAS77-4-010

Parts List for Standard Landing Gear

Key No.:	Part Name:	Qty:	Part No.:
175	Axle nut	2	371-0465-101
176	Axle spacer	2	351-0115-001
177	Brake mounting flange	2	401-01550-07
178	Bracket, inbd, main wheel pants	1/1	401-00030-01/02
179	Tire, 6.00 X 6	2	080-06060-01
180	Tube, 6.00 X 6	2	080-06075-01
181	Main wheel and brake kit	1	090-00601-01
182	High-temperature self-locking nut	4	AN363-524
183	High-temperature self-locking nut	2	AN363-428
184	Bolt	2	AN4-10A
185	Bolt	1	AN5-70
185.1	Bolt	4	AN5-20A
186	Washer	2	AN960-416
187	Washer	4	AN960-516
188	Floating nutplate	2	MF5000-4
189	Aluminum spacer	6	NAS43DD6-32
190	Bolt	8	AN6-7A
191	Bolt	6	AN6-13A
192	Washer	18	AN960-616

Key No.:	Part Name:	Qty:	Part No.:
193	Axle sleeve	2	401-01502-01
194	High-temperature self-locking nut	8	AN363-624
195	Flanged steel bushing	4	NAS77-5-019
196	Castle nut	1	AN310-5
197	Cotter pin	1	AN381-2-10
198	Bolt	2	AN7-36
199	Washer	4	AN970-7
200	Nylon self-locking nut	2	AN365-720A
201	Tire, 5.00 x 5	1	800-0660-001
202	Tube, 5.00 x 5	1	800-0675-001
203	Wheel assembly, nose	1	900-0040-591
204	Nose gear strut	1	371-5110-101
205	Nose fork assembly	1	371-5130-201
206	Shock truss assembly	1	371-5220-203
207	Rubber shock bushings	4	371-2424-002
208	Support link arm	2	371-5230-005
209	Wear pad plate	1	371-5133-001
210	Countersunk screw	1	AN507-428R10
211	Stop screw spacer	1	371-5135-003
212	Allen head cap screw	1	MS21262-38
213	Friction wear pad	1	371-5134-001
214	Nose fork washer	1	371-5101-001
215	Bellville washer	1	850-1063-080
216.01	Roll pin, 3/16" x 1/2"	4	450-0012-001
216.02	Nose wheel axle	1	362-5932-001
216.03	Axle plug	2	362-5931-001
216.04	Axle hub	2	361-5912-002
216.05	Laminated washer	1	361-5914-001
216.06	Bushing, nose wheel	2	361-5913-001
216.07	Bolt, axle	1	AN4-60
213.08	Cotter pin	1	AN381-3-10

Parts List for Standard Taildragger Landing Gear

Note The following list contains parts that are unique to the standard, 6.00 X 6 taildragger landing gear installation.

Key No.:	Part Name:	Qty:	Part No.:
217	Aluminum block, 1/4" X 1-1/2" X 1-1/2"	1	075-01251-01
218	Aluminum block, 1/2" X 1-1/2" X 2"	1	075-01500-01
219	Tailwheel assembly	1	091-01000-01
220	Tailwheel spacer	1	091-01175-01
221	Steering spring kit	1	091-01500-02
222	Lower tailwheel spring	1	401-09001-13
223	Middle tailwheel spring	1	401-09001-09
224	Upper tailwheel spring	1	401-09001-11
225	Forward tailwheel spring attach bracket	1	401-09002-01
226	Aft tailwheel spring attach bracket, left	1	401-09003-01
227	Aft tailwheel spring attach bracket, right	1	401-09003-02
228	NicoPress sleeve	2	450-0002-004
229	(Reserved)		
230	Steering cable	2	618-01020-01
231	Thimble	2	AN100C-4
232	Bolt	8	AN3-7A
233	Nylon self-locking nut	8	AN365-1032A
234	Nylon self-locking nut	5	AN365-428A
235	(Reserved)		
235.1	Nylon self-locking nut	1	AN365-624A
236	Nylon self-locking nut	1	AN365-820A
237	Cotter pin	2	AN380-2-2
238	Clevis pin	2	AN393-13
239	Bolt	4	AN4-10A
240	Bolt	1	AN4-22A
241	Bolt	1	AN5-15A
242	(Reserved)		
243	Bolt	1	AN8-23A

244	Washer	8	AN960-10L
245	Washer	6	AN960-416
246	(Reserved)		
246.1	Washer	1	AN960-616
247	Washer	1	AN960-816
248	Large washer	4	AN970-4
249	Strap shackle	2	NAS1435K4

MANUAL TRIM SYSTEM PARTS LIST

Note The following list contains parts that are unique to the manual trim installation. The electric trim installation has a separate parts list contained in the option instructions.

Key No.:	Part Name:	Qty:	Part No.:
250	Snap bushing	1	021-02001-01
251	Trim gear box	1	045-01000-01
252	Cable clamp	2	045-02001-01
253	Aluminum sheet, .032" X 6" X 6"	1	075-01003-01
254	Rod end bearing	1	170-0110-003
255	Cable tie, 4"	10	210-0018-001
256	Nylon loop clamp, 3/8"	12	450-0006-375
257	Nutclip, 8-32	4	450-0210-081
258	Trim cable	1	618-02011-01
259	Drilled-shank bolt	1	AN3-10
260	Castle nut	1	AN310-3
261	Jam nut	1	AN315-3R
262	Cotter pin	1	AN380-2-2
263	Aluminum loop clamp, 5/8"	4	AN742D10
264	Round-head machine screw	4	AN526-8R8
265	Self-tapping screw	12	AN530-6R4
266	Washer	3	AN960-10
267	Aluminum washer	12	AN960D6
268	Large washer	1	AN970-3

PARTS LIST ERRATA

Note The following list contains parts that were inadvertently omitted from the preceding PARTS LISTS when Part 1 of this section was initially published.

Key No.:	Part Name:	Qty:	Part No.:
269	Brass union tee	1	032-00301-01
270	Inspection hole cover, 4.45"	4	201-33001-01
271	Inspection hole cover, 6.2" X 4.7"	2	201-34001-01
272	Inspection hole cover, 5.75"	10	201-35001-01
273	Brass union	1	320-0268-302
274	Castle nut	2	AN310-7
275	Nylon self-locking nut	2	AN364-832A
276	Nylon self-locking nut	1	AN365-624A
277	Cotter pin	2	AN380-3-3
278	Round-head machine screw	2	AN526-8R8
279	Bolt	1	AN6-23A
280	Washer	1	AN960-616
281	Washer	2	AN960-8
282	Nutplate	84	K1000-08
283	Aluminum Spacer	2	NAS42DD8-13
350	Auxiliary fuel transfer pump	2	033-00001-01
351	Neoprene sheet, 6" X 8"	4	033-00002-01
352	Male connector, 1/8" NPT to 3/8" tubing	4	033-00003-01
353	Male connector, 1/4" NPT to 3/8" tubing	4	033-00004-01
354	Fuel line bracket	12	033-00005-01
355	Anti-Chafe Tape	1	033-01001-01
356	Aluminum sheet, .032" X 3" X 6-1/8"	2	075-01005-01
357	Fuel cap	2	201-40001-01
358	Fuel tank filler neck	2	201-40002-01
359	Left auxiliary fuel tank, Aluminum	1	201-41000-05
360	Right auxiliary fuel tank, Aluminum	1	201-41000-06
361	Fwd auxiliary fuel tank mounting channel	2	201-41001-01

362	Aft auxiliary fuel tank mounting channel	2	201-41002-01
363	Auxiliary tank sump drain plug	2	AN932-2S
364	Cable tie	15	210-0030-001
365	Butt connector, 16–14 gauge	3	210-0133-002
366	Ring terminal, 16–14 gauge, #8	3	210-0636-004
367	Ring terminal, 16–14 gauge, #10	3	210-0636-005
368	Nylon male tubing connector	2	320-0250-001
369	Nylon male tubing union	2	320-0250-003
370	Nylon tubing connector insert	10	320-0259-001
371	Fuel drain valve	2	320-0334-001
372	Finger screen	2	330-0340-001
373	Nylon loop clamp, 1/4"	6	450-0006-250
374	Large-head blind rivet, 1/8" X 1/4"	6	700-0004-004
375	Blind rivet, 1/8" X 5/16"	6	700-0045-001
376	Aluminum tubing, 3/8" O.D. X .035 wall	24 ft.	820-0524-001
377	Nylon tubing, 1/4" O.D.	12 ft.	830-0600-001
378	Single-conductor wire, 16 gauge	30 ft.	870-0228-016
379	Blind rivet, 1/8" X 3/16"	40	AAPQ-43
380	Nylon self-locking nut	5	AN365-1032A
381	Flush-head rivet, 3/32" X 3/16"	125	AN426AD3-3
382	Universal-head rivet, 3/32" X 3/16"	25	AN470AD3-3
383	Universal-head rivet, 3/32" X 7/32"	25	AN470AD3-3.5
384	Universal-head rivet, 1/8" X 5/16"	25	AN470AD4-5
385	Thin washer	6	AN960-10L
386	Thin aluminum washer	6	AN960D10L
387	Round-head machine screw	5	NAS603-8P
388	1/4" ID Grommet	12	AN931-4-7
389	Aluminum tubing, 3/8" O.D. X .035 wall	13 ft.	820-0624-002

Tool List

1. Tape measure
2. 12" rule, graduated in 32nds of an inch
3. Pencil and fine-point marking pen
4. Scriber or awl
5. Small (3") tri-square
6. Tri-square or carpenter's square
7. Protractor
8. 18" steel rule or comparable straightedge
9. Center punch
10. Carpenter's level
11. Digital level (recommended) or short spirit level (acceptable)
12. Transit, digital level or protractor level to set wing dihedral
13. Plumb bob
14. Bandsaw or scroll saw
15. Saber saw with carbide grit blade (optional)
16. Single-bladed hacksaw
17. Belt sander (highly recommended)
18. Drill press (recommended)
19. Edge deburring tool
20. Hole deburring tool
21. Electric or pneumatic drill motor, with #40, #30, #10, 1/4", 9/32", 19/64", 5/16", 11/32", 23/64" and 3/8" bits
22. Drill stop, #30
23. 90° drill motor or adapter
24. Unibit and/or hole cutter, 1/2", 9/16", 5/8", 11/16", 7/8", 1", 1-3/8" (optional), 1-5/8" and 2-1/4"
25. Heavy-duty, variable speed electric drill motor
26. Cobalt drill bits, #30 or 1/8"; #10 or 3/16"; 1/4"; and 5/16" (highly recommended)
27. 7/8" paddle bit (spade bit) for drilling wood (recommended)
28. Narrow rat-tail file
29. Assorted flat and round files
30. Die grinder with rotary cutting wheels and files (recommended)
31. Small sanding drum for drill motor, die grinder or drill press (optional)

TOOL LIST (CONTINUED)

32. Clecos, 3/32" and 1/8", approximately 25 each
33. Cleco pliers
34. Rivet gun, air compressor, bucking bars
35. Universal-head and flush-head rivet sets
36. Blind rivet puller
37. Large C-clamps, 4
38. Cleco side-grip clamps, 5
39. Small C-clamp, 1
40. Bench vise
41. Small adjustable wrenches, 2
42. Socket wrenches and open-end wrenches (sizes 3/8" to 3/4")
43. Torque wrench (optional)
44. Needle-nose pliers
45. Vise-grip pliers, 2 pairs
46. Large Phillips screwdriver
47. Medium-size standard screwdriver
48. Small hammer
49. Rubber mallet
50. Heavy-duty scissors and/or rotary cloth cutter
51. Cable cutter or sharp cold chisel
52. 1/8" cable clamps (4 should be enough)
53. NicoPress swaging tool
54. Tubing cutter
55. Tubing bender, 3/8" (highly recommended)
56. Tubing beader (borrow, if possible)
57. Utility knife
58. Air chuck for inflating tires
59. Fisherman's pocket spring scale (recommended)
60. Safety goggles (highly recommended for use while sanding or grinding fiberglass)
61. Respirator or dust mask (highly recommended for use while sanding or grinding fiberglass)
62. Wing strut drill jig kit (available on a rental basis from Glasair Aviation). The kit includes a fixture that fits over the end of the wing strut, an 11/32" drill bit, a 3/8" step reamer, drill bushings to guide the drill bit and reamer, and a length of 11/32" drill rod. (See Step 33 for details. Additional Materials

1. Corrosion-protection materials
2. Acetone
3. Loctite bearing retaining compound
4. Mold release wax or equivalent
5. Modeling clay
6. Thread sealant (e.g., Permatex High Tack Adhesive Sealant, sold in automotive stores)
7. RTV silicone sealant
8. Hot glue and gun
9. Super glue
10. Bearing grease
11. Cutting oil
12. Anti-seize compound
13. Rubber cement or spray adhesive
14. Assorted scrap wood for form blocks and temporary jigs, including a piece approximately 3/4" X 5" X 12"
15. 2-1/8" length of 3/4" wooden dowel (or equivalent) (See Step 11.)
16. Anti-chafe tape (Order P/N 062-01001-01 direct from Glasair Aviation, LLC.)
17. Vinyl tape
18. Wide masking tape or duct tape
19. Tall padded sawhorses or other supports for the wings
20. Nylon cable ties, various sizes (optional)
21. Polyethylene tubing, approximately 3/4"-diameter, 40' (optional)
22. Assorted old blankets or foam padding material
23. Sand or shot bags, 4–6
24. Straight 8' length of 2" X 2" angle stock, aluminum (preferable) or steel (acceptable)
25. Two scrap pieces of .063" aluminum, approximately 1" X 1"
26. Sandpaper, coarse and medium grits
27. Rigid piece of scrap metal, approximately 1" X 2", for use as a straightedge
28. Resin mixing sticks
29. Latex surgical gloves
30. 2" varnish-type brushes

WORKSPACE

Since the wings will be mounted to the fuselage to set the wing dihedral and install the control cables, quite a large space will be required for these procedures. The wing span is 35', the fuselage length is 22' and, with the fuselage on the tricycle gear, the tail height is about 11'. Very few people will have home workshops large enough to accommodate the assembled Sportsman, so this work will have to be accomplished at a hangar or outside. Only items 7, 10 and 11 in the ASSEMBLY SEQUENCE listed on the next page truly require the wings to be mounted to the fuselage, however. If you have gathered all the necessary tools and materials and have studied the applicable *Assembly Manual* sections in preparation, items 7–11 will take just a few days' work, so most builders will choose to simply move the airframe outside temporarily rather than transporting it to a hangar. (Only items 10 and 11 require both wings to be mounted at the same time. If you have room inside your shop to mount one wing at a time for items 7–9, you may do so.)

Note When you have finished items 1–6 of the ASSEMBLY SEQUENCE, you will be ready to mount the wings to the fuselage, after which your first task will be to drill the outboard ends of the wing struts for attachment to the strut attach arms in the wing. To accomplish this task, you will need the **Wing Strut Drill Jig Kit** (P/N 981-03000-01), which is available on a rental basis from Glasair Aviation, LLC. Especially if you are making steady progress, you should consider ordering the drill jig kit soon, so you will have it on hand when you need it.

Assembly Sequence

At the end of the Systems Section are photos showing various assembly aids which were left out of the main written section of the manual.

At this stage of assembly, your Sportsman wings have the lower main skins and leading edge skins installed and the basic fuselage structure is completed. Now it's time to install the fuselage flight control systems. Then the wings can be mounted to the fuselage so that the flap and aileron control cables can be installed. The fuel tank vent lines, fuel tanks, pitot lines and (optional) navigation light wiring are also fitted to the wings at this time in preparation for final wing closure. Finally, the landing gear, the brake system and parts of the fuel system are installed in the fuselage.

The outline of the complete systems installation procedures is as follows:

1. Rudder Control Assemblies Installation
2. Control Stick Assembly Installation
3. Flap Handle Assembly Installation
4. Fuselage Control System Pulleys Installation
5. Rudder Control Cables Installation
6. Elevator Pushrod and Control Cables Installation
7. Mounting the Wings to the Fuselage
8. Mounting the Flaps to the Wings
9. Mounting the Ailerons to the Wings
10. Flap Control Cables Installation
11. Aileron Control Cables Installation
12. Control Cable Retainers Fabrication and Installation
13. Preliminary Fuel Tank Installation
14. Wing Plumbing, Wiring and Other Miscellaneous Stuff
15. Main Gear Leg Installation
16. Main Gear Wheel and Brake Installation
17. Nose Gear Installation (Optional)
18. Tailwheel Installation (Optional)
19. Brake System Plumbing
20. Fuselage Fuel System Plumbing
21. Manual Trim System Installation (Optional)
22. Miscellaneous Fuselage Plumbing and Wiring

RUDDER CONTROL ASSEMBLIES INSTALLATION

Dual Brake Option The standard Sportsman kit includes brake pedals and wheel brakes for the pilot's side only. A **Dual Brake Option Kit**, which supplies all the necessary parts, material and hardware for brakes on the copilot's side, is available; order P/N 991-01000-03. The instructions in this section describe only the standard, pilot-side brake installation.

Note There may be a few more steel parts that will require corrosion proofing during the systems installation. Refer to Step 6 in "SECTION VIII: FUSELAGE ASSEMBLY" for a description of corrosion-protection procedures and "INTERIOR CORROSION PROTECTION" in "SECTION II: TOOLS AND TECHNIQUES" provides further details.

Note Use light grease to lubricate all moving parts throughout the entire Sportsman control system (except for the control system pulleys and bellcrank bearings, which are already lubricated). Lubrication is needed not only to prevent wear between components but also to minimize friction, which can reduce aerodynamic stability (besides making the airplane less pleasant to fly). Use grease wherever rotation occurs between parts: bushings, shackles and cable terminal ends that rotate on bolts or clevis pins, for example. If you have extras of the nylon washers left over from "SECTION VIII: FUSELAGE ASSEMBLY," you can install them strategically between moving parts to reduce friction further.

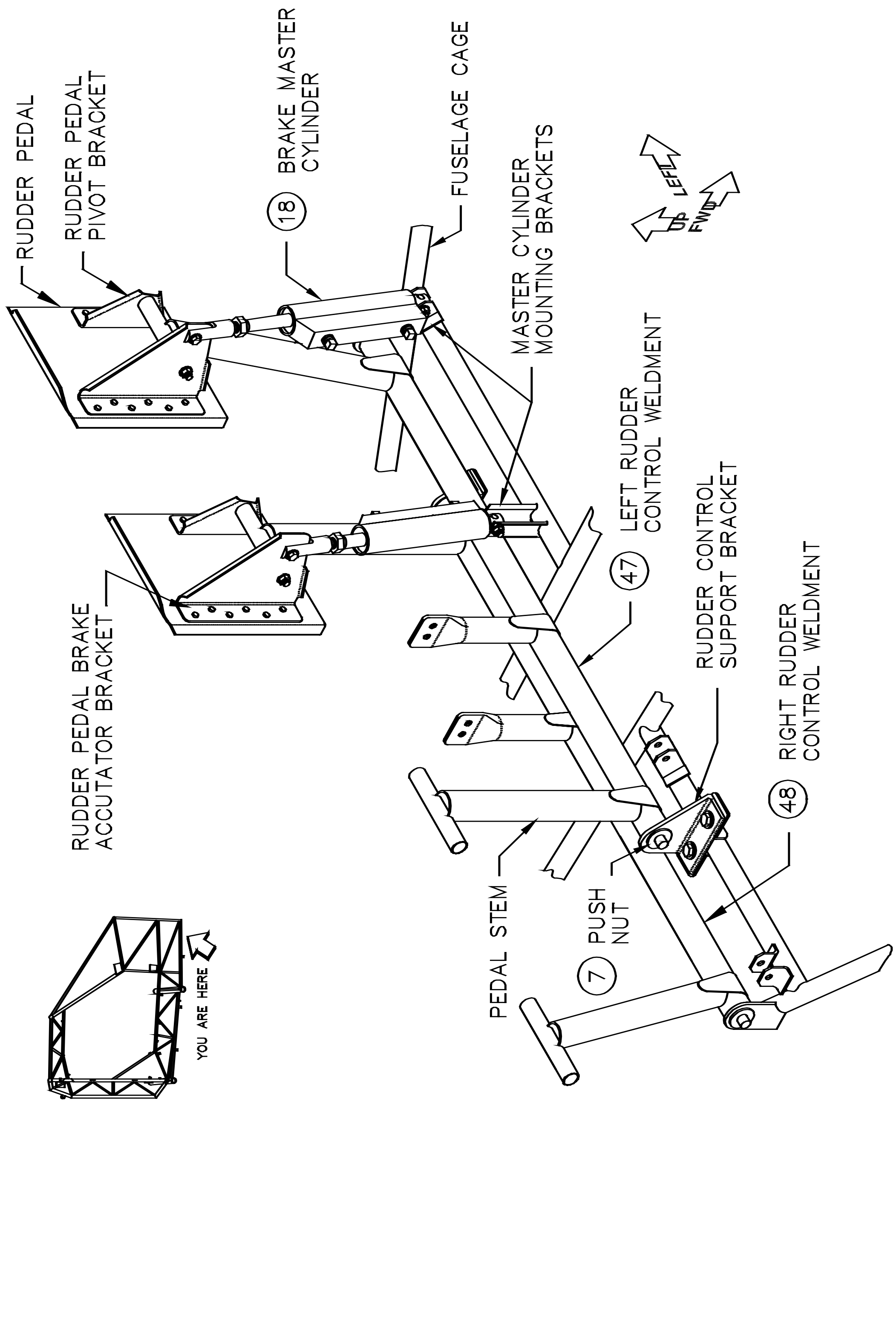


Figure 1: Rudder Control System

Step 1: Drill the Rudder Control Support Brackets

There are two **[20] Rudder pedal support brackets** included with your kit. These brackets will be bolted to support tabs that are part of the Sportsman cage. In order to bolt them in, you will need to drill two #10 holes in each bracket as shown in Figure 2. A third hole in the other leg of the bracket will be drilled later after you have leveled the rudder control weldments. The brackets are identical and there is no need to designate either one as the left or right at this point. It is recommended that you mark the locations first, verify these holes are positioned correctly over the steel support tabs on the cage (in the next step) and have adequate edge margins on all parts before drilling.

Completed: [ ]

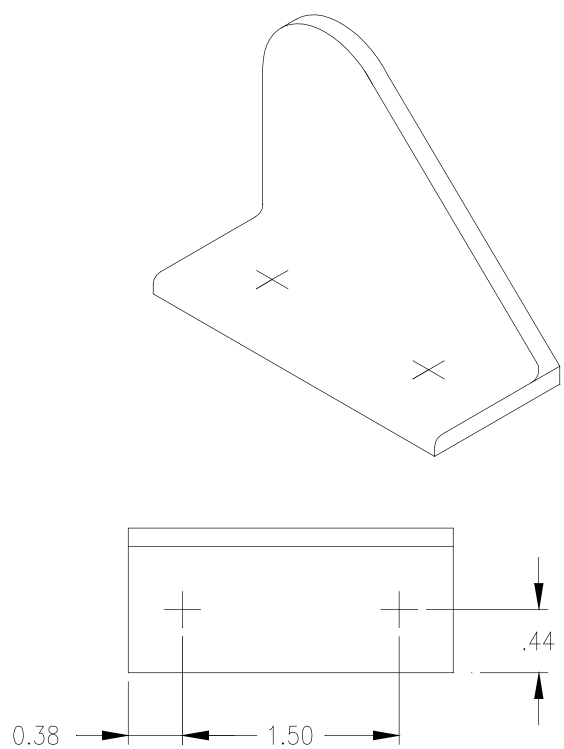


Figure 2: Rudder Pedal Support Brackets

Step 2: Mount the Rudder Controls

Hint It will be easiest to install the rudder controls by working from the open, forward end of the fuselage. Hanging the fuselage from the support structure used in "SECTION VIII: FUSELAGE ASSEMBLY" with the tail supported on a padded sawhorse will position it at a convenient height for installing all the fuselage controls and cables.

Use a large C-clamp to press the NAS77-4-009 **flanged steel bushings** [172] into the holes in the rudder control support tabs of the fuselage cage. Position the bushing flanges on the **inboard** sides of the tabs. Secure the bushings by applying Loctite bearing retaining compound before pressing them in.

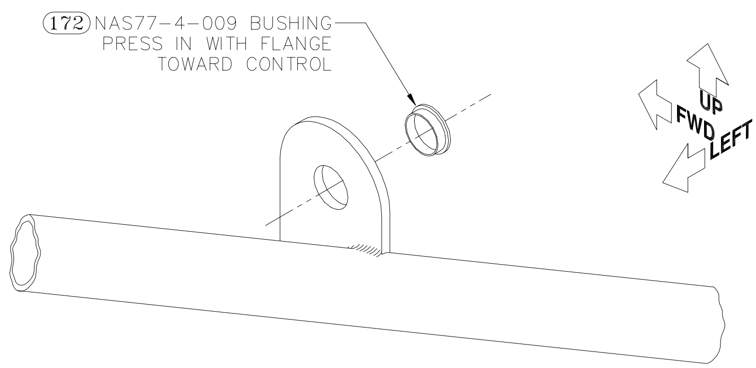


Figure 3: Bushings in Fuselage Cage Tabs

Level the fuselage laterally, using a carpenter's level on the main cross tubes between the front and rear spar. Insert the **right-hand** pivot of the **right** rudder control weldment into the flanged bushing in the support tab on the **right** side of the fuselage cage, as shown for the left control in Figure 4. (The right control is installed first so the left control won't be in the way for installing the right.)

Note To distinguish between the left and right rudder control weldments, notice that the **angled** pedal stem is located at the **outboard** end of the weldment and the small rudder pedal pivot tube at the top of each pedal stem is positioned toward the **aft** side of the stem (nearest the pilots foot).

Level the rudder control laterally and square it to the longitudinal centerline of the fuselage; support the rudder control in this position.

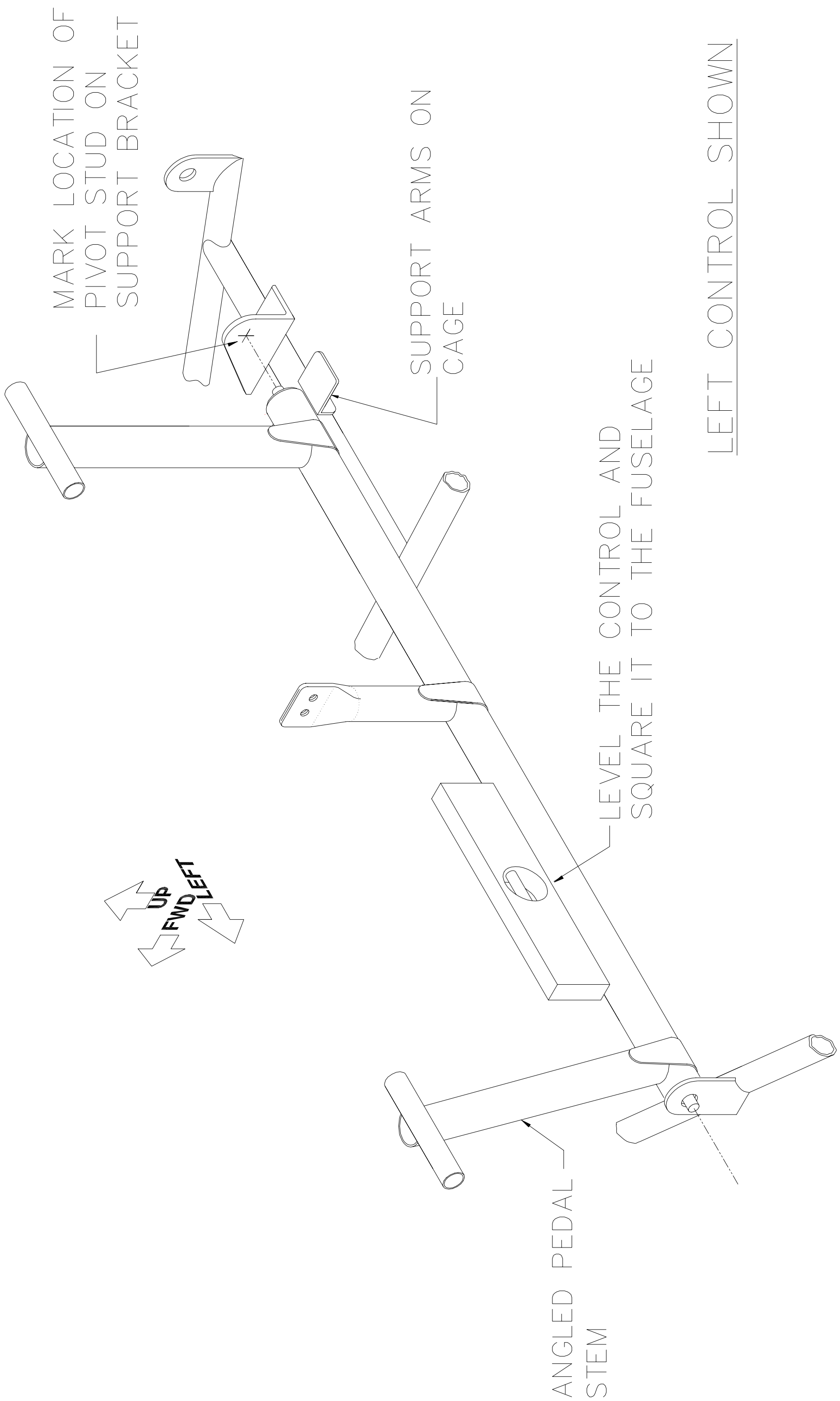


Figure 4: Leveling the pedal assembly

> **Note** Because of the extra width of the finger straps around the control weldments where the pedal and actuation stems are welded to the main tube, the tubes of the left and right weldments cannot be set **precisely** parallel to one another or perpendicular to the fuselage centerline without interference. It is necessary and perfectly acceptable to angle the left weldment slightly forward and the right weldment slightly aft to achieve clearance. This slight angle will be undetectable once the rudder pedals are installed.

With the rudder control resting in its temporary support, hold one of the support brackets drilled in Step 1 against the left-hand pivot of the control. Place the bracket on the support arms provided inside the cage. Center the bracket on the support arms and clamp it into place.

With the support bracket held in its proper position, mark the location of the rudder control end pivot onto the bracket. Remove the bracket and center punch the location of the pivot hole in the bracket. Drill the pivot hole through the bracket with a **23/64"** drill bit and then ream to **3/8"** diameter (.375" maximum, .374" minimum). This should be a slight press fit for the bushings. (If the hole ends up too large for a press fit, the bushing can always be staked in place using a center punch and Loctite.)

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

Page 23: .

Page 36: The last sentence in Step 7 will be revised to: This pivot tube centerline should be approximately 5" aft of the aft face of the 5/8" diameter firewall tubes.

Page 42: The reference to a #10 bit in the first sentence will be changed to a #12 bit, which is slightly smaller in diameter.

Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

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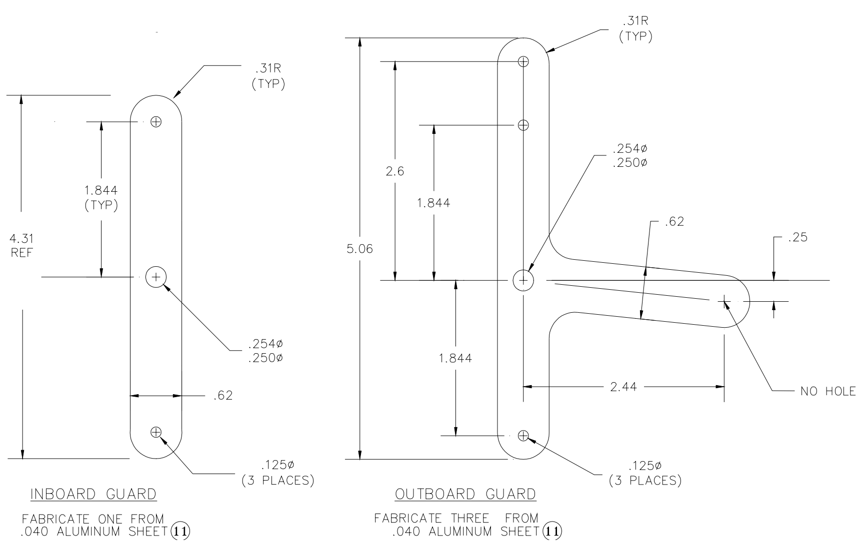

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Use a bench vise or a large C-clamp to press an NAS77-4-012 **flanged steel bushing** [173] into the support bracket assembly. Secure the bushing by applying Loctite bearing retaining compound to its circumference before pressing it in.

Note The bushing flange is located on the **inboard** side of the support bracket, next to the rudder control tube.

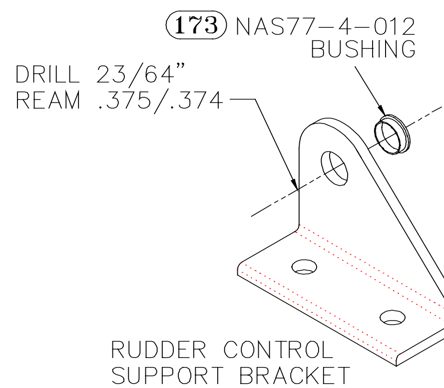

Figure 5: Bushings in Rudder Control Supports

Slip the support bracket over the inboard end pivot of the rudder control, with the bushing flange next to the rudder control. With the support bracket sitting on the cage support arms recheck your level. With everything properly leveled, mark the hole location through the support bracket and onto the support arms.

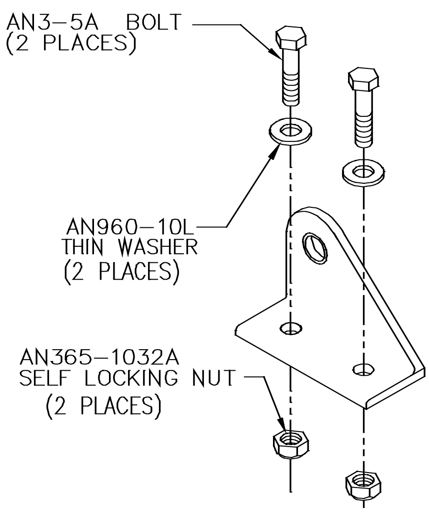

Figure 6: Rudder Control Support

Remove the rudder control and support bracket. Drill 1/4" diameter holes at the locations you just marked.

Repeat the procedures in this step for the **left** rudder control weldment.

Install both rudder pedal controls into the fuselage using a small dab of grease on both ends. Secure the pivot pins at each end of the rudder controls with **push nuts** [7], as shown in Figure 1. Bolt the rudder control supports to the support arms using an AN 3-5A bolt and an AN 960-10L washer through the top and secure it with an AN 365-1032A self locking nut on the bottom as shown in Figure 6.

Completed [ ]

Step 3: Fabricate the Rudder Pedals

The rudder pedals are first cut from aluminum sheet. The corners of the pedal blanks are then trimmed, as shown in Figure 7, and the resulting side and top flanges are bent to complete the pedals.

Dual Brake Option The standard Sportsman airframe kit includes material to make the rudder pedals for the pilot's side only (two pedals). The Sportsman Dual Brake Option Kit supplies extra material to fabricate two additional pedals for the co-pilot's side. If you are installing dual brakes, fabricate the extra pedals at the same time as the pilot's pedals**. The dual brake pedals should be mirror images of those on the pilot side shown in Figure 1.**

Hint If you are not going to install dual brakes, we recommend fabricating extensions for the right-side rudder control weldment pivot tubes to provide a wider surface for the co-pilot's feet. These extensions could consist of short lengths of steel tubing bolted to the ends of the pivot tubes with a long through-bolt and with large-diameter washers on the ends to keep the co-pilot's feet from slipping off. We'll let you devise your own pedal extensions if you want them; material for these is not supplied.

Cut the two 6" X 5-1/4" rudder pedal blanks from the supplied **.063" X 6" X 12" aluminum sheet** [12], as shown in Figure 7.

Note Part of this aluminum sheet was already used in "SECTION VIII: FUSELAGE ASSEMBLY" to make the forward shell attach fittings.

Lay out the trim lines, as shown in Figure 7, at the corners of the rudder pedal blanks. To trim the corners, start by drilling two **5/16"-**diameter holes in the **upper two** corners centered **9/16"** in from the edges. Then cut along the tangents of these holes straight out to the two closest edges. Finally, trim the **45° X 1/4"** angles on the six corners, as shown.

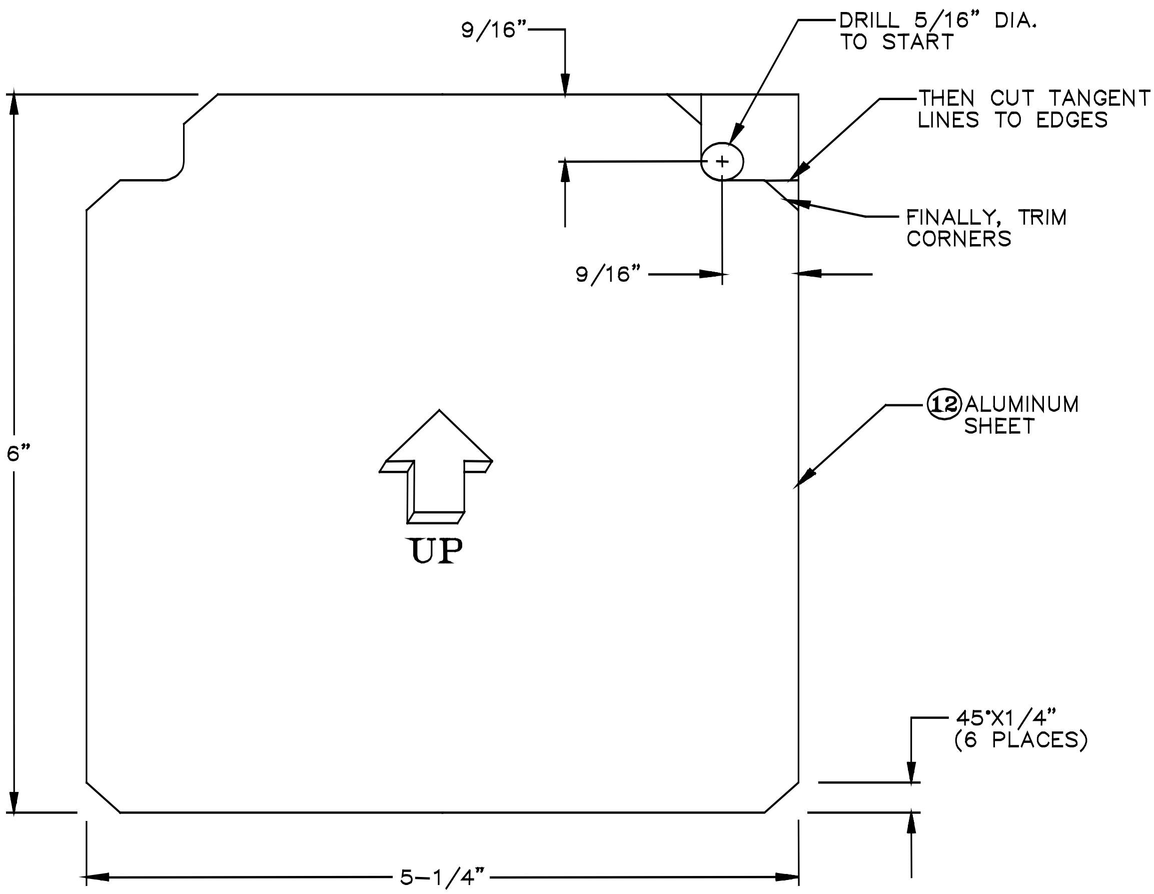

Figure 7: Trimming the Rudder Pedal Blanks

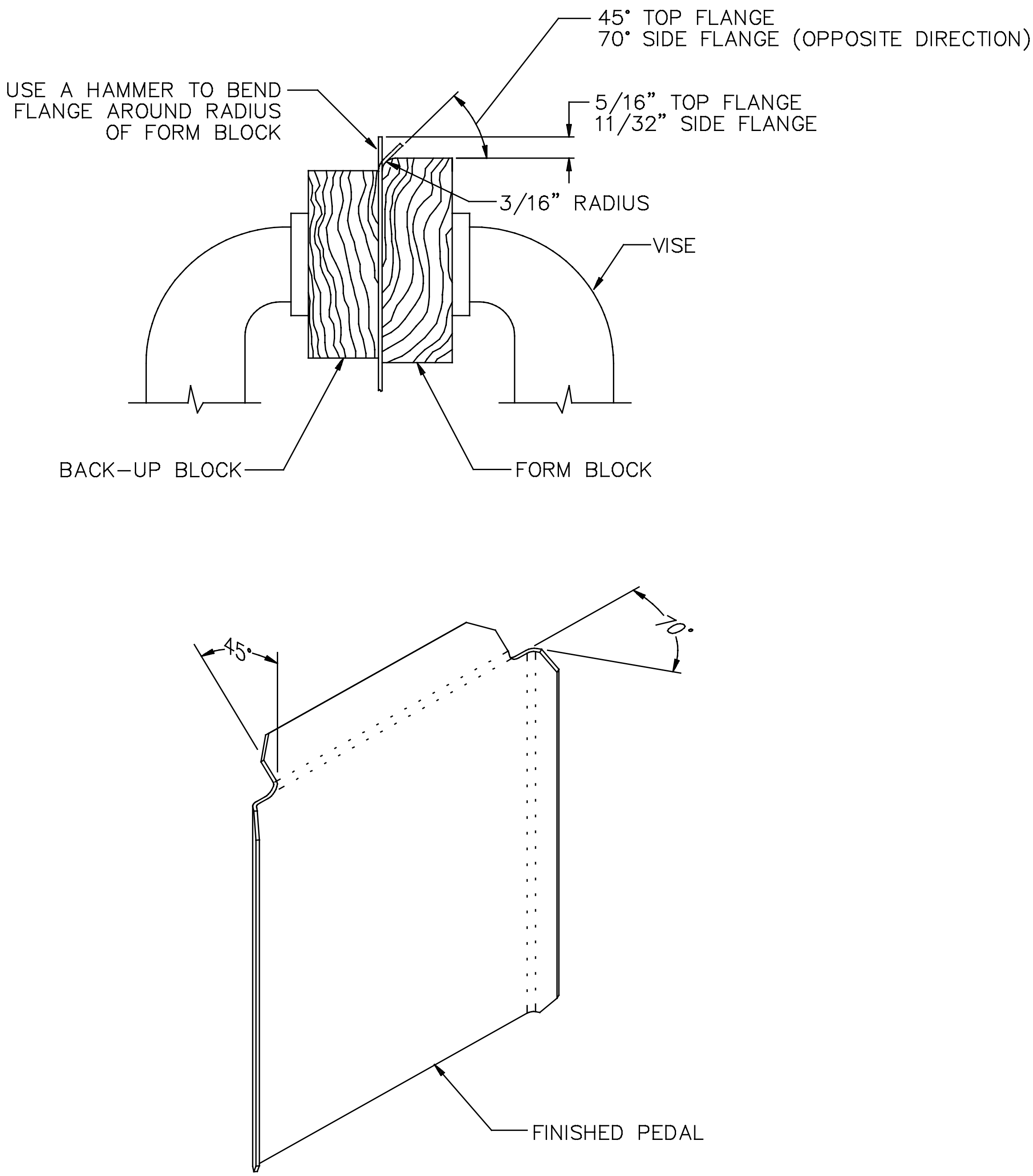

Figure 8: Bending the Rudder Pedal Flanges

The easiest way to bend the flanges on the rudder pedal blanks is to take them to a sheet-metal shop and have them use their bending brake. Otherwise, use scrap wood to make a form block with a **3/16"** radius along one edge, as shown in Figure 8. Also, make a wooden back-up block, as shown.

First, form the bend at the top by placing the rudder pedal blank between the form block and the back-up block, as shown in Figure 8, with **5/16"** of the pedal blank protruding above the top of the form block. Place the assembly in a vise (or use large C-clamps to secure it to the edge of a sturdy work bench if your vise isn't big enough) and use a 2 X 4 struck with a hammer to bend the top edge of the pedal around the radius of the form block. Bend the flange to a **45°** angle.

Note The angles of the flanges are not critical. At the top, you need just enough flange to stiffen the pedal; at the sides you need just enough to keep your feet from slipping off. The pedals will look better, however, if you match the angles closely from one pedal to the next.

Next, use similar procedures to bend the side flanges to **70°** angles in the **opposite direction** from the top flange. When clamping the pedal to form the side flanges, let **11/32"** of the sheet protrude beyond the form block before bending.

Repeat these procedures for both pedals.

Completed: [ ]

Step 4: Fabricate the Rudder Pedal Brackets

Fabricate the **rudder pedal pivot brackets** from the **.050" X 3/4" X 1.55" formed steel rudder pedal pivot angle** [45], as shown in Figure 9. Fabricate the **rudder pedal brake actuator brackets** from the **.050" X 3/4" X 3" formed steel rudder pedal brake actuator angle** [46], as shown in Figure 10. Fabricate two of each type of bracket: two **left-flange** pivot brackets and two **left-flange** actuator brackets. **The right-flange brackets would be used with the dual brakes on the co-pilot side or if you are installing a single set of brakes on the right side of the aircraft. Reference Figure 1, 9 and 10 for specific orientation.**

To make the brackets, first cut the brackets to length from the formed angle stock. Then, lay out the trim lines on the wider flanges of the angles; use a hacksaw to cut outside the lines and finish the cuts with a belt sander or a file. Next, use a form block with a **5/32"** radius to bend the flanges of the brackets; bend all the flanges **45**° toward the existing 90° flange of the angle, as shown. (The 45° angle isn't critical; even bending the flanges to just 30° would stiffen them adequately.)

Drill **19/64"**-diameter **pivot holes** in all the brackets and **19/64"**-diameter **brake master cylinder attach holes** in the brake actuator brackets. Then, ream these holes to **5/16"** diameter (.313" maximum, .312" minimum). Finally, lay out and drill the **#40** pilot holes through the mounting flanges of the brackets, as shown in Figures 9 and 10.

> **Note** To drill and ream the 5/16"-diameter **pivot holes**, pair each pivot bracket with an opposite-flange brake actuator bracket. Place each pivot bracket and its paired actuator bracket back-to-back with their mounting flanges resting on a flat surface. Clamp the two brackets together, and drill and ream the pivot holes through both brackets at the same time to ensure that the pivot axis of the pedal assembly is parallel to the pedal. Once the pivot holes have been reamed in each pair, mark the brackets and keep that pair together as a set.

Completed: [ ]

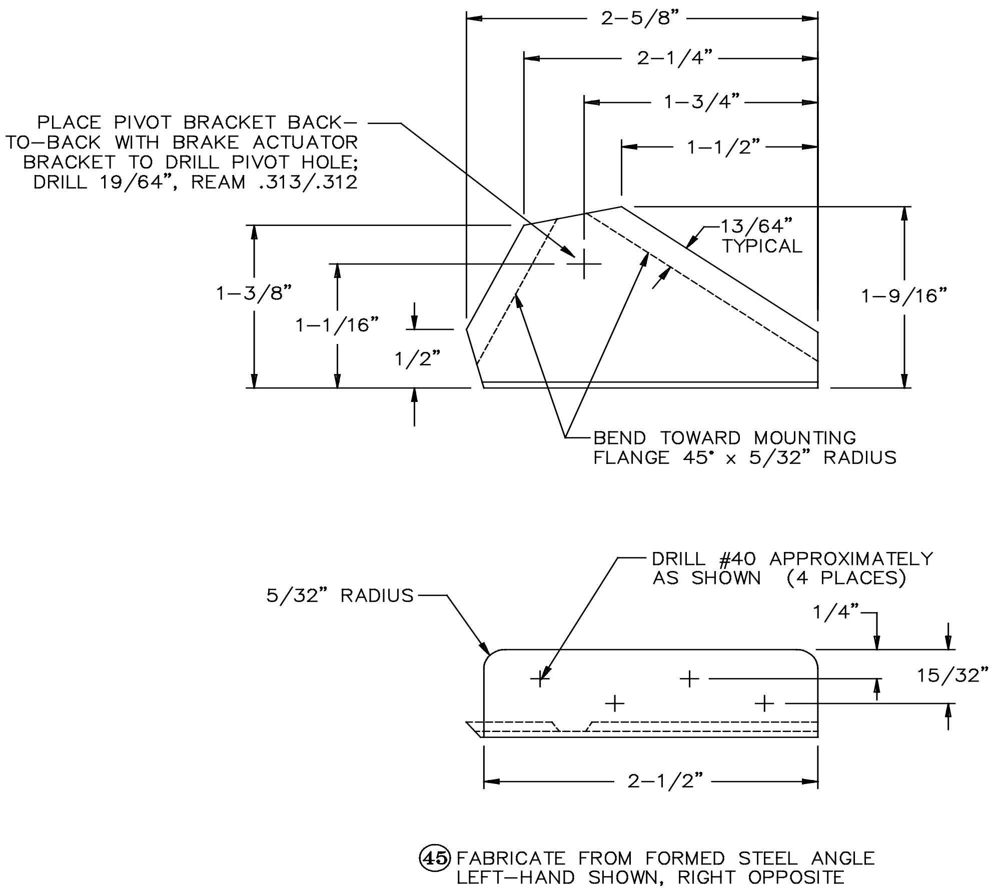

Figure 9: Rudder Pedal Pivot Bracket

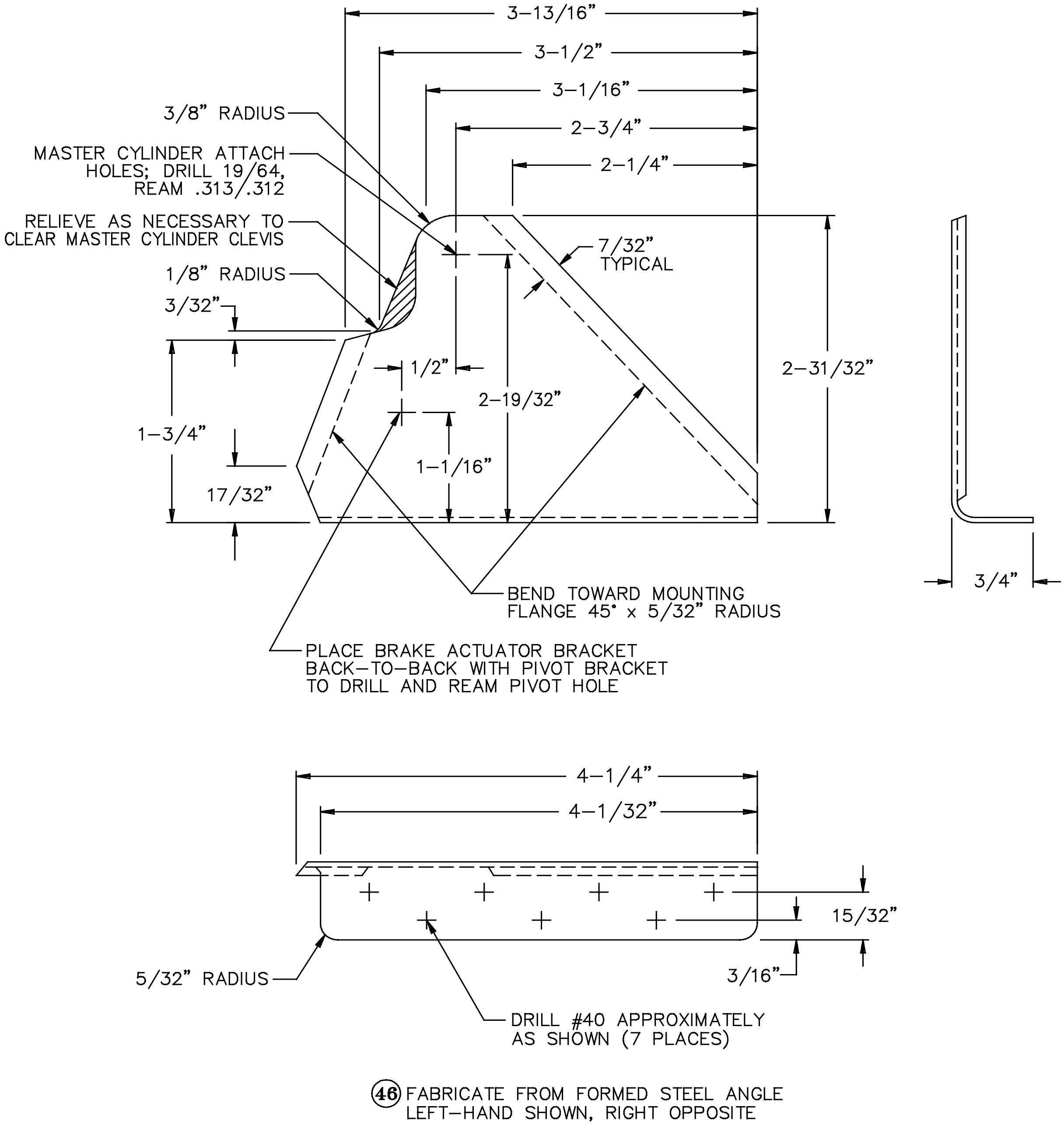

Figure 10: Rudder Pedal Brake Actuator Bracket

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Step 5: Assemble the Rudder Pedals

Position each brake actuator bracket/pivot bracket pair on the forward side of a rudder pedal, as shown in Figure 11, with the pivot holes in the two brackets **1-5/8"** above the lower edge of the pedal. Position the two brackets **3-5/32"** apart, equidistant from the vertical centerline of the pedal, as shown. Make sure the two brackets are parallel to each other and square to the pedal. Clamp the brackets to the pedal.

> **Note** The pedal assembly shown in Figure 11 is the **pilot's side** pedal. The passenger side rudder pedals are a mirror-image of the pilot's.

Use the #40 pilot holes in the bracket flanges as guides to drill **#30** rivet holes through the bracket/pedal assembly.

Disassemble the rudder pedals, deburr the rivet holes and apply corrosion protection to the parts.

> **Note** Because you'll be riveting two dissimilar metals together (steel to aluminum), it's especially important to apply adequate corrosion-protection to the contact surfaces of the parts.

As shown in Figure 11, press NAS77-3-006 **flanged-steel bushings** [171] into each of the brake pedal bracket pivot holes with the bushing flanges toward each other. Also, press NAS77-3-006 bushings into the master cylinder mounting holes of the brake actuator brackets. Secure the bushings by applying Loctite bearing mount adhesive before pressing them in, or stake the bushings if they are loose in their holes.

Rivet the rudder pedal brackets to the rudder pedals with 1/8" AN470AD4 universal-head rivets. Place the rivet heads on the pedal sides of the assemblies.

Completed: [ ]

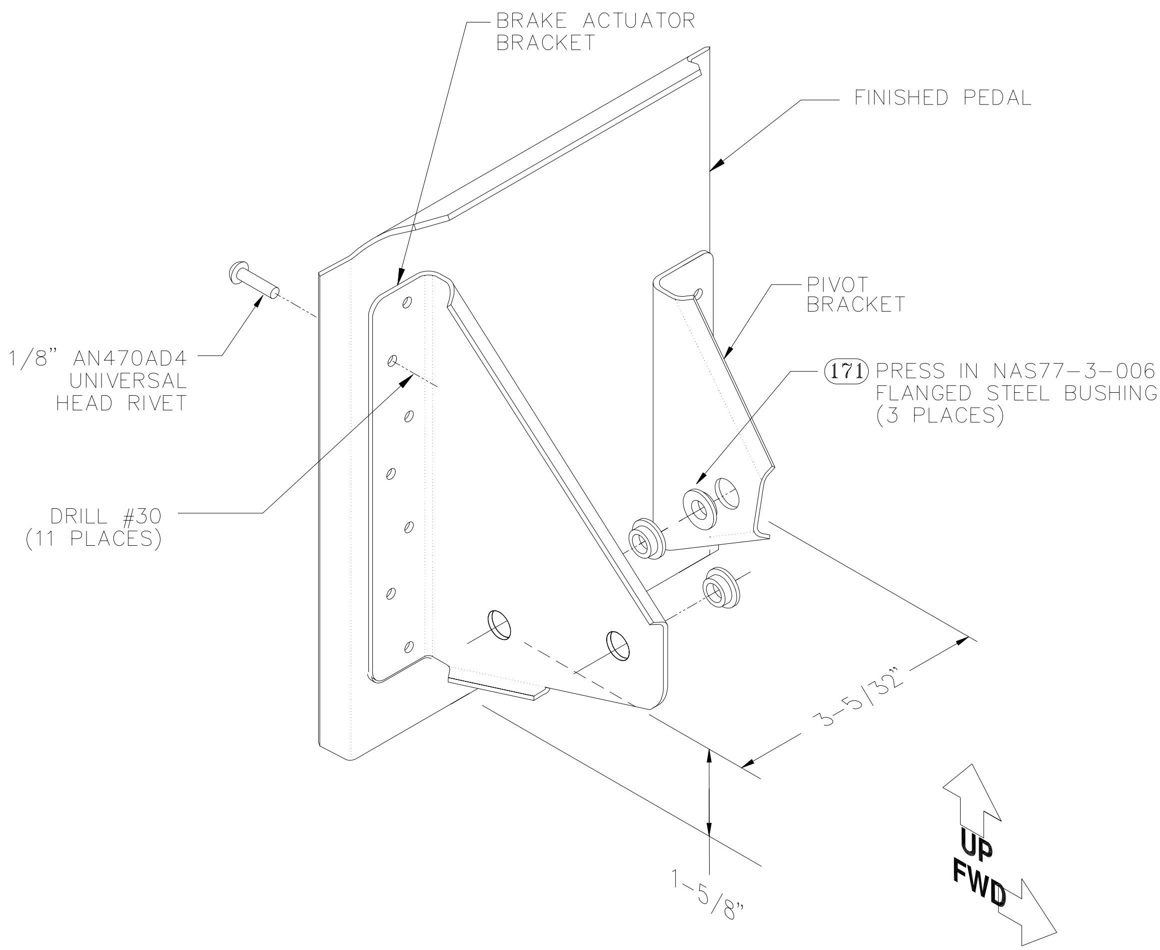

Figure 11: Rudder Pedal Assembly, Pilot Side

Step 6: Mount the Rudder Pedals on the Rudder Control Weldments

Note Use a small dab of grease on all moving parts to eliminate friction and

Use an AN3-35 **drilled-shank bolt** [93], two AN960-10L **thin washers** [141], an AN310-3 **castle nut** [100] and an AN380-2-2 **cotter pin** [113], as shown in Figure 12, to mount each rudder pedal to its rudder control. Position the brake actuator brackets of the left and right pedals identical to each other, as shown in Figure 1.

Completed: [ ]

Warning Start a list of critical to do items prior to first flight. Check the security of all bolts, nuts and cotter pins throughout your control system

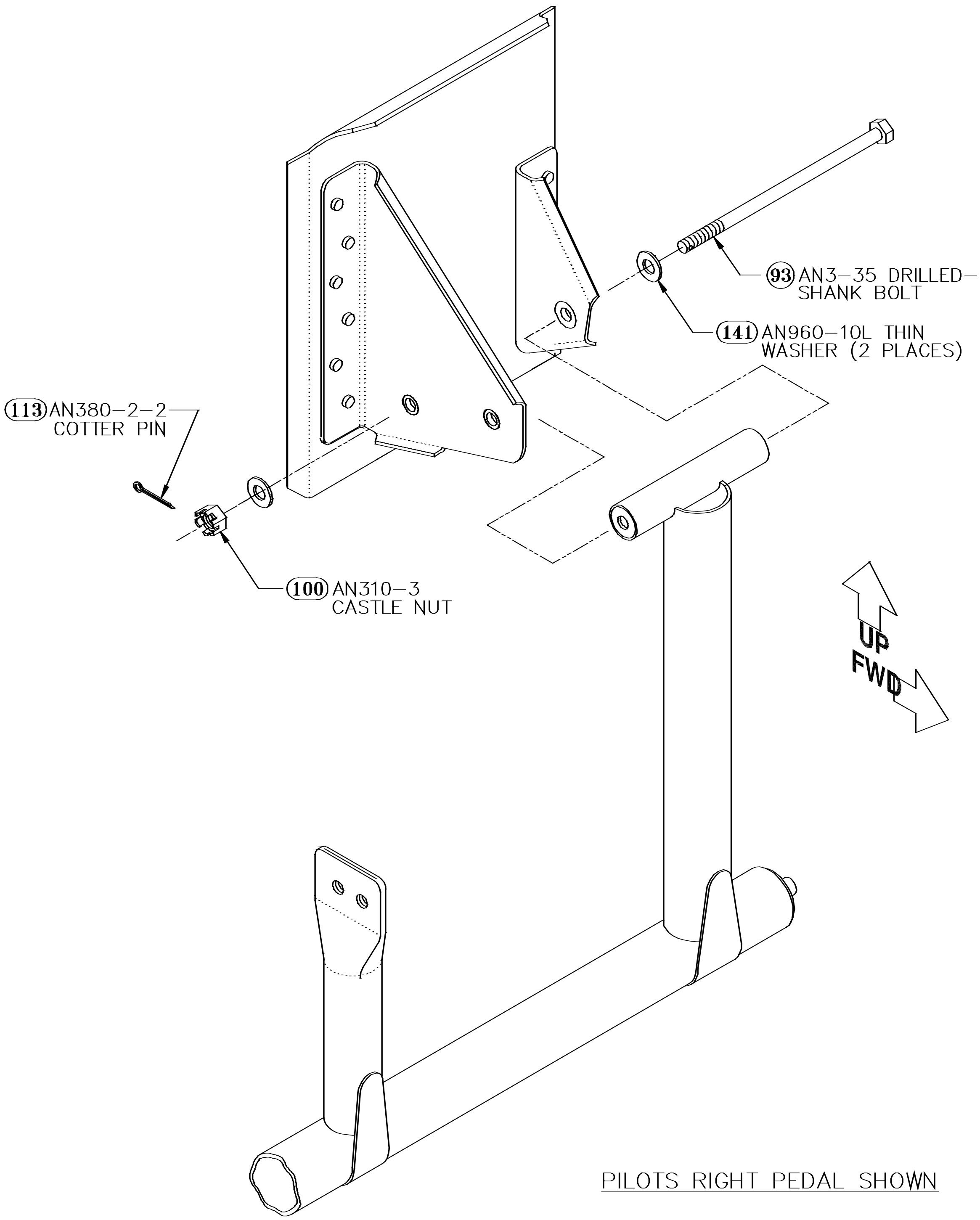

Figure 12: Mounting the Rudder Pedals

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

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Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as “elevator reversing pulley”, the small center pulley is the “left rudder cable pulley” and the far right pulley is the “flap reversing pulley”.

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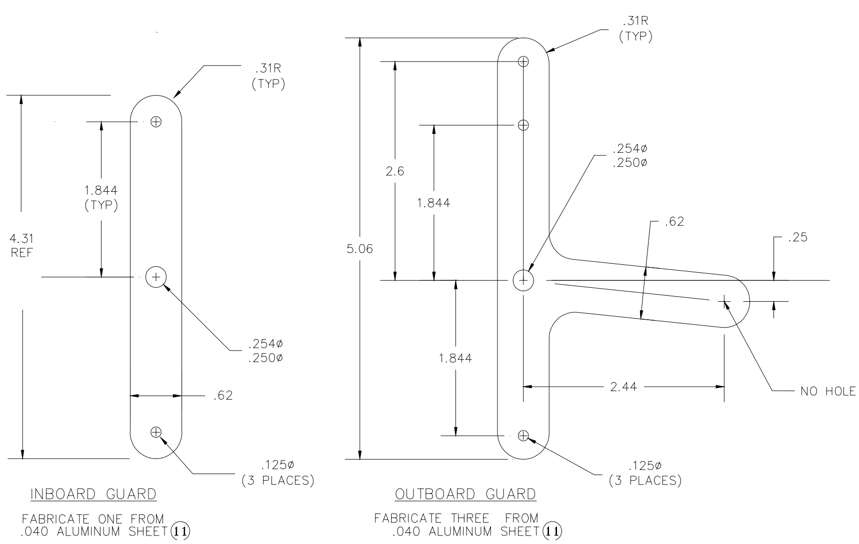

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Step 7: Install the Brake Master Cylinders

In the neutral position, the rudder pedal pivot tubes (the small, horizontal tubes to which the rudder pedals are attached) for the left and right rudder controls are aligned, which means that the right rudder control stem (the upright tube to which the rudder pedal pivot tube is welded) must angle forward slightly and the left rudder pedal stem must angle aft slightly, as shown in Figure 14. This pivot tube centerline should be approximately 3" aft of the aft face of the 5/8" diameter firewall tubes.

The rudder pedals themselves, in the neutral position, are perpendicular to the waterline or can be rotated slightly top forward. This can be adjusted later to suite your personal preference on the feel of the pedals. Use tape, wire, clamps or any means necessary to securely support the rudder controls and the rudder pedals in the neutral positions.

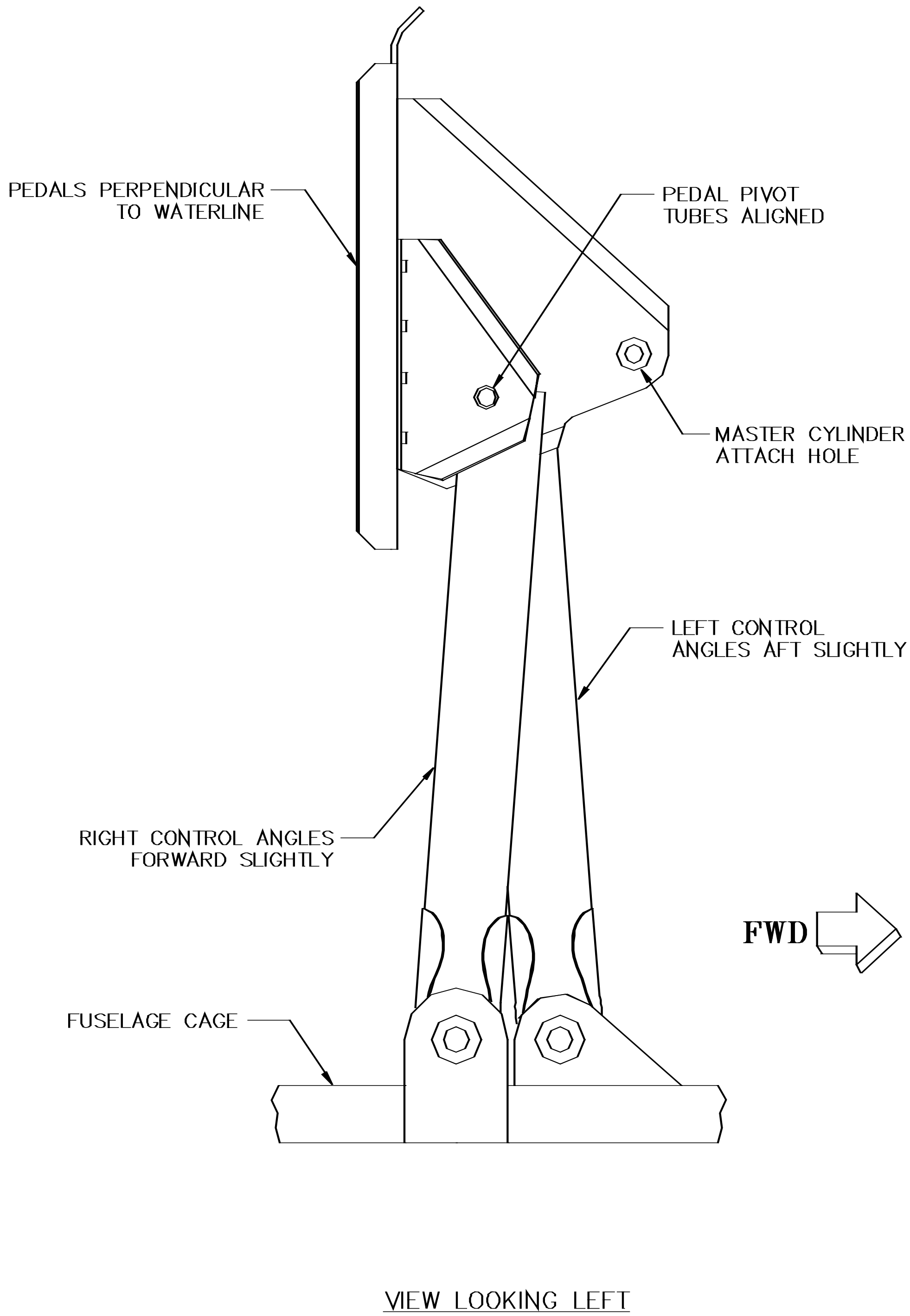

Figure 14: Rudder Pedal Neutral Position

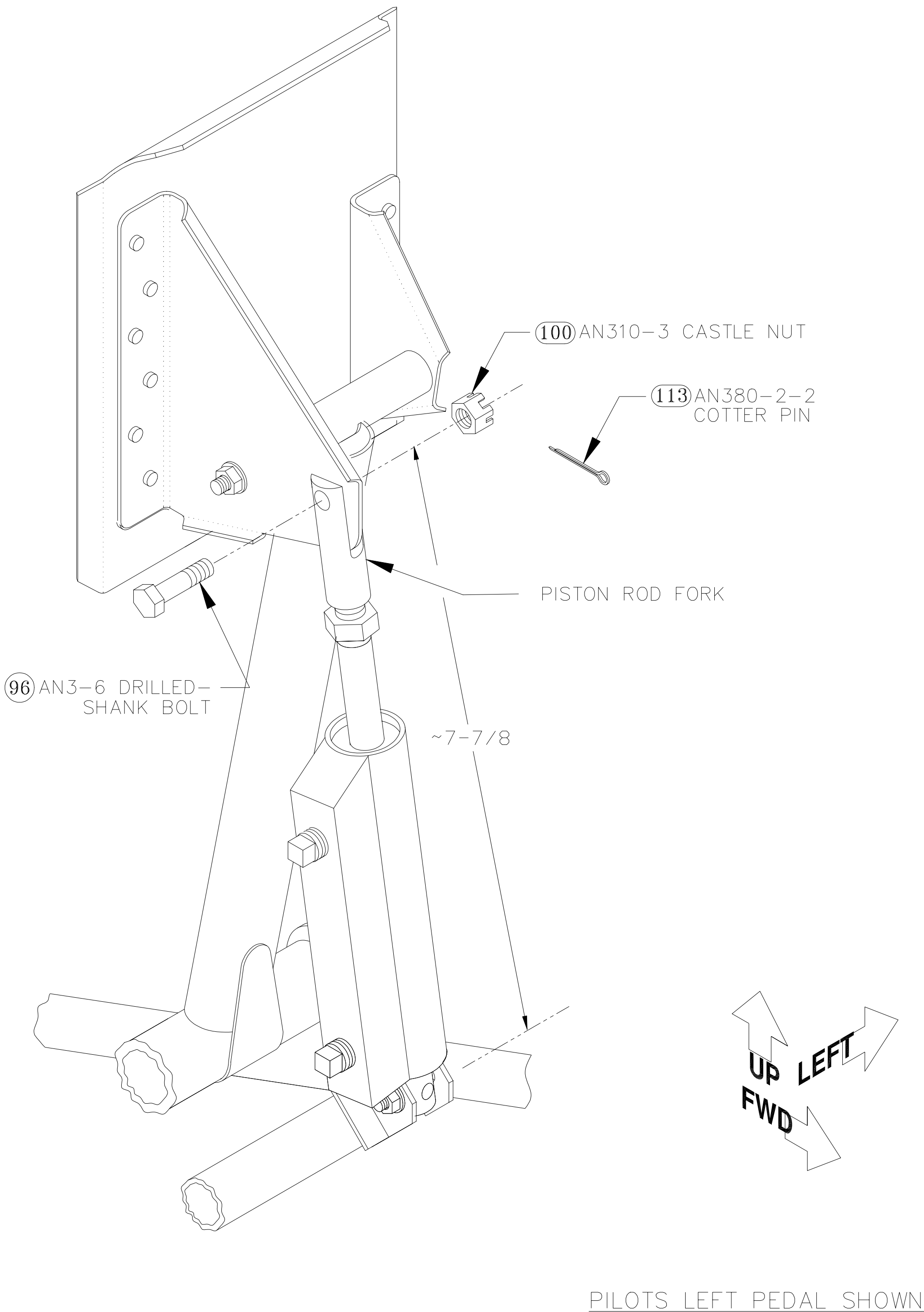

Figure 15: Master Cylinder Installation

With each **brake master cylinder** [18] in the extended (relaxed) position, thread the piston rod fork onto the piston rod until the distance between the hole in the fork and the hole at the base of the master cylinder body is **7-7/8"**, as shown in Figure 15. Do not worry about the jam nut at this time.

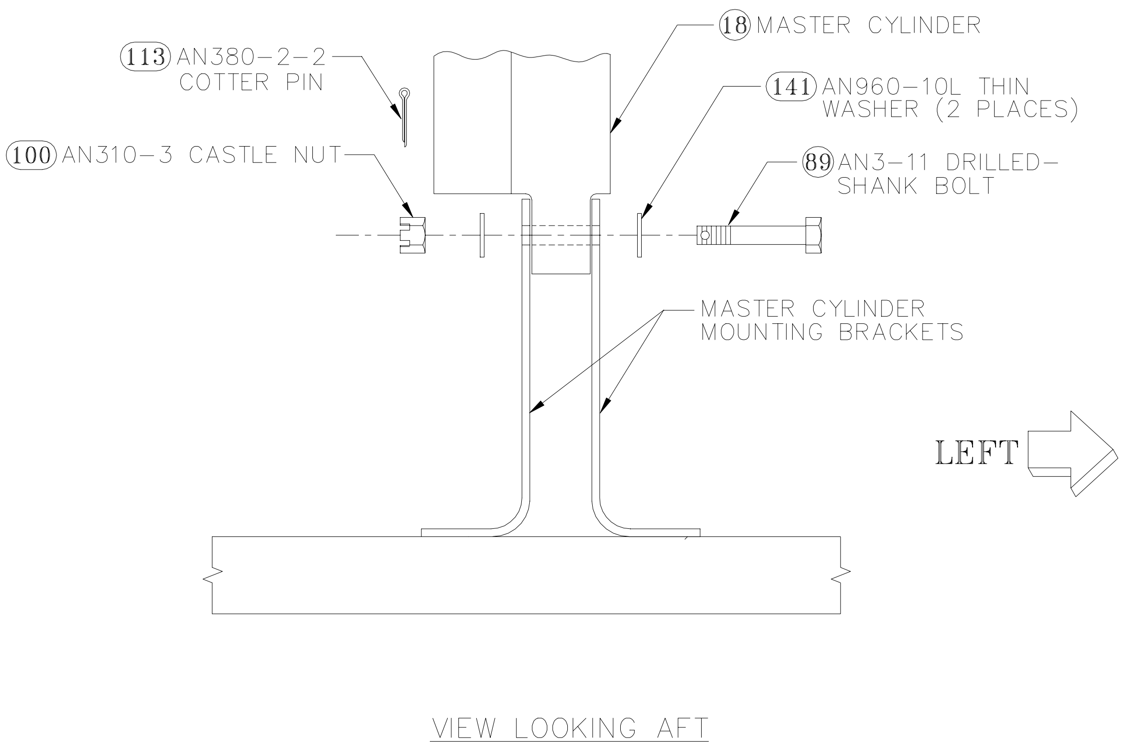

Figure 16: Finishing the Master Cylinder Mounting Brackets

> **Note** The master cylinders come with small, plastic plugs in the ports. To prevent the entry of contaminants, leave the plugs in until you are ready to connect the brake lines, which will be described in a later step.

Fasten the piston rod end of the left master cylinder to the brake actuator bracket of the left rudder pedal, using an AN3-6 **drilled-shank bolt** [96], an AN310-3 castle nut and an AN380-2-2 cotter pin. Depending on the fork, you may need trim some of the bracket away to get good clearance. If the threads bottom out on the threaded rod, the threaded portion of the fork can be shortened should any length adjustment on the cylinders be necessary.

Mount the lower end of the master cylinder between the master cylinder mounting brackets, using an AN3-11 **drilled-shank bolt** [89], AN960-10L thin washers, an AN310-3 castle nut and an AN380-2-2 cotter pin, as shown in Figure 16. When installing the master cylinders, point the ports for the fluid lines **inboard**.

Note In order for the rudder pedals to maintain the same angle throughout their entire stroke, the master cylinders would have to form perfect parallelograms with the pedal stems. The geometry of the rudder control system does not permit this. Using the specified dimensions for positioning the master cylinders is actually better than a pure parallelogram linkage in that, as the rudder pedal is pushed forward, the top of the pedal rotates aft slightly, making it easier to apply brake with rudder. The position of the left master cylinder relative to the left rudder control weldment is different from the position of the right cylinder relative to the right rudder control weldment because the neutral positions of the two pedals are different.

Completed: [ ]

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Section IX: Systems Installation

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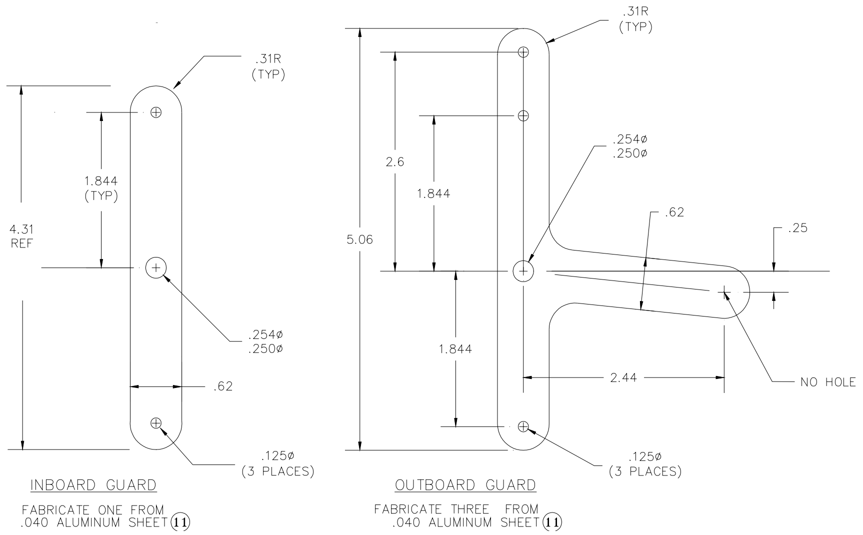


CONTROL STICK ASSEMBLY INSTALLATION

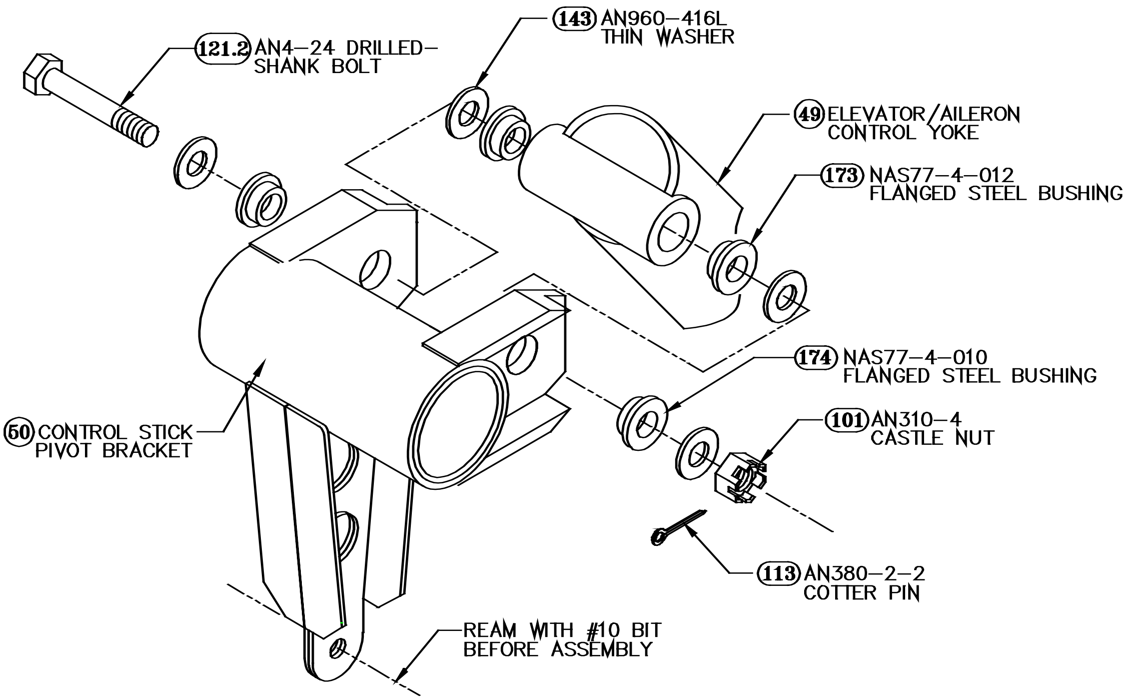
Step 8: Assemble the Elevator/Aileron Control

Use a **#10** drill bit to ream the lower hole in the long arm of each **control stick pivot bracket** [50], as shown in Figure 17. Use Loctite to install the **NAS77-4-012 flanged steel bushings [173]** in the control yoke assembly and the **NAS77-4-010 flanged steel bushings [174]** in the pivot brackets. Use AN4-24 **drilled-shank bolts** [121.2], AN960-416L **thin washers** [143], AN310-4 **castle nuts** [101] and AN380-2-2 cotter pins to bolt the control stick pivot brackets to the **elevator/aileron control yoke** [49], as shown in Figure 17. If there is play between the bushing insert AN960-416L thin washers as needed. Do not over tighten.

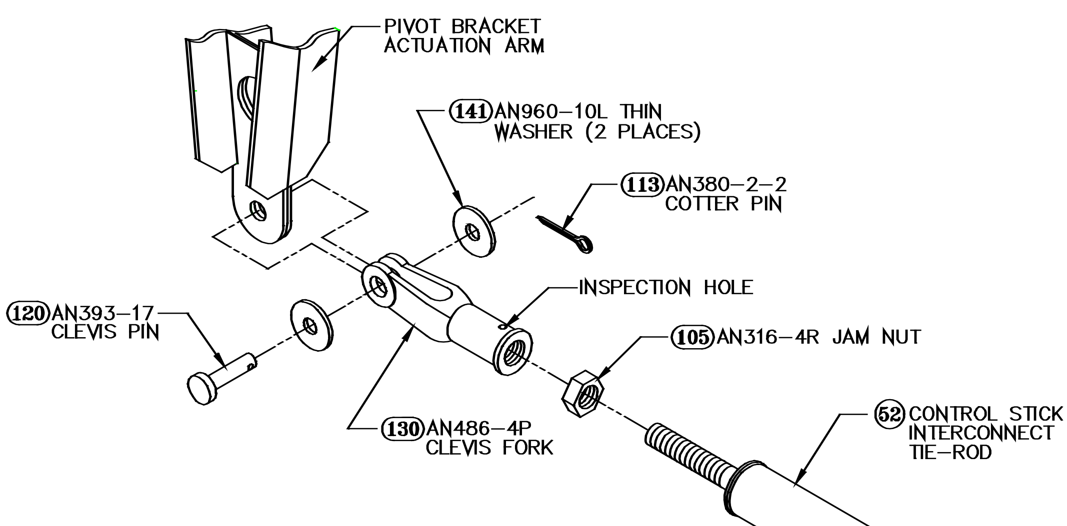
Thread an AN316-4R **jam nut** [105] and an AN486-4P **clevis fork** [130] onto each end of the **control stick interconnect rod** [52], as shown in Figure 17, until the bolt holes in the ends of the two forks are **18"** apart, as shown in Figure 18. (The 18" dimension is a starting point; the length of the linkage may be adjusted later to achieve the specified aileron deflections.) The control stick pivot brackets will be canted inward to reach the 18" dimension.

Use a small dab of grease on all moving parts to eliminate friction and reduce wear. **If your control yoke assembly appears to be too tight when installed inside the pivot brackets, sand down the powder coat on the yoke assembly. You may even slightly sand (.010-.015) the heads of the bushing if necessary.**

Warning Each clevis fork must be threaded onto the tie rod stud past the inspection hole in the fork. Use a stiff wire inserted into the inspection hole to feel for the end of the stud. If the wire passes through the inspection hole in the fork without contacting the stud, an unsafe condition exists, and the fork must be readjusted.



PIVOT BRACKET TO TORQUE TUBE ASSEMBLY



PIVOT BRACKET TO INTERCONNECT ASSEMBLY

Figure 17: Elevator/Aileron Control Yoke Assembly

Section IX: Systems Installation

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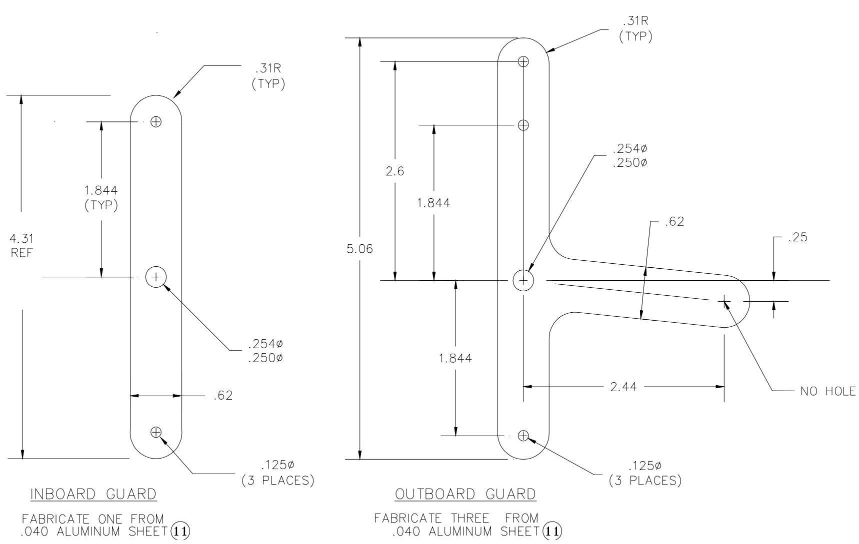

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

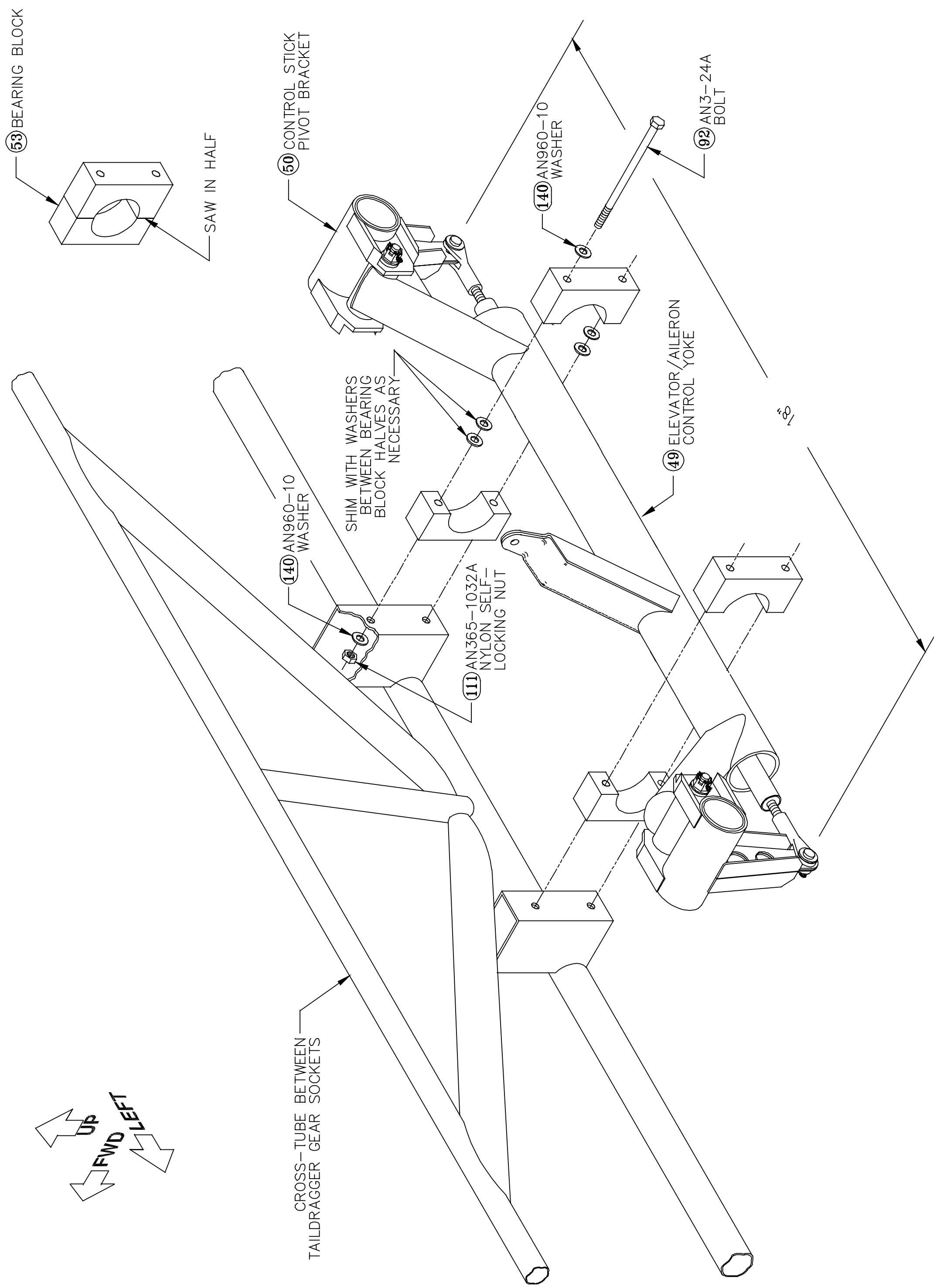

Figure 18: Control Yoke Assembly Installation

Insert the control stick interconnect assembly through the elevator/aileron control yoke torque tube, as shown in Figure 18, and use the AN393-17 **clevis pins** [120], AN960-10L thin washers and AN380-2-2 cotter pins to secure the interconnect rod forks to the control stick pivot bracket actuation arms, as shown in Figure 17.

> **Note** The AN393-17 clevis pin is longer than it needs to be to secure the interconnect rod forks. The extra length will be taken up by the strap shackles on the ends of the control cables, which will be installed in a later step.

Step 9: Install the Control Yoke Assembly

Use a bandsaw or a hacksaw to split the UHMW polyethylene **control yoke bearing blocks** [53] in half perpendicular to the two 3/16"-diameter mounting holes, as shown in Figure 18. (For a neater installation, you can form a 1/16" chamfer on all the corners of the bearing blocks, as shown in Figure 19.)

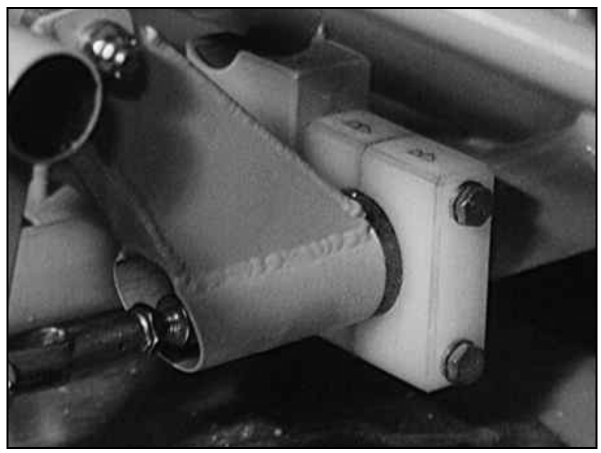

Figure 19: Control Yoke Installation (GlaStar yoke shown)

> **Note** Cutting the control yoke bearing blocks in half removes a saw kerf of material, so you will have to shim between the bearing block halves with washers to regain the circular cross-section of the large bearing hole and to achieve free rotation of the control yoke. The desired result is to have the bearing blocks **firmly** clamped up, but with rotational friction as low as possible. When sawing the blocks in half, stop part way through one of them to determine the washer stack-up needed to fit the width of the kerf.

Use the bearing blocks, AN3-24A **bolts** [92], AN960-10 **washers** [140] and AN365-1032A **nylon self-locking nuts** [111] to mount the control yoke assembly to the fuselage cage. Coat the inside round surface of the bearing blocks with a thin film of grease

> **Note** A potential problem is weld shrinkage in the fuselage cage that can pull the bearing block mounting pads out of parallel. If the bearing blocks are misaligned when viewed from the **aft** side, use a small, round file to slot the holes in an inboard and outboard direction in the mounting pads on the on the **right** side of the cage to bring the blocks into alignment. If the blocks are out of alignment when viewed from **above**, bevel the mounting surfaces of the blocks.

> **Note** Another potential source of friction is weld penetration on the insides of the small tabs that reference the aileron/elevator control yoke to the bearing blocks. If such roughness is found, file it smooth.

Completed: [ ]

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ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

Section IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4)

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Flap Handle Assembly Installation

Step 10: Assemble the Flap Handle

Press the MS16555-341 **3/16" dowel pin** [157] into the **flap handle plunger** [57], as shown in Figure 20. Insert the other end of the flap handle plunger into the **flap handle plunger extension** [56] and secure the extension to the plunger with super glue. Install the **flap handle thumb button** [75] into the flap handle plunger extension; secure the button with super glue, also. Dab a small amount of grease on all moving parts.

> **Note** It's OK to use super glue here because all the loads on both glue joints tend to tighten rather than to loosen the assemblies. If you wish, you can drill holes and pin the parts together with 1/16" or 3/32" roll pins (not supplied).

Fabricate a **2-1/8"** long spacer from 3/4" O.D. thick-wall plastic tubing or 3/4" wooden dowel.

> **Note** You can use just about any material you want for the spacer; its only purpose is to occupy space under the spring inside the flap handle. If you use a wooden dowel, varnish it so the moisture in the wood doesn't induce corrosion on the inside of the handle. The 2-1/8" dimension is a good starting length; you can shorten the spacer slightly to soften the action of the spring, if you wish, as long as the spring forces the flap plunger pin solidly into the notches of the ratchet plate.

Insert the spacer and then the **flap handle spring** [78] into the **flap handle** [58]. Then insert the flap plunger assembly into the flap handle, aligning the slot in the plunger with the slot in the handle. Insert the **flap handle ratchet plate** [55] through the slot in the handle, as shown, until one of the notches in the ratchet plate captures the dowel pin in the plunger. Press the 3/16" X 1/2" **roll pin** [42] into the hole at the upper end of the flap handle ratchet plate; this pin serves as a limit stop for the flap handle.

Completed: [ ]

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Section V: Elevator Assembly

Pages [illegible] tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

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ADVANCE NOTICE OF REVISION

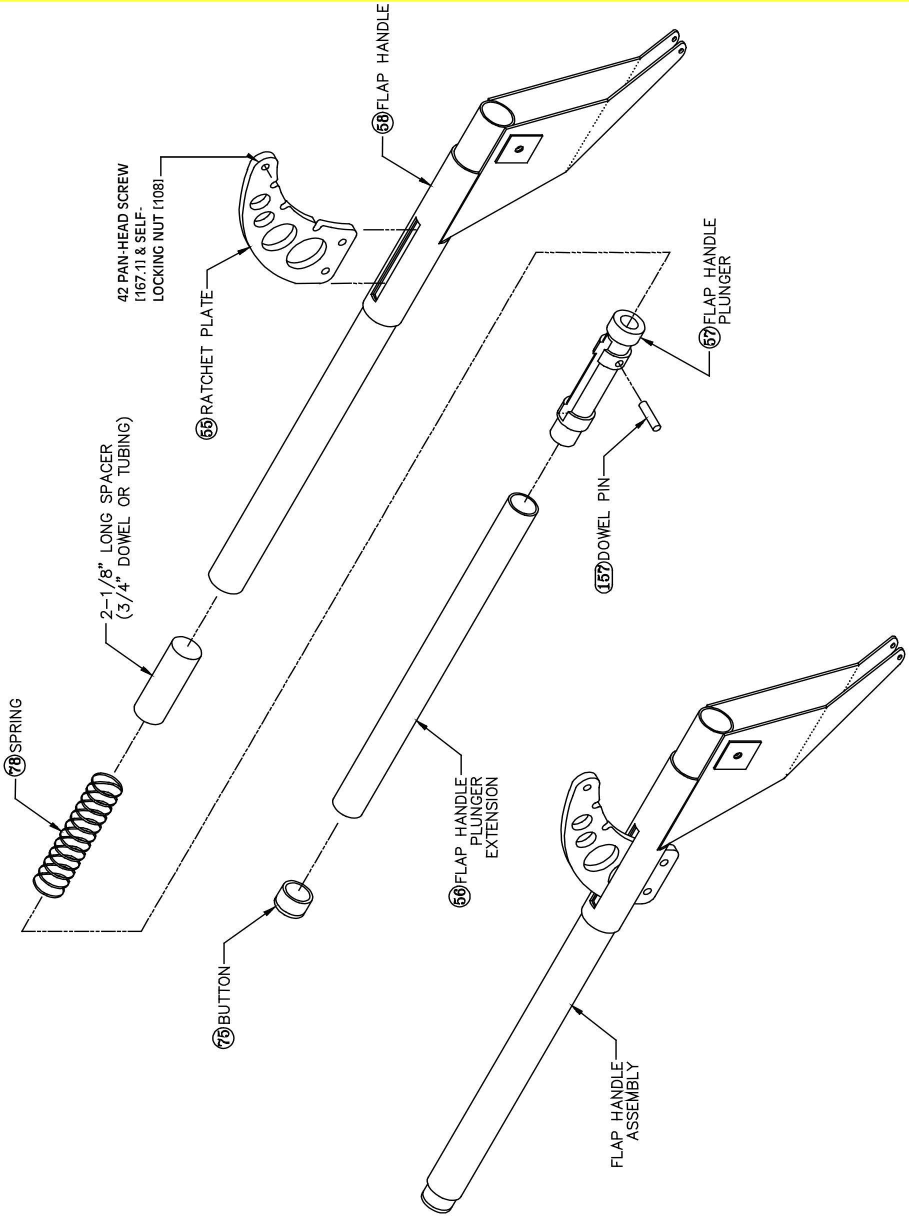

Figure 20- Flap Handle Assembly

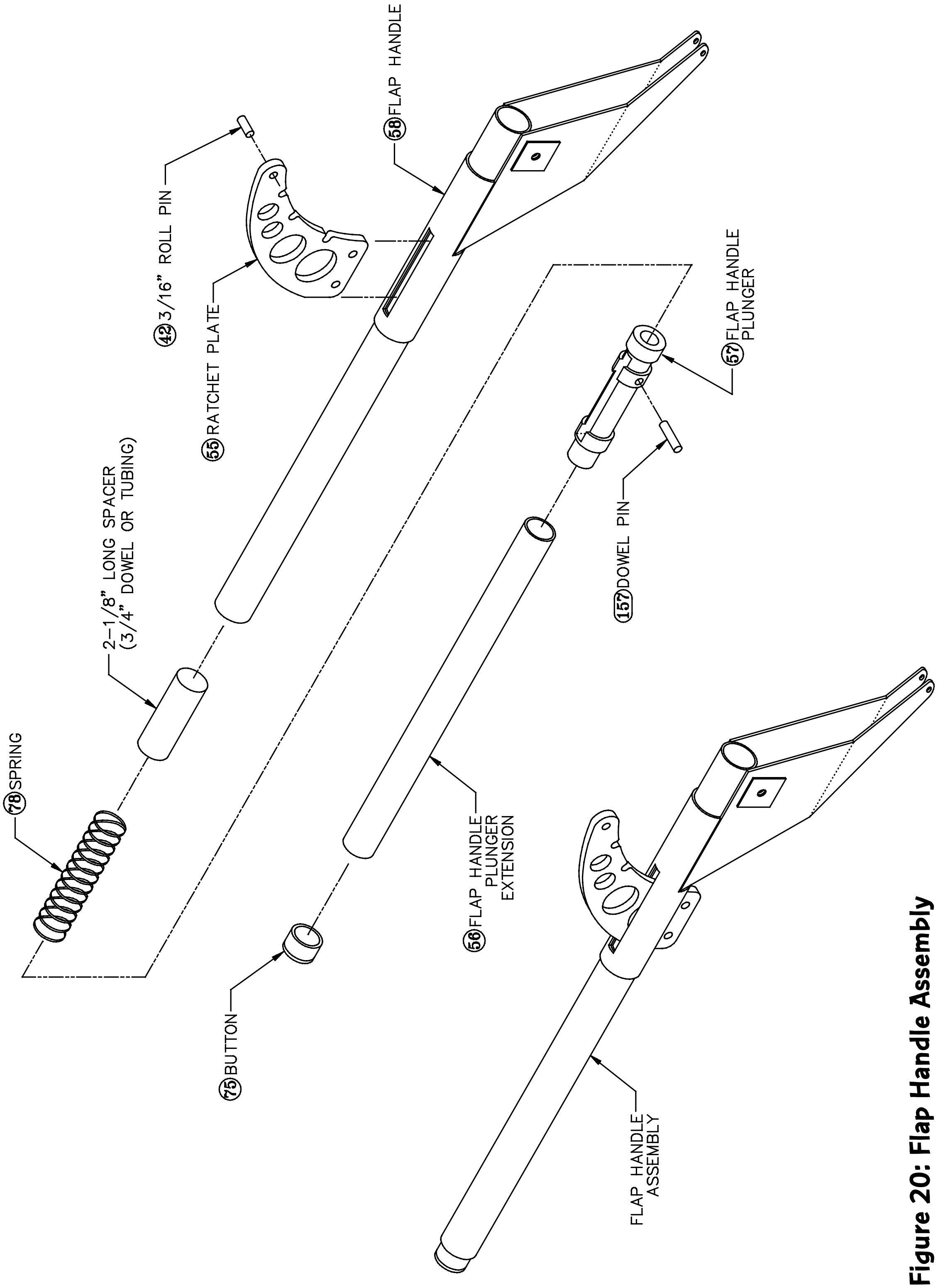

Figure 20: Flap Handle Assembly

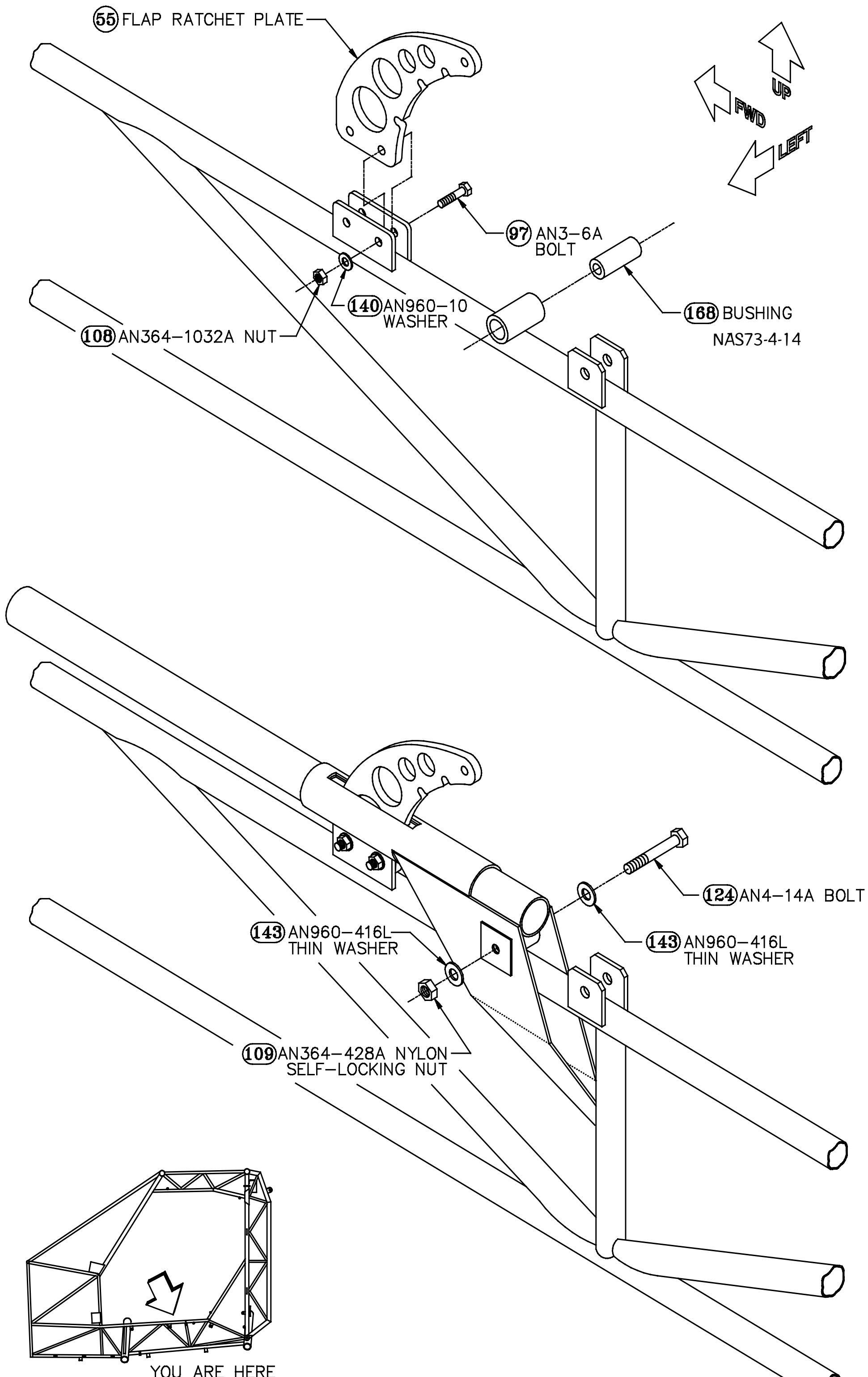

Figure 21: Flap Handle Installation

Step 11: Install the Flap Handle

Coat the NAS73-4-14 **clamp-up bushing** [168] with grease and insert it into the small tube welded to the top of the longitudinal cage tube between the pilot and copilot seats, as shown in Figure 21.

> **Note** If weld penetration or paint inside the cage tube prevents insertion of the clamp-up bushing, ream the tube with a **7/16"** (.4375") straight reamer.

Carefully spread apart the two arms of the flap handle assembly and slip them over the mounting tube on the fuselage cage. Align the flap handle pivot hole with the bushing in the mounting tube, and secure the handle with an AN4-14A **bolt** [124], AN960-416L thin washers and an AN364-428A **nylon self-locking nut** [109]. Tighten the nut securely to clamp the pivot bushing between the flap handle arms; the only rotation is between the pivot bushing and the tube on the fuselage cage.

Secure the ratchet plate to its mount on the cage with AN3-6A **bolts** [97], AN960-10 washers and AN364-1032A nylon self-locking nuts.

Completed: [ ]

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

Page 23: In the third paragraph, you should drill #10 diameter holes and not 1/4" diameter for the control bracket hardware.

Page 36: The last sentence in Step 7 will be revised to: This pivot tube centerline should be approximately 5" aft of the aft face of the 5/8" diameter firewall tubes.

Page 42: The reference to a #10 bit in the first sentence will be changed to a #12 bit, which is slightly smaller in diameter.

Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52:

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

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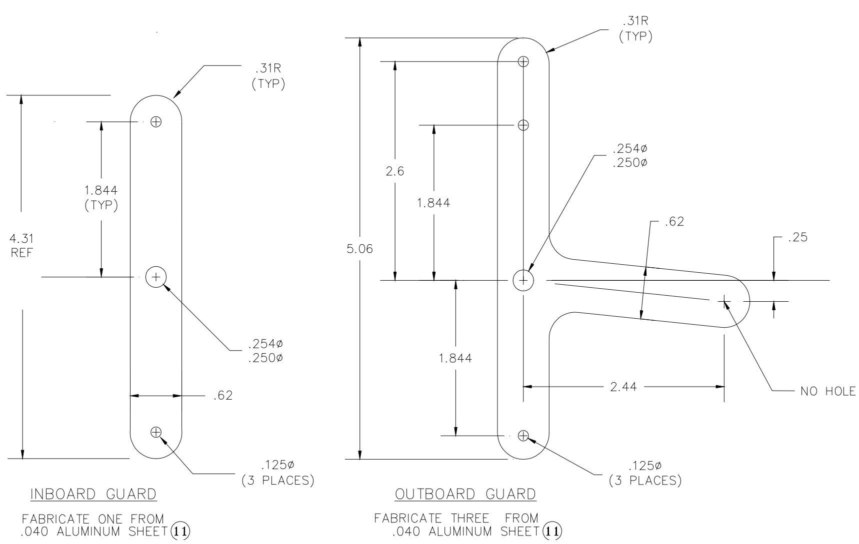

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Fuselage Control System Pulleys Installation

Steps 12-19 describe procedures for installing control system pulleys in the fuselage. Pulley guard straps and other cable retainers will be left off the pulleys until after the control cables have all been routed. Cable retainers will be described in Step 48.

Step 12: Install the Forward Pulleys

The forward pulley group between the pilot and copilot consists of three pulleys to rout the elevator, flap and rudder cables through the cabin area. The forward most pulley is the elevator reversing pulley. The smallest of the three pulleys is for the left rudder cable and the third pulley on the right is the flap reversing pulley. A pulley is not required for the right rudder cable. A plan view of the pulleys can be seen in Figure 22. Figure 23 shows an exploded view of the group with all the hardware. The spacer lengths are approximate and your lengths may vary.

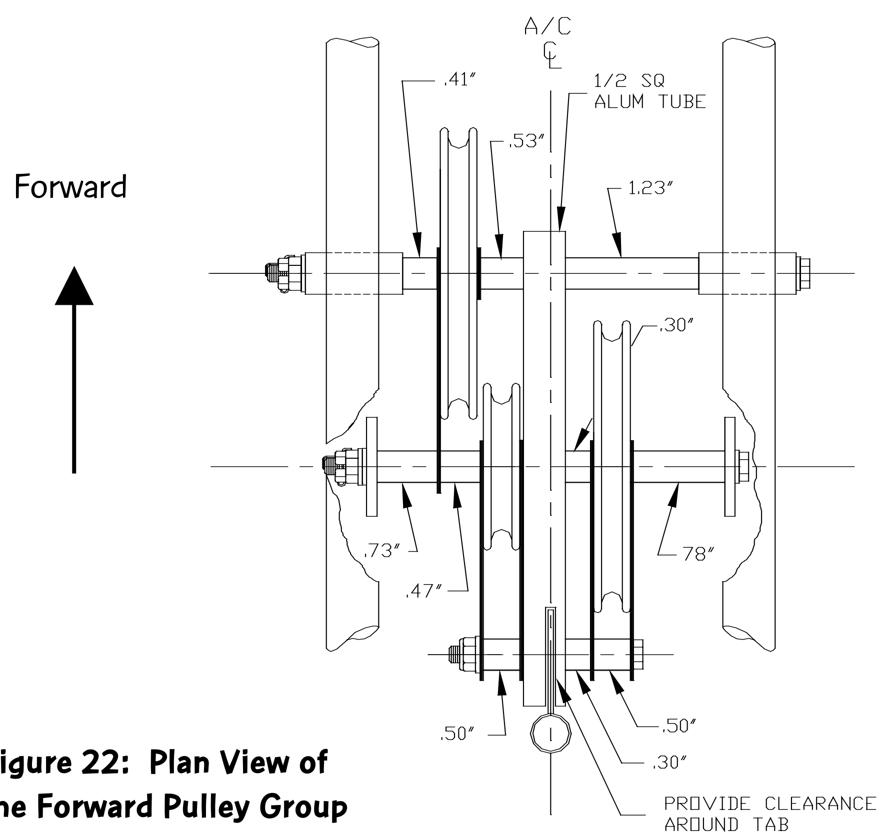

Figure 22: Plan View of the Forward Pulley Group

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

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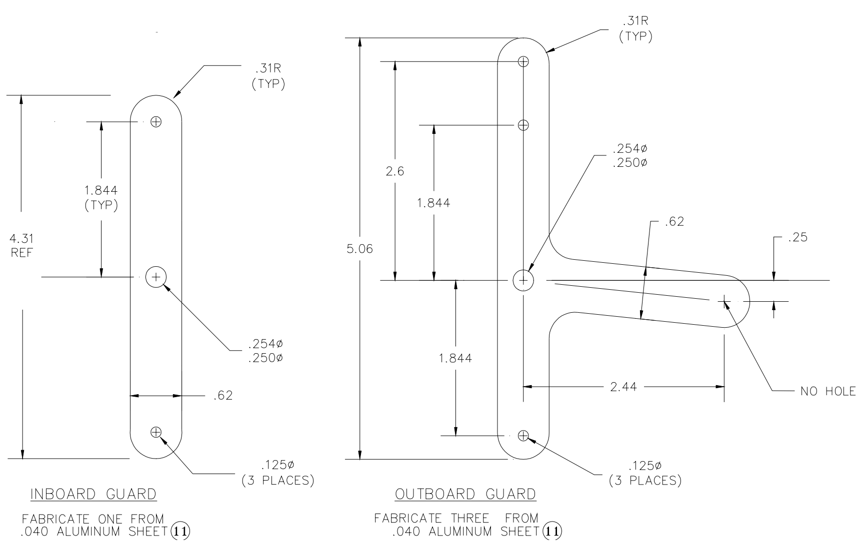
Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: [redacted]

Page 54: The first sentence will change to make (3) outboard pulley guards. The sentence 'The second hole at 2.60" on the third pulley guard can be trimmed off as shown in the left side of Figure 23' will be added to the first paragraph.



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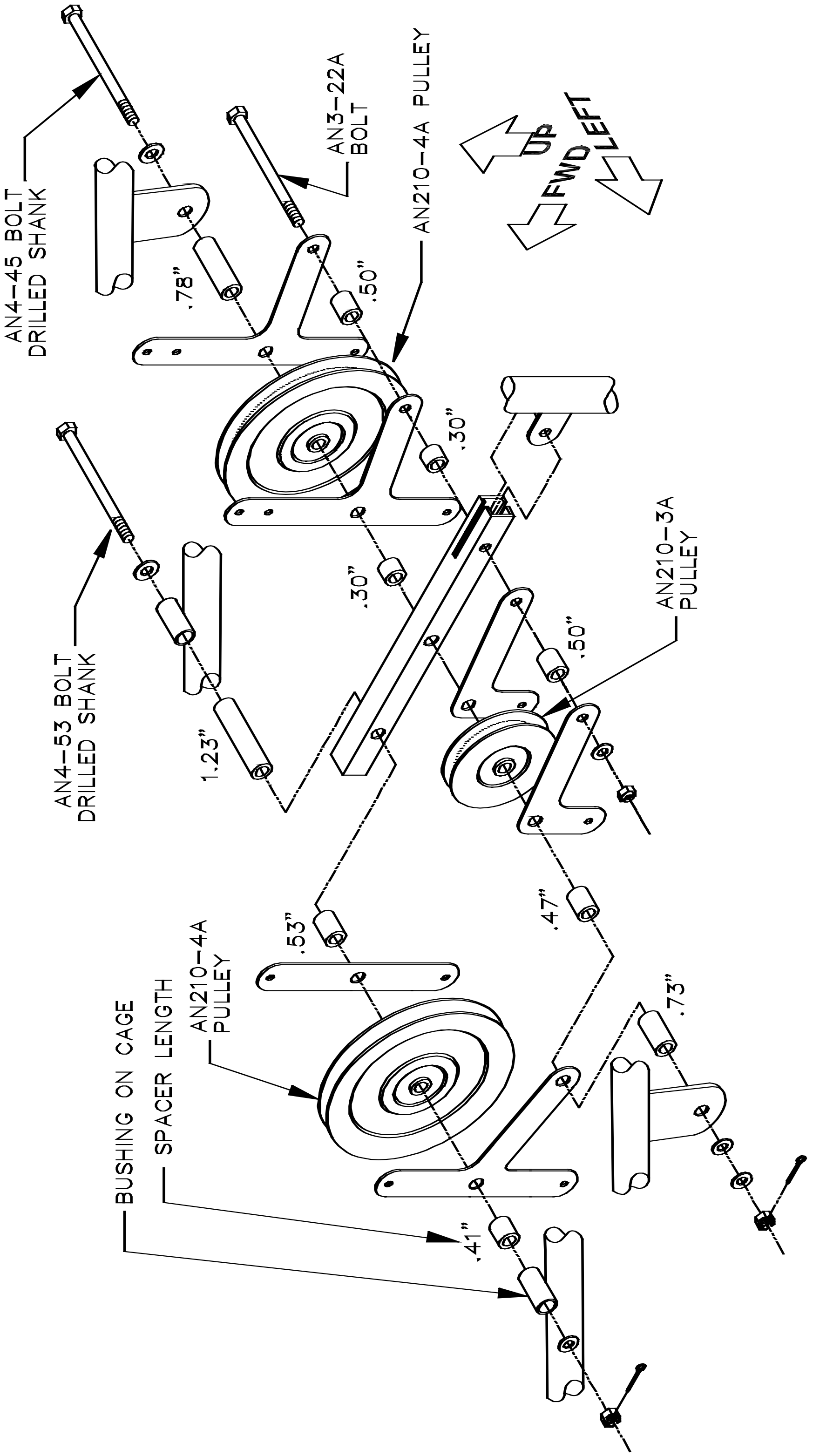

Figure 23: Exploded view of the forward pulley group

Section IX: Systems Installation

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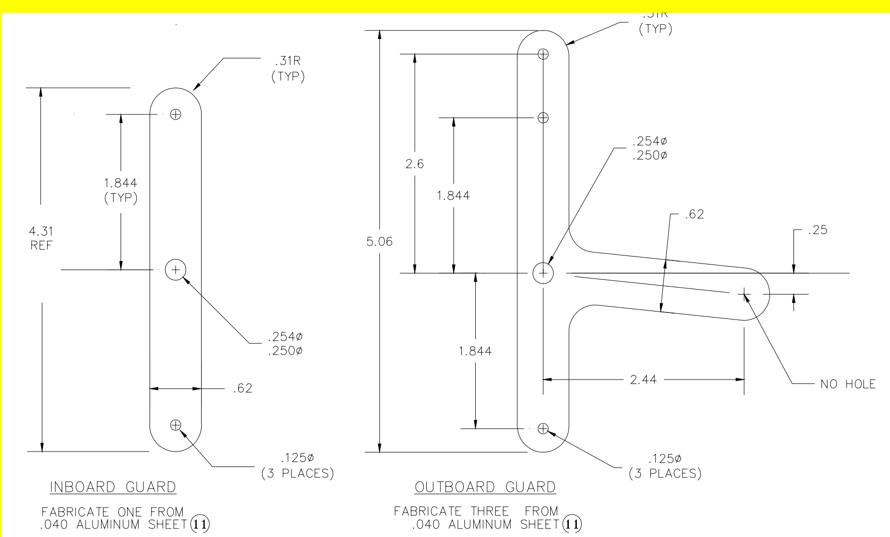
Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

Page 54:



Fabricate one inboard and one outboard cable guard for the elevator cable reversing pulley from the **.040" X 6" X 6" aluminum sheet** [11], as shown in Figure 24. Use a Unibit (or equivalent) to drill the 5/16" radii for the inside corners of the outboard guard, and then make the rest of the cuts on a bandsaw, finishing with a belt sander, files and sandpaper. Clamp the two guards together to drill the **1/4"** pulley axle hole and the **#30** clevis pin holes.

Note The dimensions for the 1/4" hole in the angled aft arm of the outboard guard are approximate and should be used for reference only. **It is recommended that you make the arm a little bigger and longer at first and then trim to a final size after the hole has been drilled.** To drill the hole, install the guard on the elevator cable reversing pulley pivot bolt and use the holes in the mounting tabs for the aft two pulleys as a guide to locate the hole. The purpose of this hole is to anchor the cable guard, preventing it from rotating, so it's not a problem if the hole is a little off or oversized to align with the bolt. **The 1-27/32 dimension should be held as close as possible in order to keep the clearance between the clevis pin and the pulley to a minimum as shown in Figure 28**

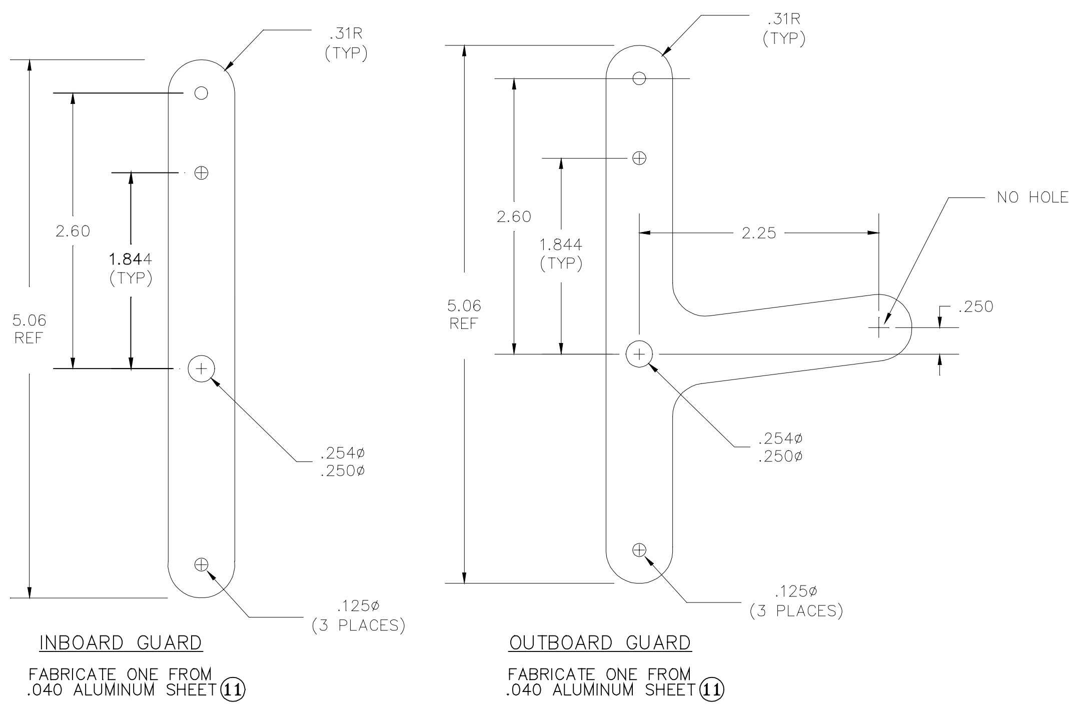
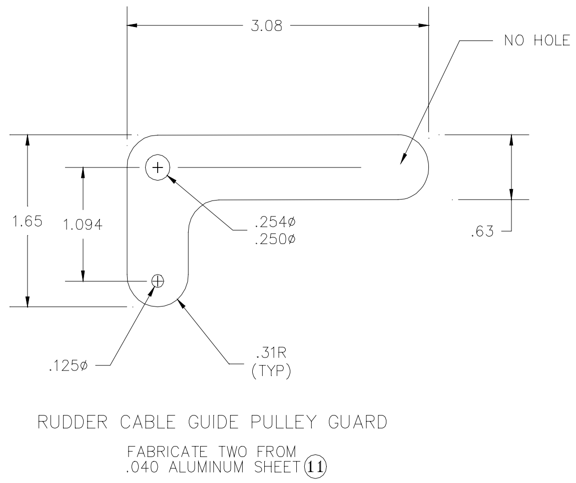


Figure 24: Elevator Cable Reversing Pulley Guards

Page 55:



Page 56-58: The reference to "drill this up up to 1/4" diameter" in the first paragraph will be changed to "drill to 1/4" diameter". A general procedure note of how to drill the holes in the square tube will be as follows. Mark a centerline on the 1/2" square tube. Using a drill press, drill a 1/4" diameter hole on end located 1-1/4" in from the end. Insert the forward pulley bolt through the cage bushing and then through the tube and across to the other bushing. Install the AN4-45 bolt through the tabs on the cage. Swing the tube up until it contacts the AN-45 bolt and mark this location on the tube. (Note: the bolt path would actually be an arc centered about the AN4-53 bolt, so the projected contact point with the centerline of the 1/2" tube will be slightly aft of this mark by about .015".) Use a drill press to drill this hole. It is also OK to open these holes up to .265 diameter if necessary. Set the tube back in the cage (off to one side of the aft center tab and install both bolts. Use the tab to drill the tube at this location.
With regards to pulley cable retainers, the stiffer the retainer is, the more clearance you may allow between the retainer the edge of the pulley. Cotter pins and the welded brackets are your stiffest kinds. The aluminum straps should be held closer since the thin aluminum strap may deflect more that others.

Page 79-80: In Step 21, the following note will be added to the end of the first paragraph; "Note: Do not worry that the cables do not meet the rudder arms on the same angular plane." The note on the bottom of page 80 should refer to Step 7 and not step 8

Page 100-102: If you plan on folding the wings on the Sportsman, the lower trailing edge of the wing strut will need to be cut back more to clear the side of the composite fuselage. These dimensions can vary somewhat between aircraft. The two dimensions given in Figure 54 on page 102 will be changed to 4-1/2" and 1-5/8". When folding the wings for the first time take note of the clearance between the strut and the fuselage.

Fabricate cable guards for the flap cable reversing pulley and the left rudder cable guide pulley, as shown in Figure 25, using the same material and similar procedures as described for the elevator cable guards, above. Clamp the two guards of each set together to drill the **1/4"** pulley axle hole and the **#30** clevis pin holes. **Do not drill the #10 holes in the angled, aft arms of the guards at this time.**

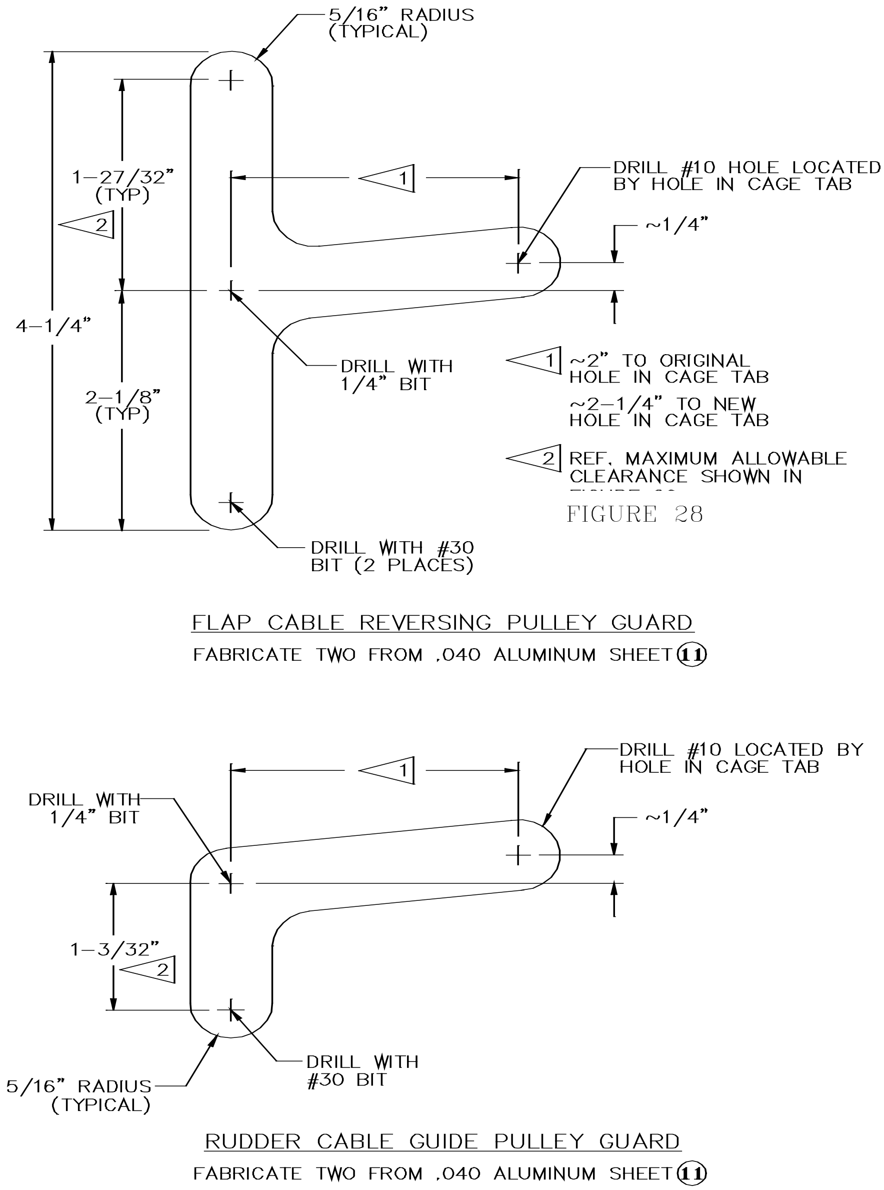
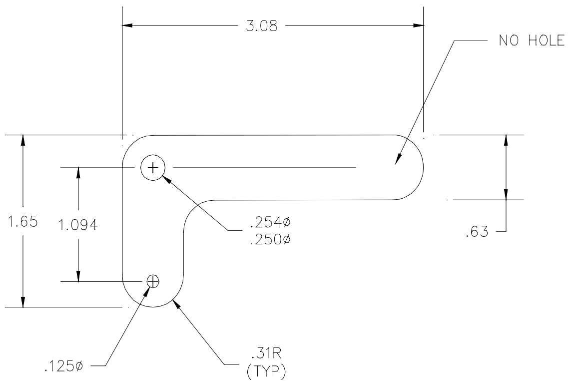


Figure 25: Flap Cable Reversing Pulley Guards

Page 55: The top figure in Figure 25 will be deleted and the reference to this cable guard in the paragraph will revised. (If you have already made your pulley guards per the steps defined in Revision A, the guards are acceptable. These newer revised guards are oriented a little better in the pulley cluster.) Figure 25 will be revised as shown:



RUDDER CABLE GUIDE PULLEY GUARD

FABRICATE TWO FROM
.040 ALUMINUM SHEET 11

Page 56-58: [redacted]

Page 79-80: In Step 21, the following note will be added to the end of the first paragraph; "Note: Do not worry that the cables do not meet the rudder arms on the same angular plane." The note on the bottom of page 80 should refer to Step 7 and not step 8

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Once your cable guards are made, install an **AN210-4A [87]** elevator cable reversing pulley and the two forward pulley guards using an **AN4-53 [126]** drilled shank bolt through the two welded bushings on the cage as shown in Figure 23, omitting the spacers for now. Using the two tabs for the aft pulleys, locate and mark the position of the 1/4" hole on the outboard guard. The dimension should be approximately the 2-5/16" in Figure 24. Drill this hole up to 1/4" diameter and make sure you can insert the **AN4-45 [128]** drilled shank bolt through the two tabs and the outboard pulley guard. Make any adjustments to the guard necessary to get the bolt to pass through to the tab on the other side.

Note Instead of the **AN210-4A** pulleys specified in the preceding paragraph and in Figure 23, some kits include **MS24566-4B** pulleys. Both types of pulleys are aircraft-grade, 3-1/2" phenolic pulleys and are thus completely interchangeable. Which pulley is supplied simply depends on current pricing and availability from our vendors.

The long bolts common to the pulleys are supported in the center by a square aluminum tube that is bolted to the aft center tab on the tail dragger gear truss as illustrated in Figure 23. You will use the outboard pulley guard as a drill guide to drill two 1/4" diameter holes in the **1/2" x 1/2" x .06 [51]** square aluminum tube. The first hole should be approximately 1/2" in from one end and the second hole near the center will be approximately 2-5/16" away. Use a drill press and make sure the hole is perpendicular to the tube.

Depending on your cage configuration, you may have to drill a hole in the center tab on the tail dragger gear truss. Even if your tab has the predrilled hole (first six cages only), due to weld tolerances, you might have to drill a new hole aft of the predrilled hole as shown in Figure 26. Begin by inserting the **AN4-45 [128]** drilled shank bolt into the aft pulley bracket tab on the right side if the cage. Install the second AN210-4A pulley, the two flap cable pulley guards, the **AN210-3A [86] rudder cable pulley** and the smaller cable guards as shown in Figure 23. Omit the spacers and the square aluminum tube for the time being.

Next, insert the **AN3-22A [98] bolt** through the pre-existing hole in the aft center tab. If there is no interference between the bolt and the AN210-4A pulley, you can use this pre-drilled hole. If there is interference, you will have to drill a second #10 hole aft of this hole as shown in Figure 26. This hole will never have a forward load on it. It will always have an aft compression load applied here from the aluminum tube that is supporting the elevator reversing pulley, so you can space the two holes close to each other allowing enough room for the square tube to clear the welds on the tab. Before drilling this hole, cut the aluminum tube to a length that will just clear the center tube supporting the tab and provide a slot running down the center that will clear the tab as shown in Figure 23.

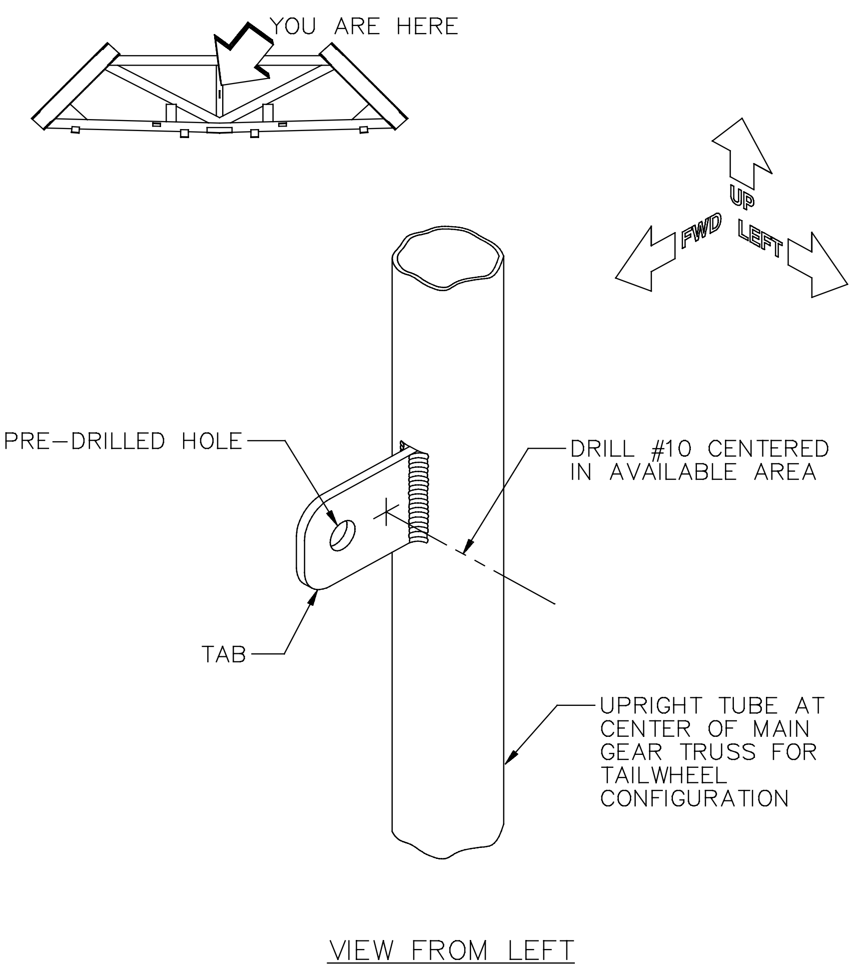

Figure 26: Hole in Tab on Fuselage Cage

Install the tube using the two long pulley bolts and note if the tube centerline falls above or below the tab hole. You may have to favor the new tab hole on the upper or lower side of the tab for best alignment. Transfer the hole location to the square tube and drill this **#10** hole now through both the tube and the tab. Transfer this hole to the arms on all four of the rudder cable and flap cable pulley guards. Deburr all the parts and apply the corrosion proofing of your choice.

You are now ready to align the pulleys and install the spacers that will position the pulleys in their correct locations. The spacer lengths given in Figures 22 and 23 may need to be adjusted slightly depending on your installation. It is recommended you use string to help align the pulleys and the control arms. Install all the pulleys, cable guards and the aluminum tube using the three bolts.

Review the cable installation for the flaps, rudders and elevator in Steps 22-24 for routing the string through the forward pulley group. Double check that you have met the minimum clearance between the elevator pulley and the aft rudder pulley, as shown in Figure 27. When you are confident of the positioning of the pulleys and the cable routing, begin by measuring one spacer length at a time and cutting this spacer length from the **3/8 x .035 6061 aluminum tubing [389]**. Use a tubing cutter to cut each spacer. Keep the end cuts flat and parallel to each other. Proceed across the entire pulley group until you have all the spacers made as shown in Figure 23.

After all spacers are cut and all your cable guards are ready, install all the pulleys, spacers, square tube and pulley guards as shown in Figure 23 using the appropriate AN4-53, AN4-45, AN960-416 **washers**[142], AN960D416 **aluminum washer** [151], AN310-4 castle nuts and an AN380-2-2 cotter pins.

Secure the aft end of the square tube and the pulley guards using the AN3-22A bolt, the appropriate spacers, an AN960D10 washer and an AN364-1032A nylon self-locking nut until snug. To not over tighten this bolt as you will just crush the aluminum tube.

Later, after the cables have been routed over the pulleys, use AN392-17 **clevis pins** [118] secured with AN380-2-2 cotter pins to retain the cables in the pulleys, as shown in Figure 28. Verify that the clevis pins are positioned a maximum of **.05"** from the edges of the pulleys to effectively retain the cables.

Completed: [ ]

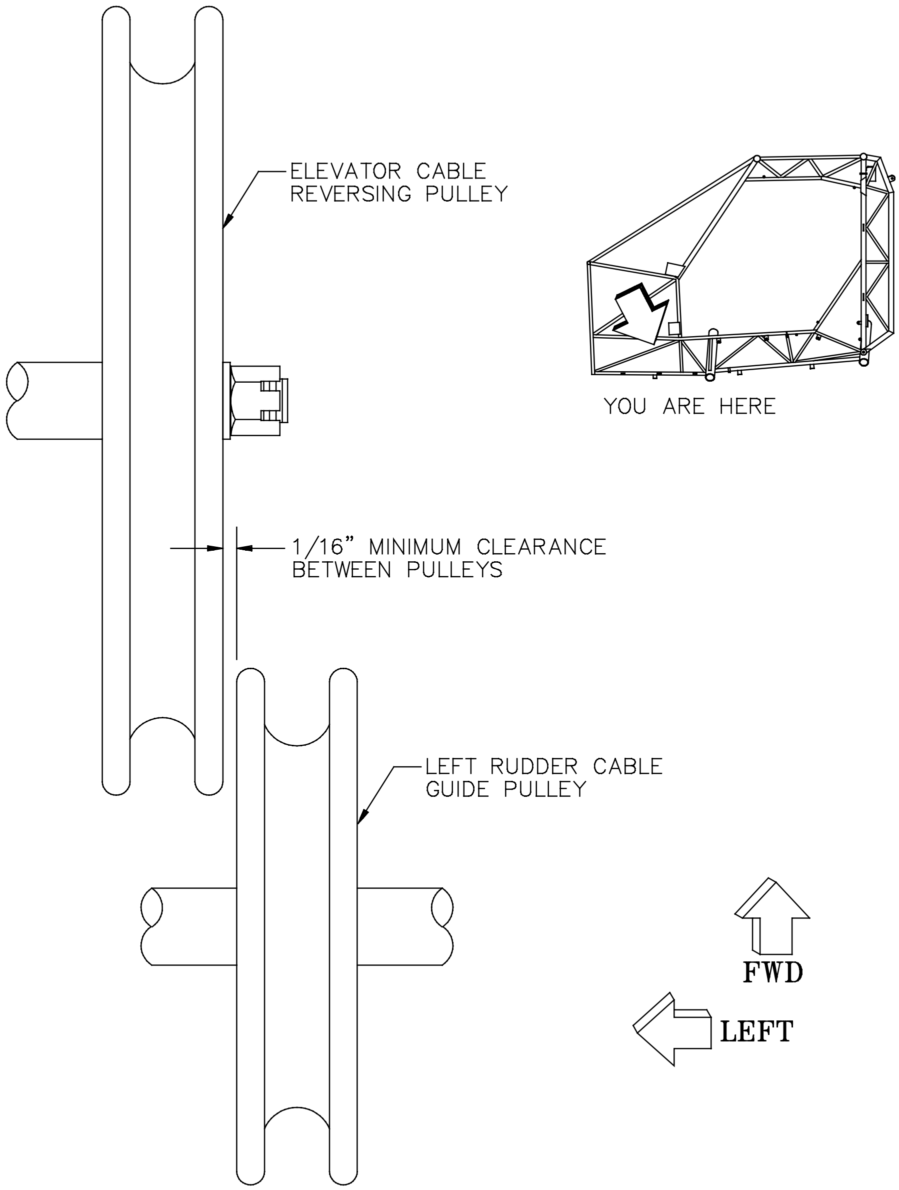

Figure 27: Proper Pulley Clearance

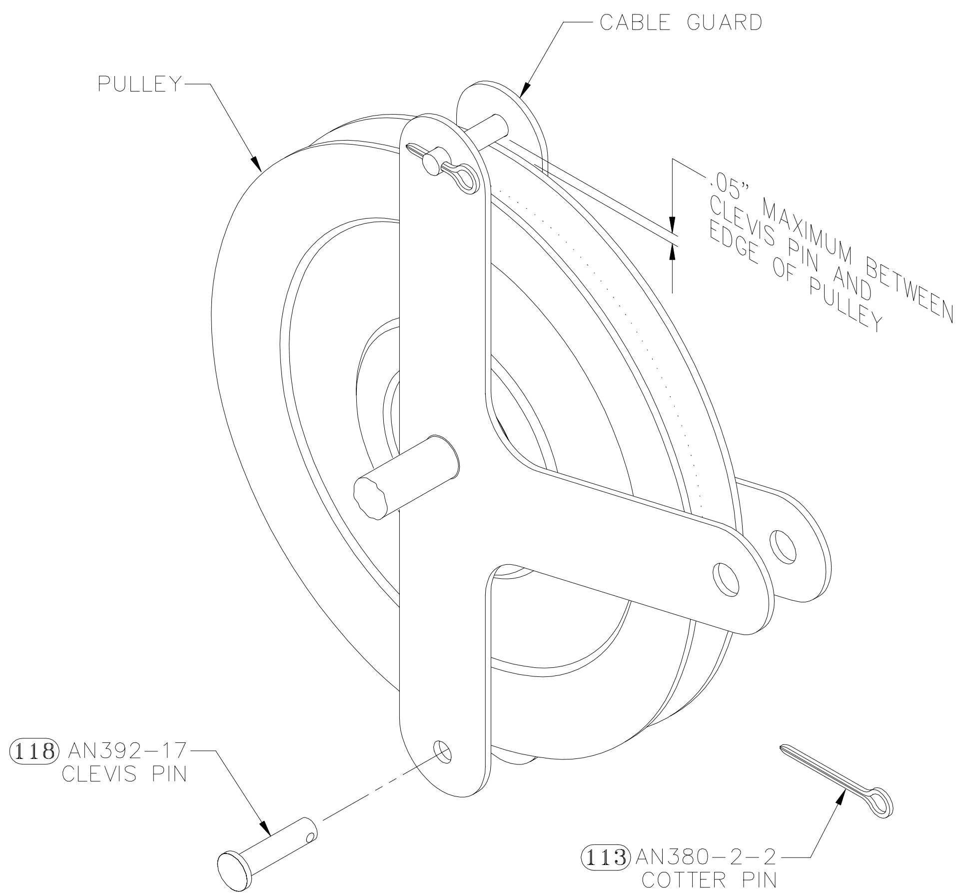

Figure 28: Typical Cable Retainer Installation

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Step 13: Install the Lower Forward Aileron Pulleys

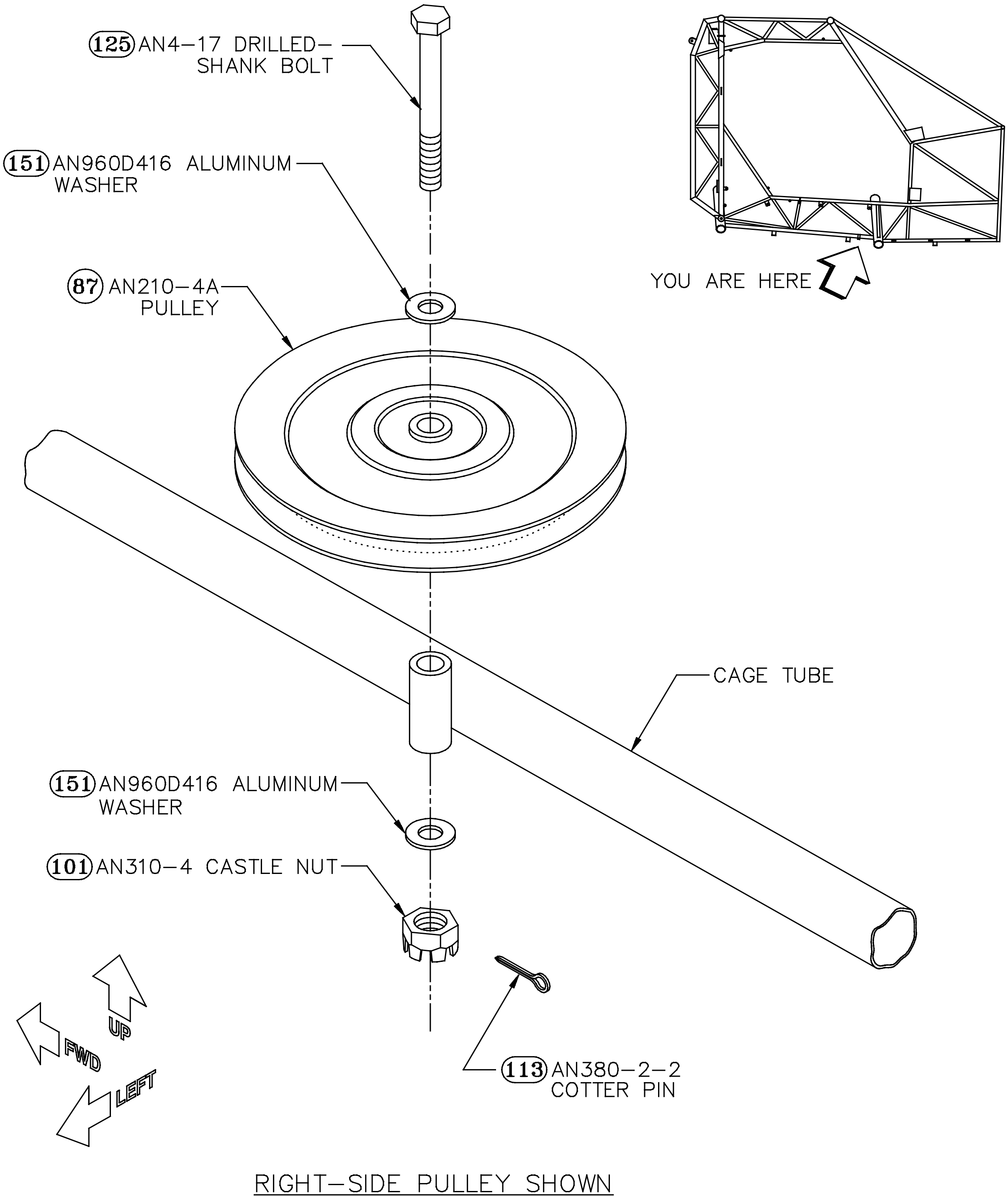

Figure 29: Forward Aileron Pulleys

On each side of the fuselage, mount an AN210-4A pulley to the bushing on the lower outboard fuselage cage longeron about 4-1/4" aft of the taildragger main gear truss. Mount the pulleys with AN4-17 **drilled-shank bolts** [125], AN960D416 aluminum washers, AN310-4 castle nuts and AN380-2-2 cotter pins, as shown in Figure 29. **The cable guard shown in Figure 30 and the pulley in figure 31 will be described later (in Step 48). In order to save time later, you may fabricate all these cable guards now and install the cables as described in their specific sections. This will eliminate the step of having to remove the guards and pulleys in order to install the cables later.**

Figure 30: Forward Aileron Pulley

> **Note** In rare instances, the cage tubes or the fuselage shell can interfere with the pulleys. If necessary, use washers to space the pulleys away from the cage tubes. Interference with the shell can be relieved by grinding away the interior laminates and foam core and then applying a one-layer bi-directional patch laminate.

Completed: [ ]

Step 14: Install the Lower Aft Aileron Pulleys

Mount MS20220-3 **pulleys** [158] to the bushings near the lower end of the aft main cage upright on each side, just outboard of the tricycle main gear sockets. Use AN5-20 **drilled-shank bolts** [133], AN970-5 **large washers** [155], AN960-516L **thin washers** [145], AN320-5 **castle nuts** [102] and AN380-2-2 cotter pins, as shown in Figure 33, to mount the pulleys

Completed: [ ]

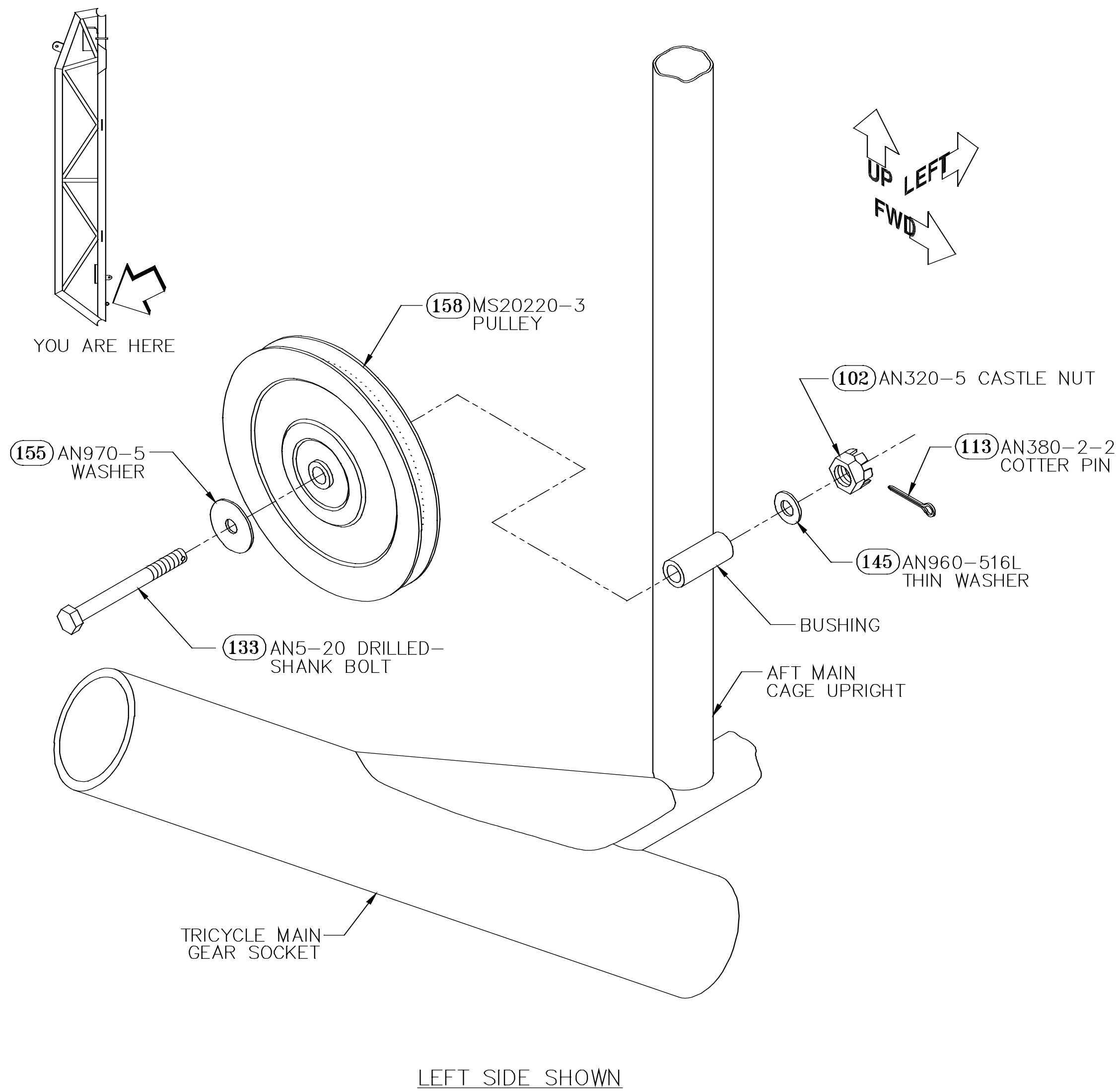

Figure 31: Lower Aft Aileron Pulleys

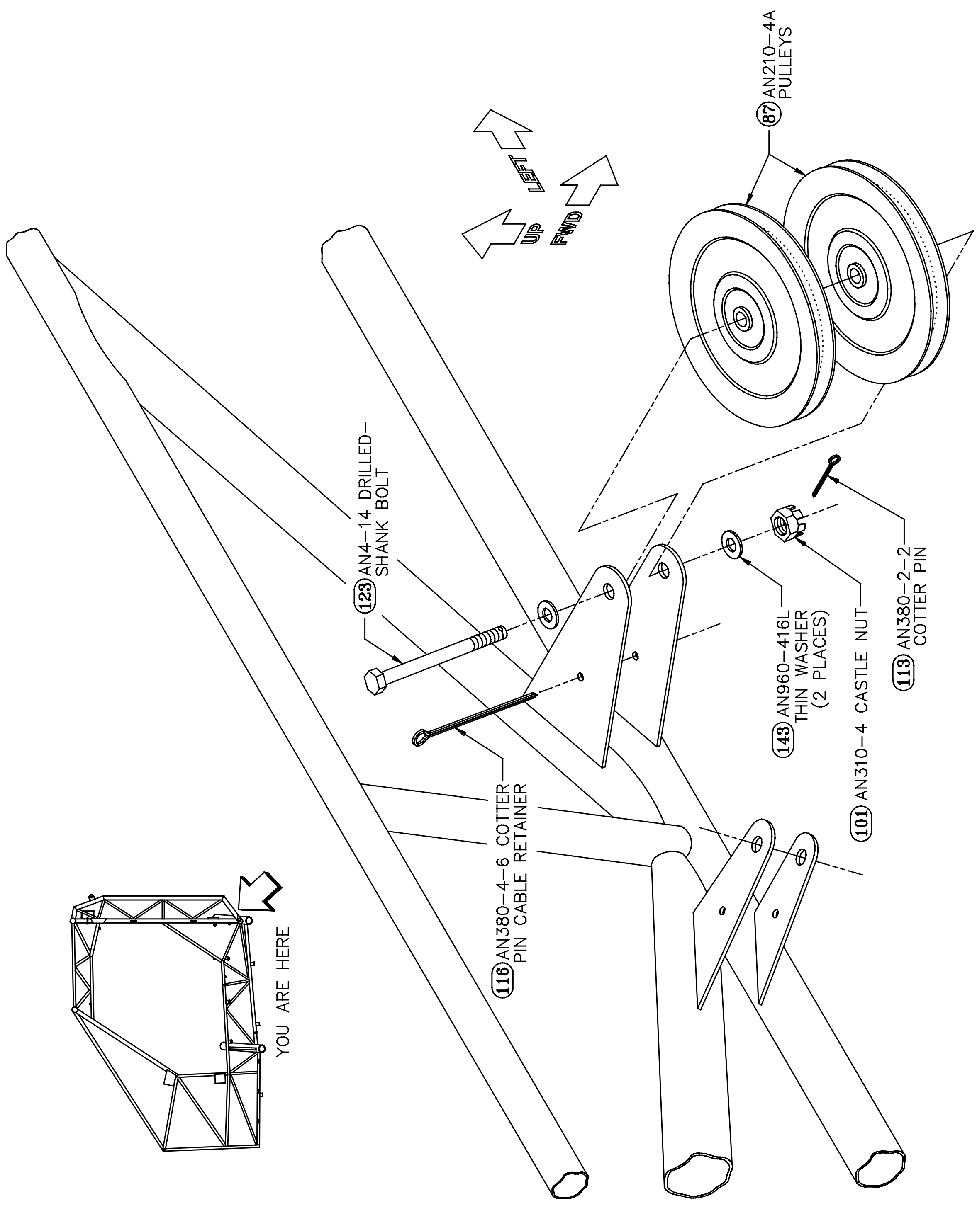

Figure 32: Center Flap Pulleys

Step 15: Install the Center Flap Pulleys

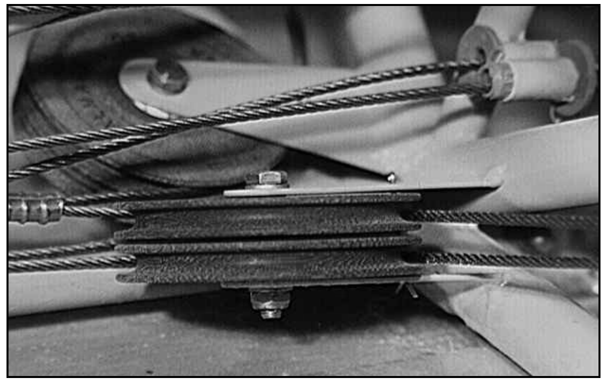

Figure 33: Center Flap Pulleys

Install two AN210-4A pulleys on each side near the fuselage centerline between the arms welded near the bottom of the tricycle main gear truss, as shown in Figure 32. Use AN4-14 [123] drilled-shank bolts, AN960-416L thin washers, AN310-4 castle nuts and AN380-2-2 cotter pins to mount the pulleys, as shown. After the flap cable installation has been completed, install the AN380-4-6 **cotter pin** [116] as a cable retainer (refer to Step 48).

Completed: [ ]

Step 16: Install the Lower Outboard Flap Pulleys

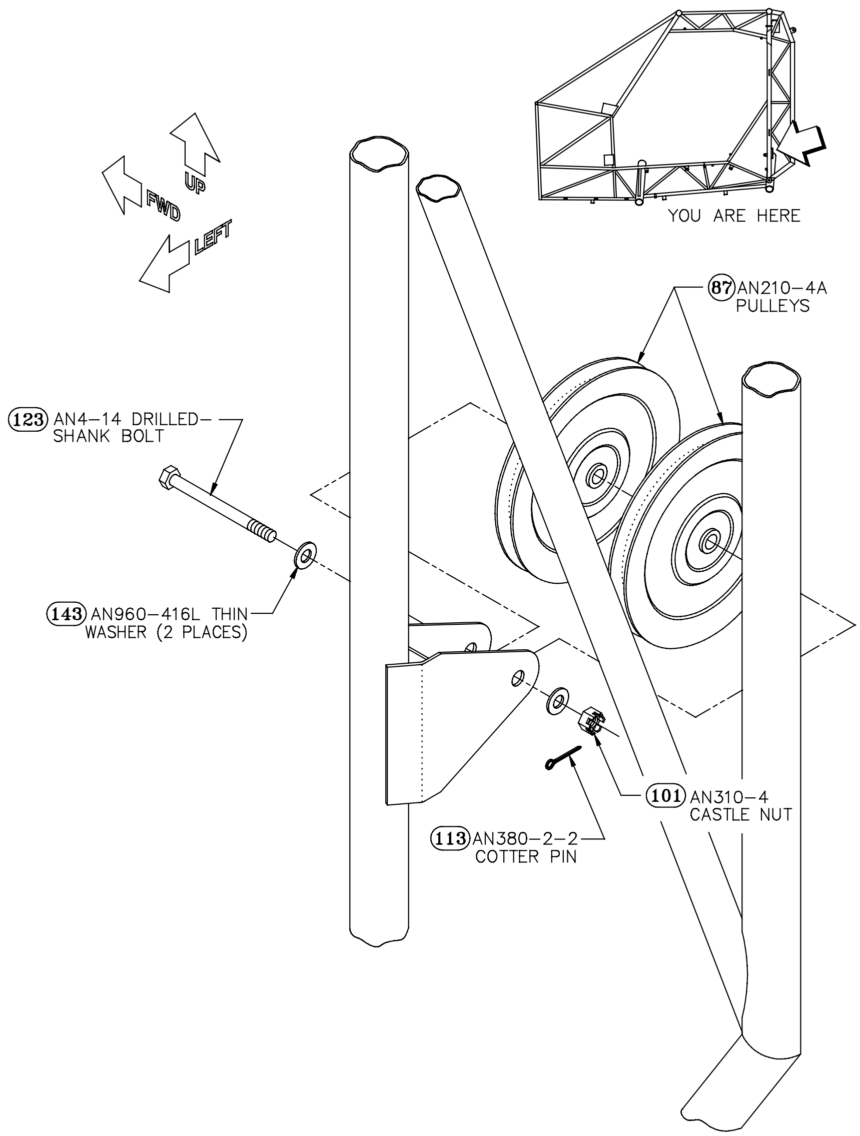

Figure 34: Lower Outboard Flap Pulleys

Mount two AN210-4A pulleys on each side between the arms on the inboard side of the main vertical tube just aft of the cabin door. Use AN4-14 drilled-shank bolts, AN960-416L thin washers, AN310-4 castle nuts and AN380-2-2 cotter pins to mount the pulleys, as shown in Figure 34.

Completed: [ ]

Step 17: Install the Upper Crossover Pulleys

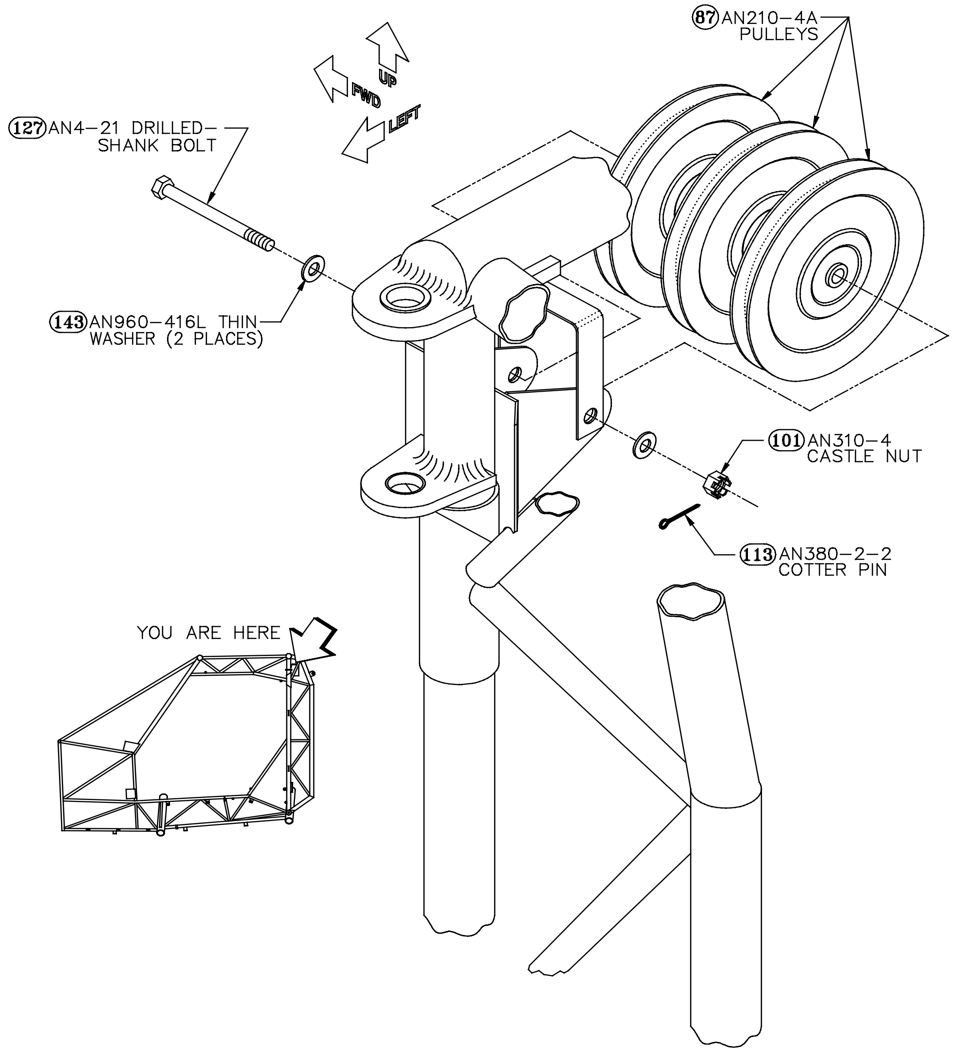

Figure 35: Upper Crossover Pulleys

Mount three AN210-4A pulleys between the arms at the upper aft corners of the fuselage cage on each side near the aft wing spar attach fittings, as shown in Figure 35. Secure the pulleys with AN4-21 **drilled-shank bolts** [127], AN960-416L thin washers, AN310-4 castle nuts and AN380-2-2 cotter pins.

Completed: [ ]

Step 18: Fabricate and Install the Bulkhead A Pulley Brackets

Two pairs of pulleys are installed on the aft side of Bulkhead A. Two of the pulleys guide the rudder control cables; the other two guide the elevator control cables. The pulleys are mounted in brackets fabricated from formed aluminum angle, as shown in Figure 36, and installed on the aft side of Bulkhead A, as shown in Figures 37 and 43.

To fabricate the Bulkhead A pulley brackets, first cut the **four** angles to length from the **.063" X 7/8" X 2-1/2" formed aluminum angle** [60], as shown in Figure 36. Separate the four angles into two pairs, and clamp each pair together with the narrow flanges of the angles nested together, as shown, and with the wide flanges spaced **1"** apart. Drill the two **#10** mounting holes through the base of each bracket pair and use AN3 bolts to bolt the two angles together.

Mark the side profile and the pivot hole and cable retainer hole locations onto the side of one of the angles of each pair. Clamp a 1"-thick wood block between the legs of the angles, and drill the holes all the way through both angles and the wood block from one side, being careful to keep the drill bit perpendicular. Use a hacksaw or a bandsaw to cut the angles to rough shape and then use a belt sander or files to finish the cuts. Also, cut the cable openings in the bases of the brackets, as shown, by first drilling **1/4"** holes in the corners of the openings and then removing the material between the holes. Round all corners, deburr and corrosion-proof the brackets.

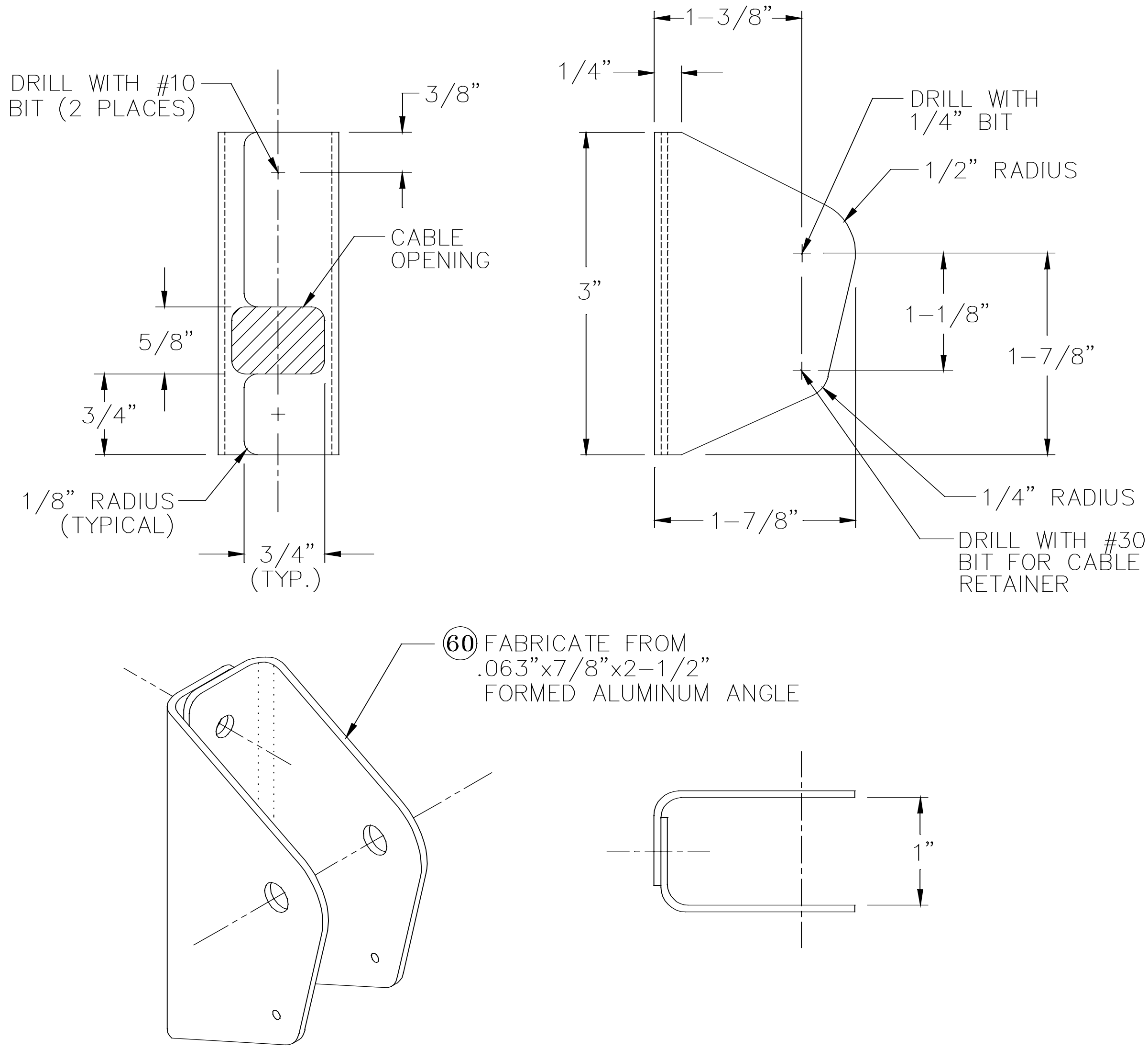

Figure 36: Bulkhead A Pulley Brackets

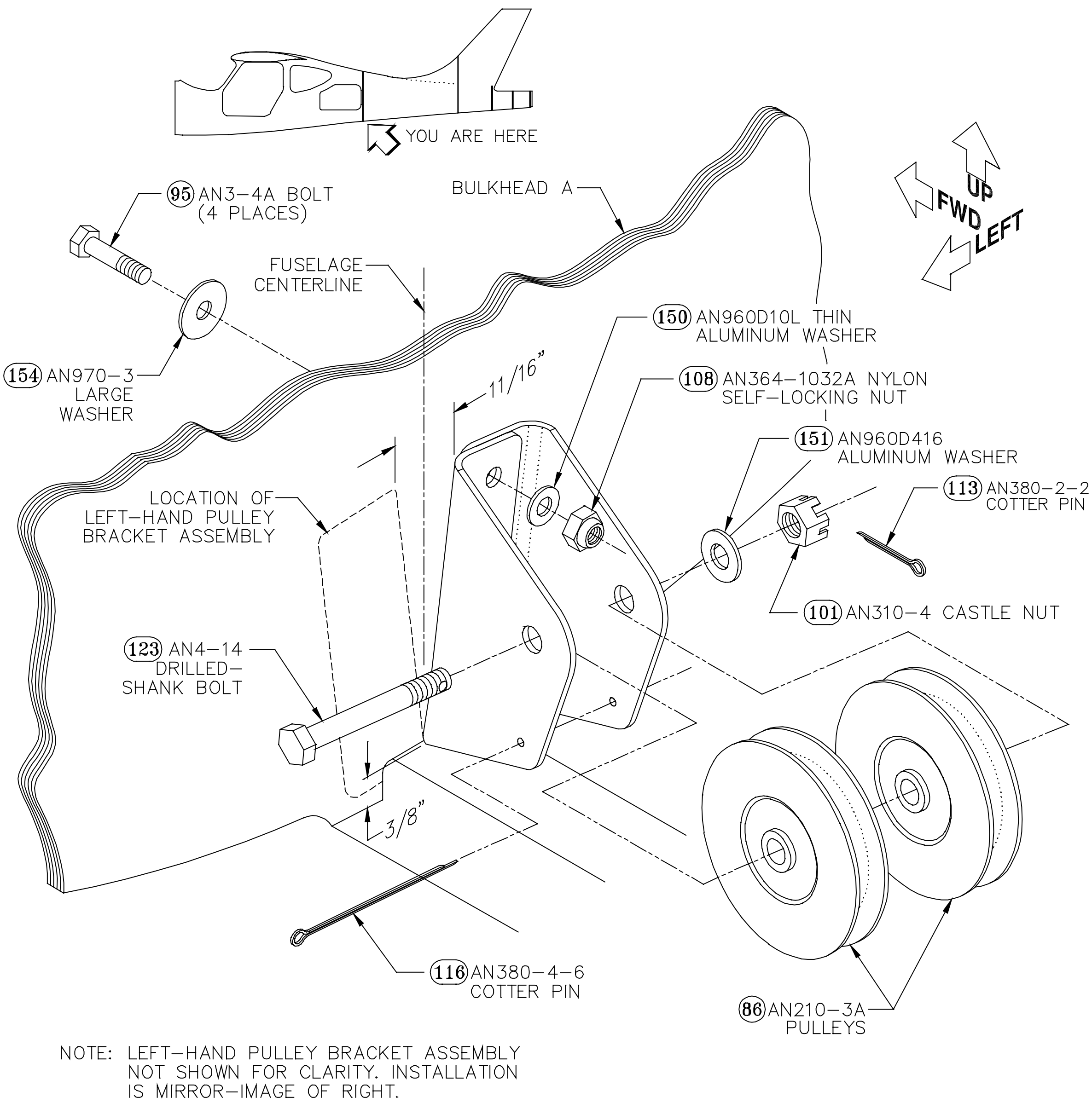

Figure 37: Bulkhead A Pulley Bracket

Hold the two pulley bracket assemblies in position **3/8"** above the fuselage belly on the aft side of Bulkhead A and centered laterally in the fuselage, as shown in Figures 37 and 43. Angle the bracket assemblies with their bottom ends touching each other and their top ends **11/16"** apart (the top end of each bracket assembly is 11/32" outboard of the fuselage centerline). Use the mounting bolt holes in the brackets as guides to drill **#10** mounting holes through Bulkhead A.

Mark around the insides of the cable openings in the brackets onto Bulkhead A. Remove the brackets and cut away the bulkhead inside the marked areas so the cables can pass through.

Mount two AN210-3A pulleys [86] between the legs of each pair of bracket angles, using an AN4-14 drilled-shank bolt [123], an AN960D416 **aluminum washer** [151], an AN310-4 castle nut and an AN380-2-2 cotter pin; place the heads of the bolts on the **inboard** sides of the brackets. Install AN380-4-6 **cotter pins** [116] as cable retainers with the heads on the **inboard** sides of the brackets; you'll probably have to flatten the heads of the cotter pins to eliminate interference between them when the brackets are installed.

Secure the brackets to the bulkhead with AN3-4A **bolts** [95], AN970-3 **large washers** [154], AN960D10L thin aluminum washers and AN364-1032A nylon self-locking nuts.

Completed: [ ]

Step 19: Install the Cable Fairleads

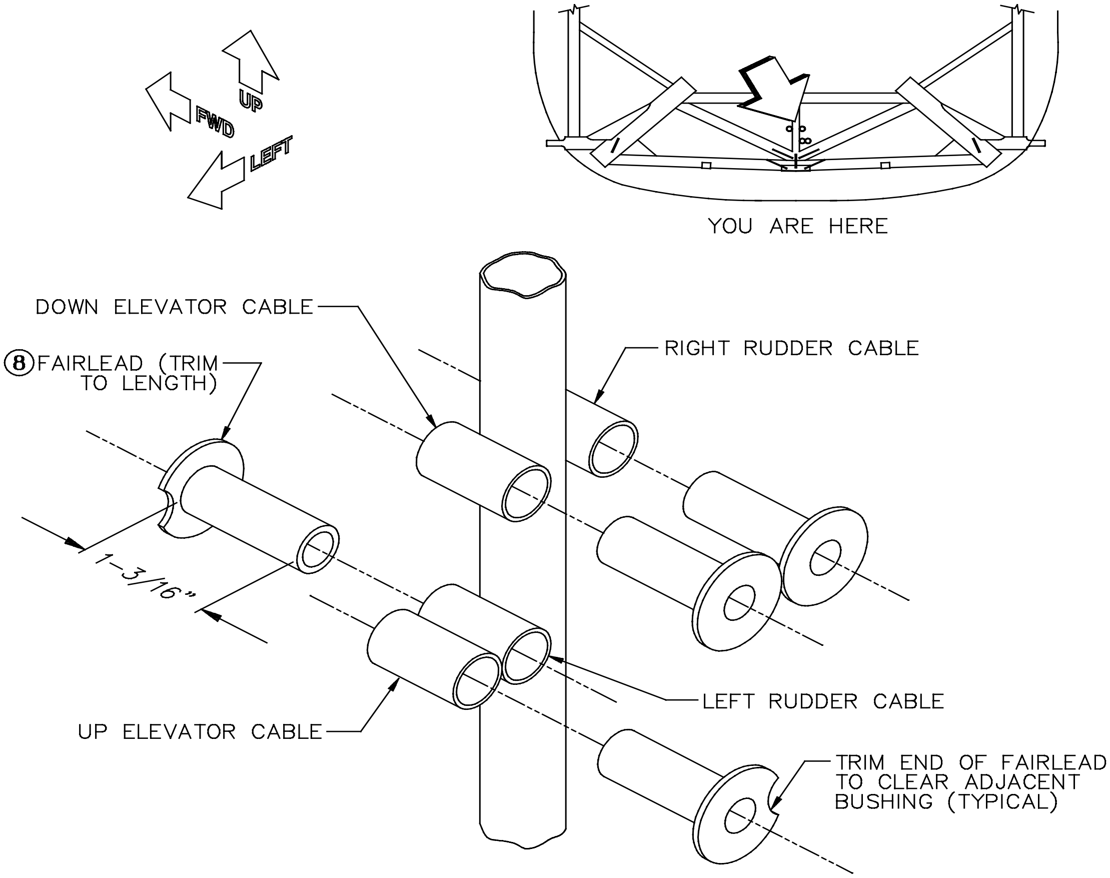

Figure 38: Cable Fairlead Installation

Four plastic **fairleads** [8] are installed in bushings welded to the aft end of the fuselage cage, as shown in Figure 38. The fairleads guide the rudder and elevator cables to provide proper clearance from the flap handle and control stick assemblies. Figure 38 also shows which fairlead guides each cable.

Cut the fairleads **1-3/16"** long, as shown. Relieve the "heads" of the left rudder cable and up elevator cable fairleads to clear the adjacent bushings in the fuselage cage.

Use a hammer to tap the fairleads into the bushings on the cage. Install the left rudder cable and up elevator fairleads from opposite ends of the cage bushings, as shown.

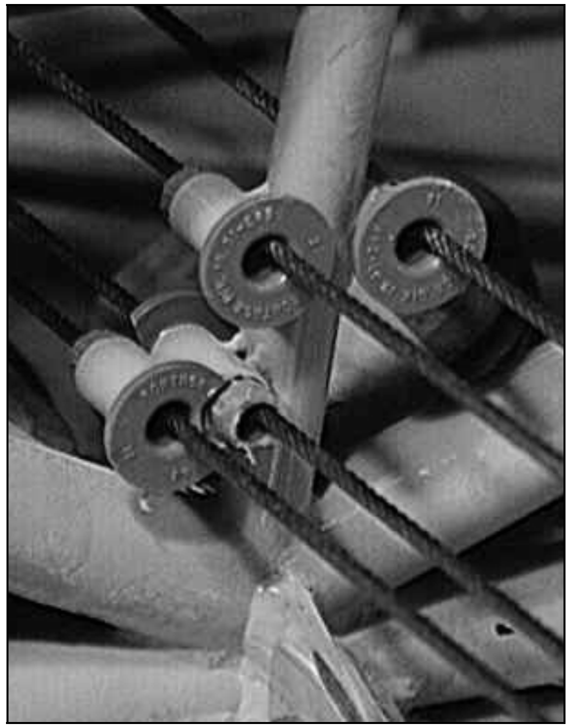

Figure 39: Cable Fairleads

Completed: [ ]

RUDDER CONTROL CABLES INSTALLATION

Figure 40 is a schematic of the rudder control cable system. The left rudder cable is routed aft from the actuator arm on the rudder control, under the small guide pulley in the forward pulley group (mounted in Step 12) and then through a fairlead at the aft end of the fuselage cage. The right cable is routed from the rudder control directly to its fairlead. From the fairleads, the cables run aft under the Bulkhead A pulleys to the horns on the rudder yoke. A turnbuckle is incorporated in the middle of each cable run (in the area just aft of the fuselage cage) for easy adjustment. Springs between the rudder controls and the fuselage cage maintain tension on the cables.

Note Before beginning installation of the rudder and other control cables, we recommend reviewing the general procedures described in "Control Cables" in "Section II: Tools and Techniques."

To reduce friction, be sure to add a small drop of grease on all moving terminal ends of the rudder control cable assemblies.

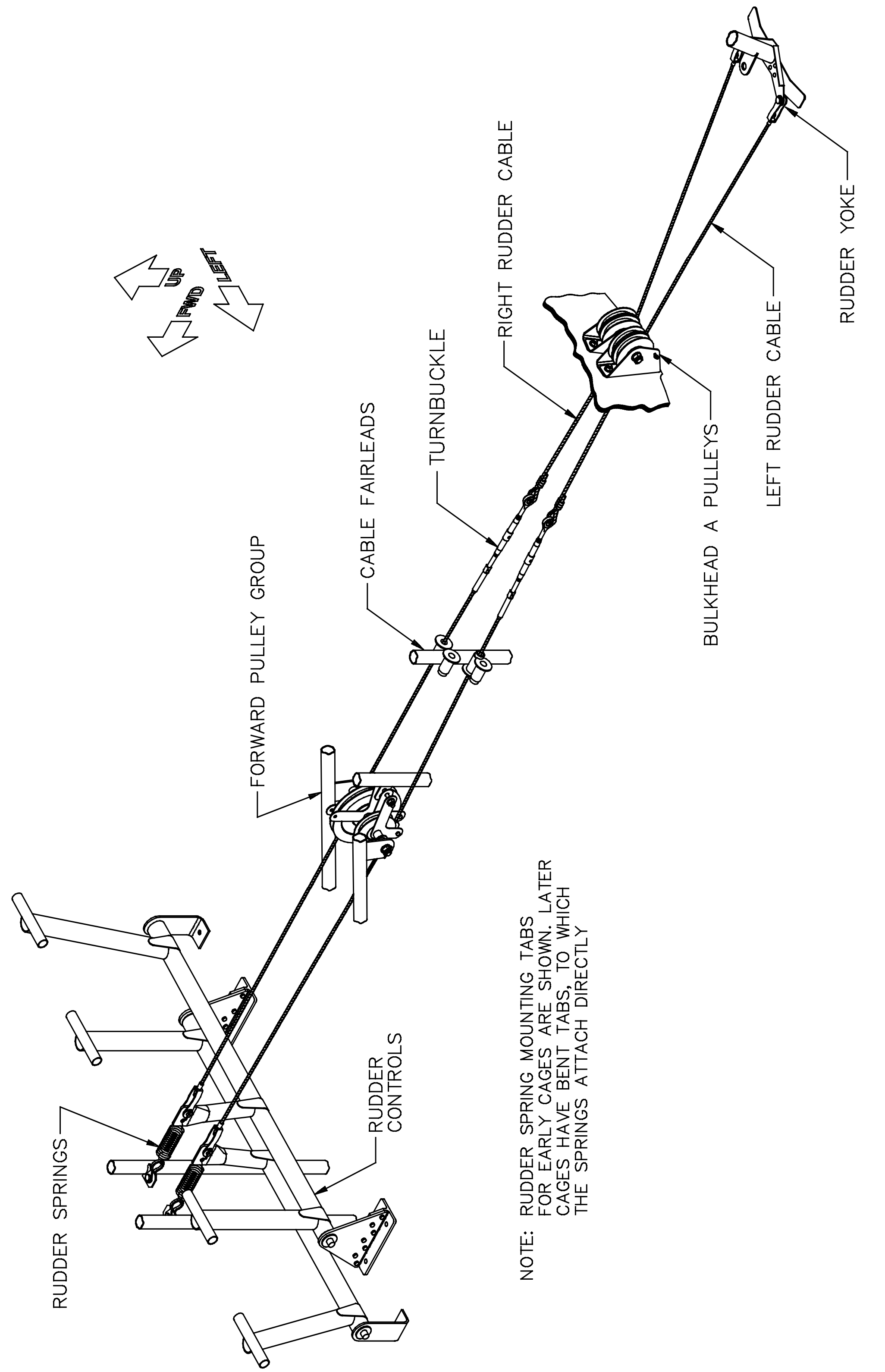

Figure 40: Rudder Control System

Step 20: Install the Forward Rudder Cables

Fasten the strap shackles at the ball ends of the **forward rudder cables** [63] to the **aft** holes in the rudder control uprights with AN393-13 **clevis pins** [119.1], AN960-10L thin washers and AN380-2-2 cotter pins, as shown in Figure 41. (To identify the forward rudder cables, they are about 69-1/2" long, measured from the attach holes in the strap shackles to the ends of the swaged turnbuckle ends.)

Note The space between the arms of the strap shackles can be increased or decreased by bending the arms apart with pliers or squeezing them together in a vise to more closely fit their attach points.

Route the left cable aft, under the small, AN210-3A guide pulley in the forward pulley group and then through the fairlead at the aft end of the fuselage cage. Route the right cable aft from the pedal stem directly to the fairlead. See Figure 38 to choose the correct fairlead for each cable.

Hint The swaged ends of the cables are a tight fit through the fairleads; you can use a 21/64" or 11/32" drill bit to ream the fairleads, if you wish, to make the cable installation easier.

Thread the swaged turnbuckle ends of the forward rudder cables into MS21251-B5S **turnbarrels** [159], as shown in Figure 41. Thread MS21255-5LS **cable eyes** [160] into the other ends of the turnbarrels. Adjust each turnbuckle so that all of the threads on both ends just disappear into the turnbarrel and both ends of each turnbuckle are threaded on an equal amount.

Note The swaged turnbuckle ends of the forward rudder cables have right-hand threads. The MS21255-5LS cable eyes have left-hand threads. The **externally-grooved** end of the turnbarrel is the end with the **left-hand** threads.

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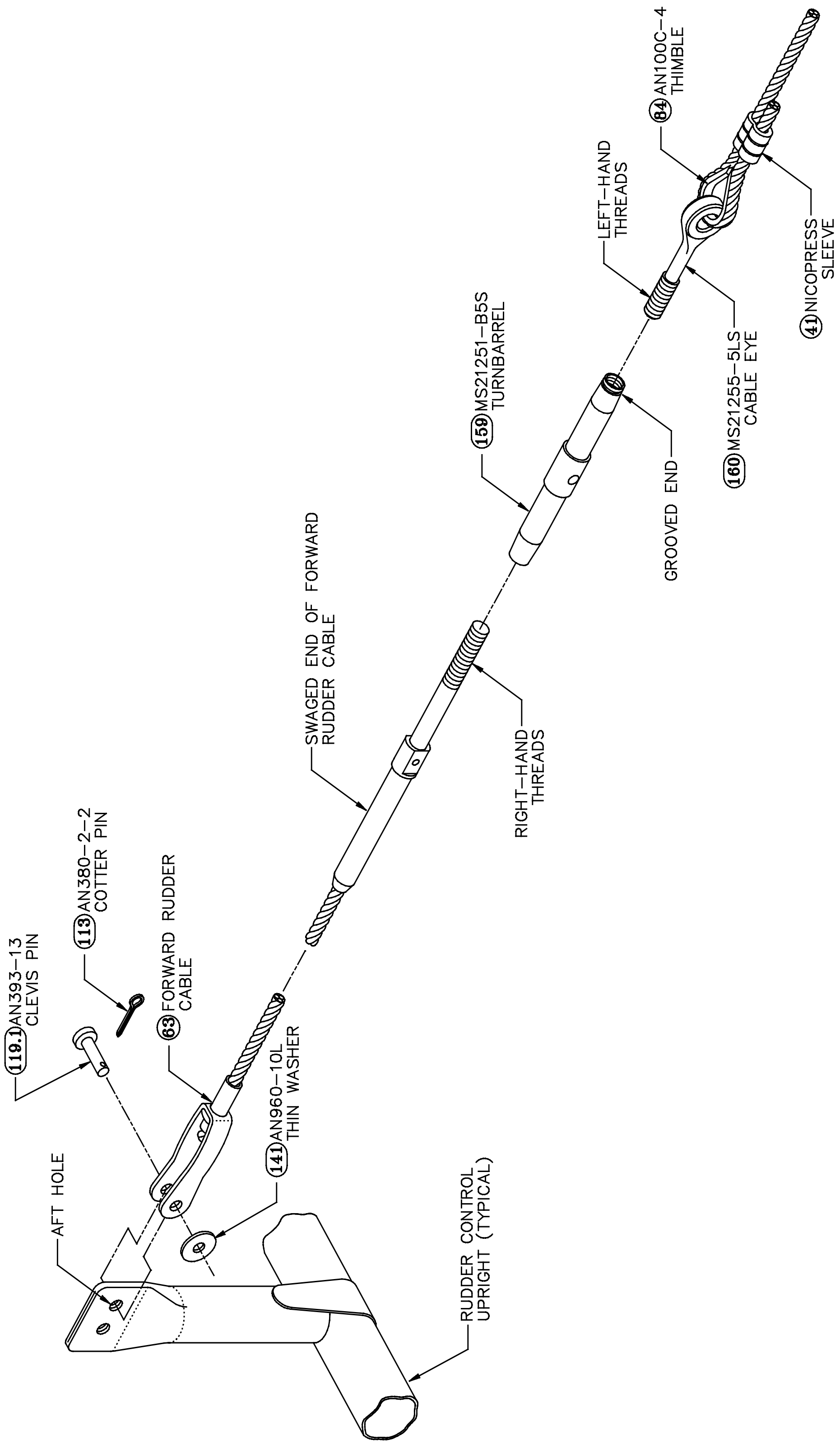
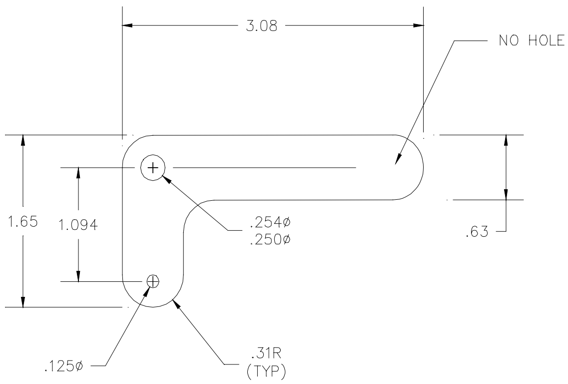


Figure 41: Forward Rudder Cable Installation

Page 55: The top figure in Figure 25 will be deleted and the reference to this cable guard in the paragraph will revised. (If you have already made your pulley guards per the steps defined in Revision A, the guards are acceptable. These newer revised guards are oriented a little better in the pulley cluster.) Figure 25 will be revised as shown:



RUDDER CABLE GUIDE PULLEY GUARD

FABRICATE TWO FROM
.040 ALUMINUM SHEET (11)

Page 56-58: The reference to "drill this up up to 1/4" diameter" in the first paragraph will be changed to "drill to 1/4" diameter". A general procedure note of how to drill the holes in the square tube will be as follows. Mark a centerline on the 1/2" square tube. Using a drill press, drill a 1/4" diameter hole on end located 1-1/4" in from the end. Insert the forward pulley bolt through the cage bushing and then through the tube and across to the other bushing. Install the AN4-45 bolt through the tabs on the cage. Swing the tube up until it contacts the AN-45 bolt and mark this location on the tube. (Note: the bolt path would actually be an arc centered about the AN4-53 bolt, so the projected contact point with the centerline of the 1/2" tube will be slightly aft of this mark by about .015".) Use a drill press to drill this hole. It is also OK to open these holes up to .265 diameter if necessary. Set the tube back in the cage (off to one side of the aft center tab and install both bolts. Use the tab to drill the tube at this location.
With regards to pulley cable retainers, the stiffer the retainer is, the more clearance you may allow between the retainer the edge of the pulley. Cotter pins and the welded brackets are your stiffest kinds. The aluminum straps should be held closer since the thin aluminum strap may deflect more that others.

Page 79-80:

Page 100-102: If you plan on folding the wings on the Sportsman, the lower trailing edge of the wing strut will need to be cut back more to clear the side of the composite fuselage. These dimensions can vary somewhat between aircraft. The two dimensions given in Figure 54 on page 102 will be changed to 4-1/2" and 1-5/8". When folding the wings for the first time take note of the clearance between the strut and the fuselage.

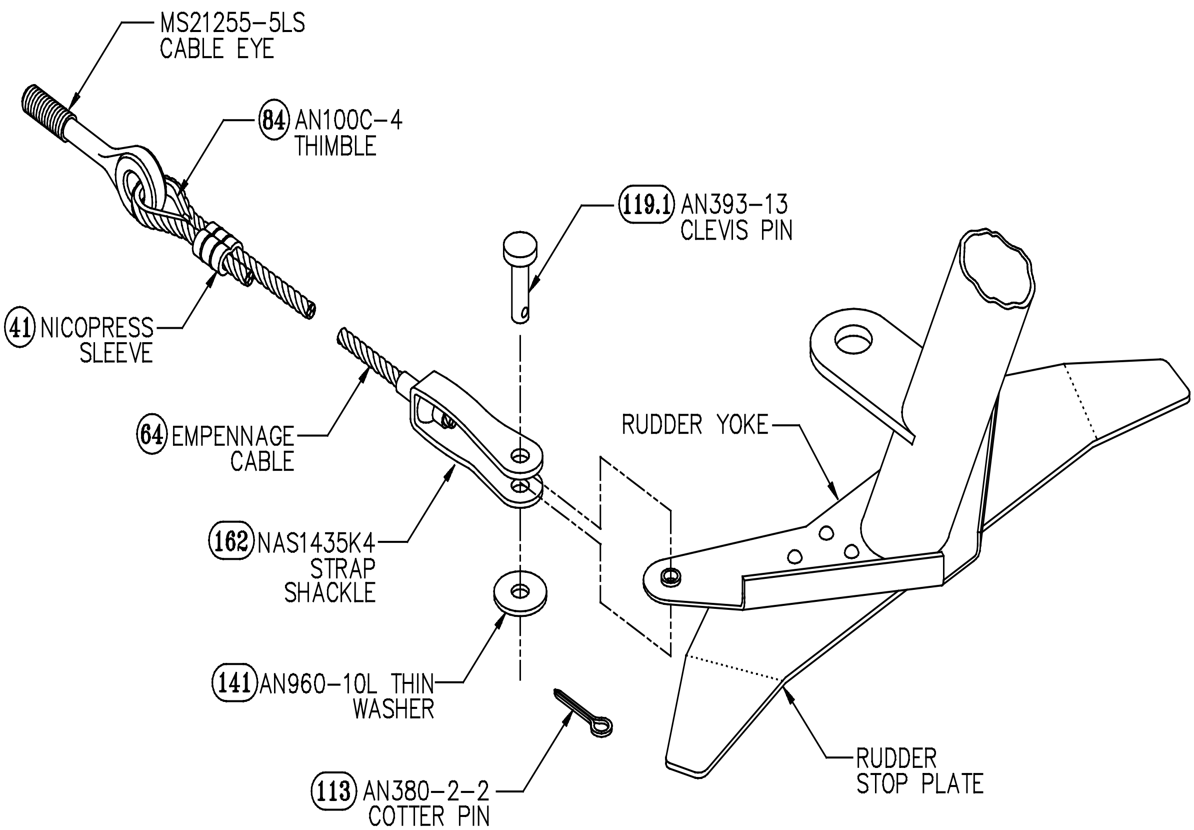


Figure 42: Aft Rudder Cable Attachment to Rudder Yoke

Step 21: Complete the Rudder Cable Installation

Slide NAS1435K4 **strap shackles** [162] onto two **empennage cables** [64], as shown in Figure 44, until the ball ends of the cables settle in the recesses of the shackles. (The empennage cables are about 10' long, with a swaged ball on one end and nothing on the other.) Use an AN393-13 clevis pin, an AN960-10L thin washer and an AN380-2-2 cotter pin to fasten the strap shackle end of an empennage cable to each arm of the rudder yoke weldment.

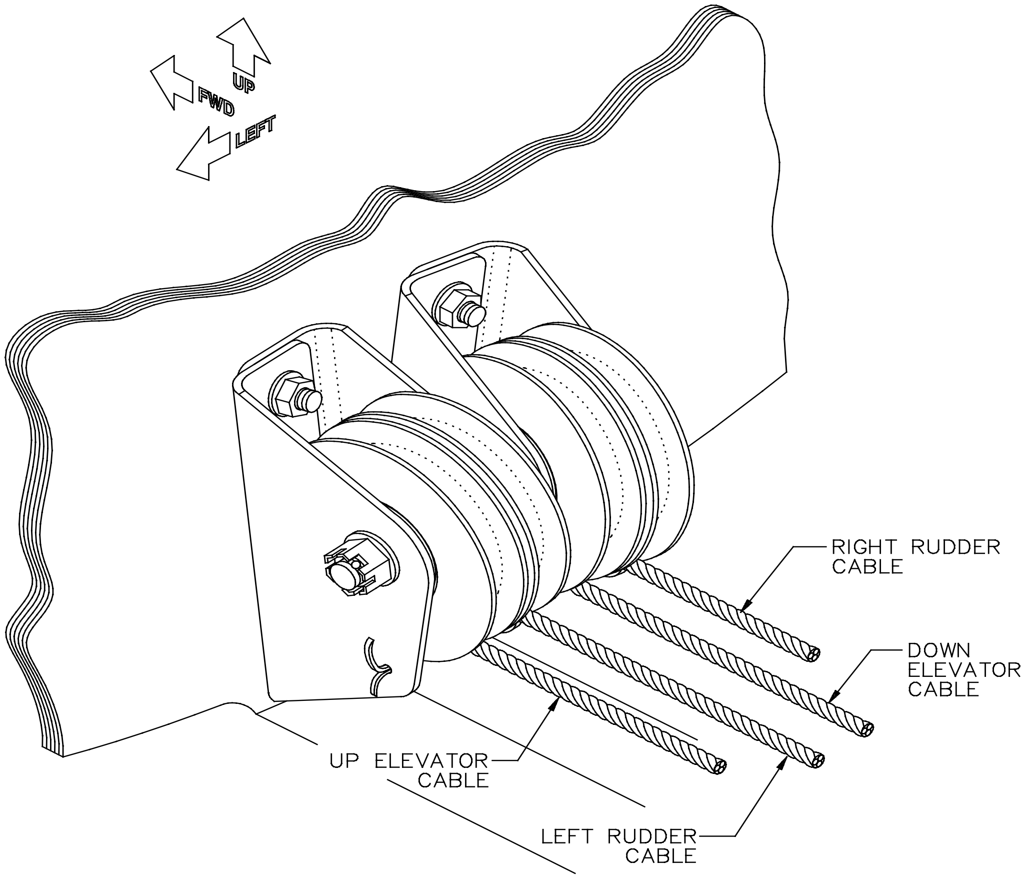


Figure 43: Cable Routing over Bulkhead A Pulleys

Route the two empennage cables forward to the Bulkhead A guide pulleys. Route the right cable under the **right** pulley in the **right-hand** pair of guide pulleys, as shown in Figure 45; route the left cable under the **right** pulley in the **left-hand** pair of guide pulleys.

Secure the rudder and the rudder pedals in the neutral positions.

> **Note** Refer back to Step 8 of this section for a description of the rudder pedal-neutral position.

Hint For the purposes of this step, you can assume that, when the rudder is in the neutral position, the forward rudder skin is aligned with the leading edge of the vertical fin; use tape to secure the rudder to the fin. (The true rudder-neutral position won't be known until the airplane has flown and any necessary rudder trim tab installed and adjusted.) **Refer to Figure 14 for the rudder-pedal-neutral positions and temporarily secure them there.**

Pull the empennage cables forward from the Bulkhead A pulleys to the cable eyes in the aft ends of the forward rudder cable turnbuckle assemblies, being careful to properly match up the cables, right to right and left to left. Insert an AN100C-4 **thimble** [84] into each of the cable eyes in the forward cable turnbuckles. Slip a **NicoPress sleeve** [41] over the end of each empennage cable, thread the end of the cable around the thimble in the cable eye and back through the sleeve. Pull each cable taut and complete the NicoPress splice as described in "SECTION II: TOOLS AND TECHNIQUES."

Hint We recommend using 1/8" cable clamps (available at any hardware store) to temporarily secure the control cables during initial fit-up. The clamps make it easy to adjust the lengths of the cables and to keep the adjustment from slipping. (Don't tighten the clamps too much, however; light pressure is all that's needed. Over-tightening could kink the cable, which would ruin it.) Once the proper lengths of the cables have been determined, compress the NicoPress sleeves to finalize the cable installation, and then remove the temporary cable clamps

Remove whatever temporary fixtures you used to secure the rudder and rudder pedals in the neutral positions.

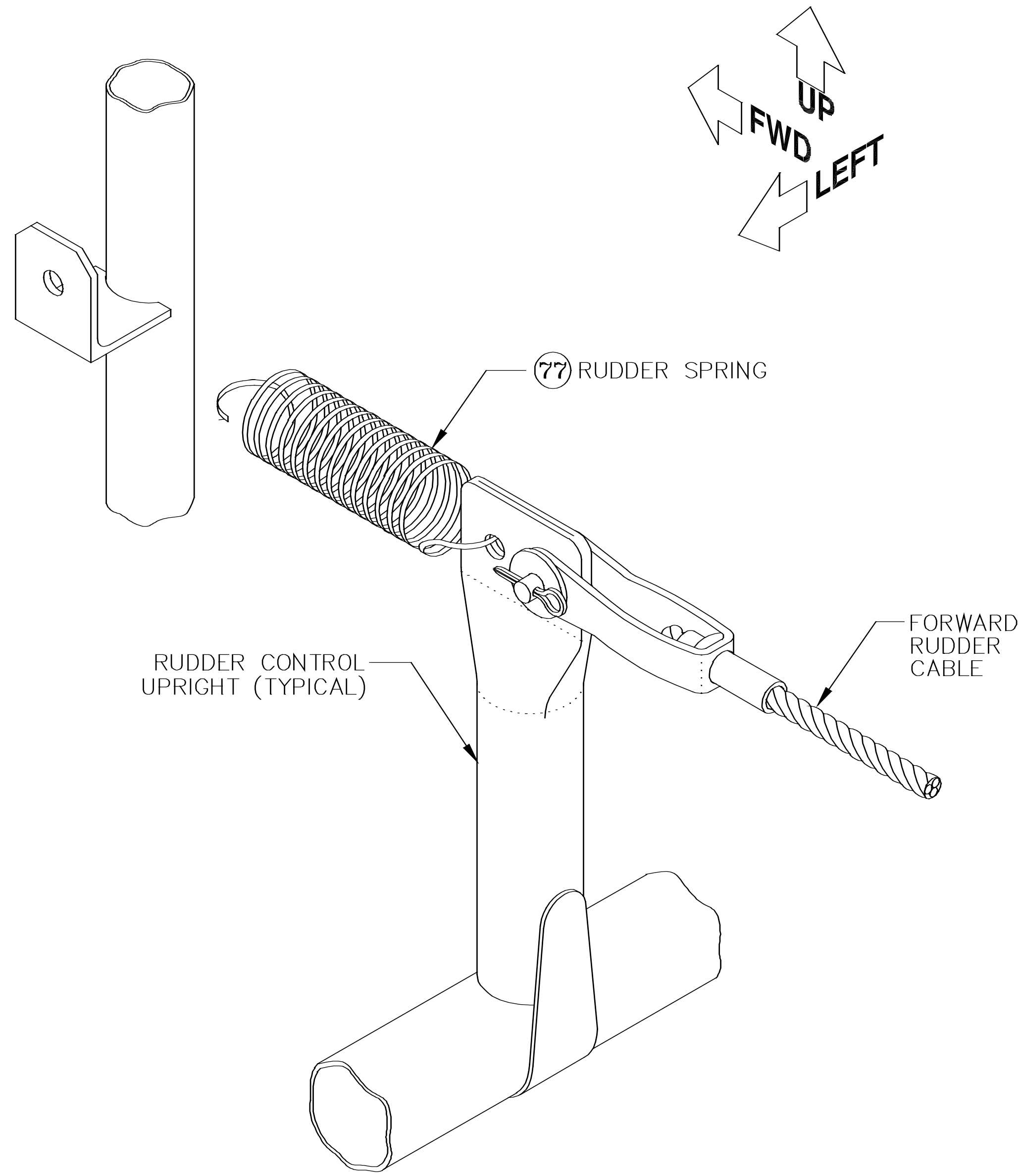


Figure 44: Rudder Control Spring Installation

Install the **rudder control springs** [77] between the forward holes in the rudder control uprights and the fixed tabs on the fuselage cage, as shown in Figure 44

Adjust the cable turnbuckles so that the rudder pedals are neutral and the rudder is centered when there is no force on either pedal.

Note If you encounter difficulty stretching the springs to the cage tabs on later kits, make **extension links** from .063" thick steel sheet to fit between the springs and the cage tabs. A link that has worked for us is shown in the figure below. Drill **3/16"** holes in both ends of the links and fasten them to the cage tabs with AN3-4 bolts. By making the extension links extra long and drilling a series of mounting bolt holes, the links can also provide an additional adjustment point in the system besides the turnbuckles. (The forward ends of the links will eventually have to be trimmed off, however, to provide clearance for the firewall.)

Note The turnbuckles will be safetied during final assembly, when the aircraft is being prepared for the first flight.

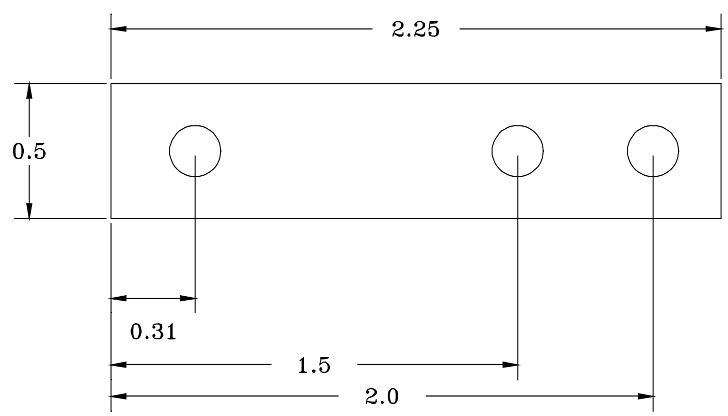


Figure showing typical extension link.

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Elevator Pushrod and Control Cables Installation

The elevator bellcrank (mounted on Bulkhead C) is actuated by cables routed from the actuation stem on the elevator/aileron control yoke; a pushrod mounted between the bellcrank and the elevator horns completes the elevator control system (see Figure 45). The **up** elevator cable runs forward from the actuation stem to the elevator cable reversing pulley described in Step 12; the up cable then runs aft through a fairlead to the Bulkhead A pulleys and then to the **left** side of the elevator bellcrank. The **down** elevator cable routes directly aft from the actuation stem through a fairlead and the Bulkhead A pulleys to the **right** side of the elevator bellcrank.

To reduce friction and wear, be sure to add a drop of grease to the terminal ends of all cable assemblies.

Note When you have finished the procedures in this section, you will be ready to mount the wings to the fuselage, after which your first task will be to drill the outboard ends of the wing struts for attachment to the strut attach arms in the wing. To accomplish this task, you will need the Wing Strut Drill Jig Kit (P/N 981-03000-01), which is available on a rental basis from Glasair Aviation, LLC. If you have not yet ordered the drill jig kit, do so now so that you will have it on hand when you need it.

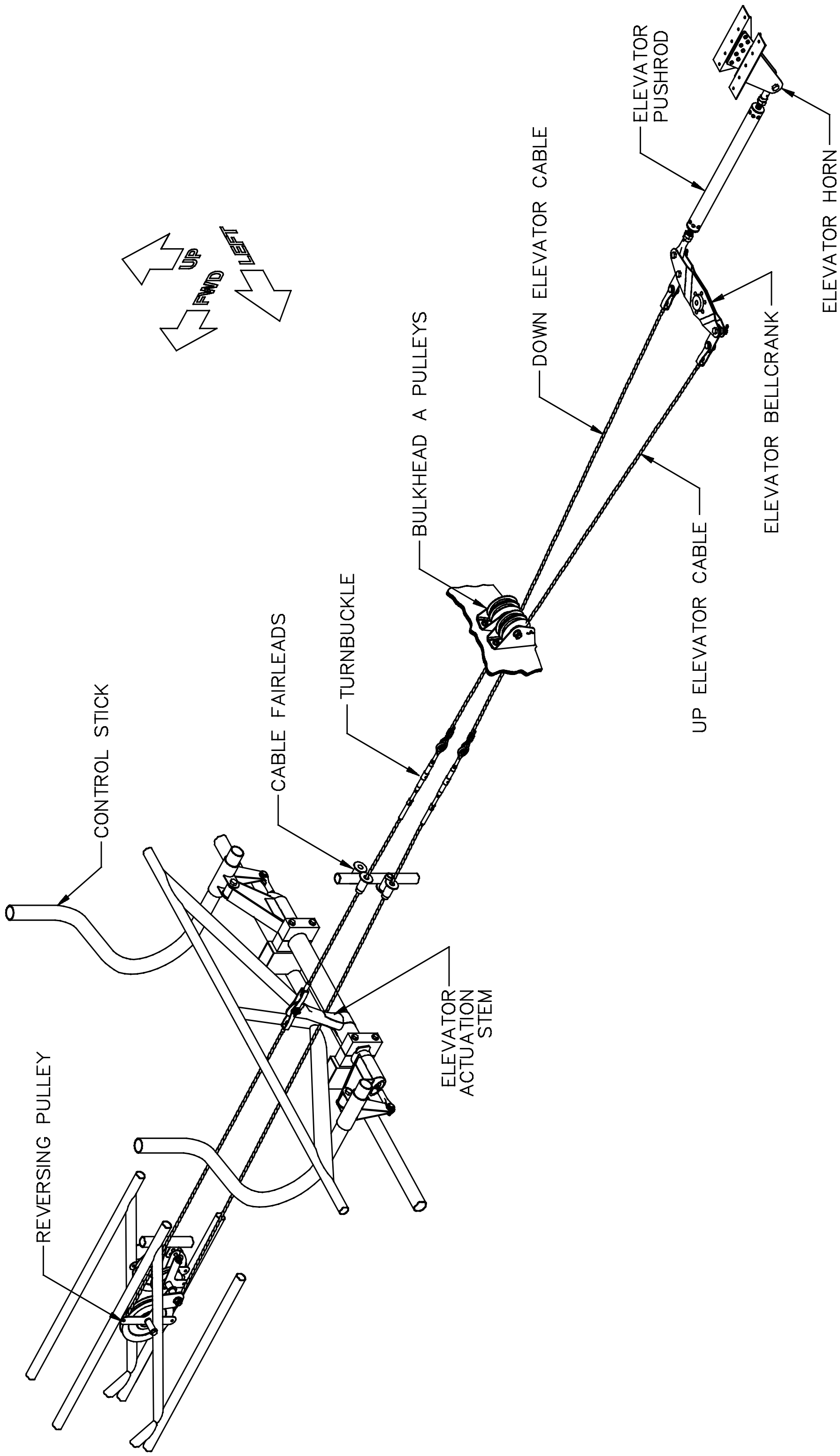

Figure 45: Elevator Control System

Step 22: Fabricate the Elevator Pushrod

The elevator pushrod is fabricated from **3/4" aluminum tubing** [80], as shown in Figure 48 (the tubing is 6061-T6 with a .058" wall thickness). Six **monel blind rivets** [76] are used at each end of the elevator pushrod to secure a **3/4" rod end insert** [43] in place.

In order to install the elevator pushrod, holes should have been drilled through Bulkheads D and E. These holes were specified and detailed in the bulkhead templates, or come predrilled in Sportsman Pre-Built Fuselage Kits.

Secure the elevator bellcrank in the neutral position. In the neutral position, a line through the attachment holes for the **up** elevator cable at the **left** end of the bellcrank and for the elevator **pushrod** at the **right** end is aligned parallel to the bellcrank brackets, as shown in Figure 46. (Use duct tape, safety wire, string, clamps or whatever works best for you to secure the bellcrank.)

Note The **left** arm of the bellcrank has a single hole for attaching the **up** elevator cable. The **right** arm of the bellcrank has two holes: the inboard, 3/16"-diameter hole is for attaching the **down** elevator cable; the outboard, 1/4"-diameter hole is for attaching the pushrod.

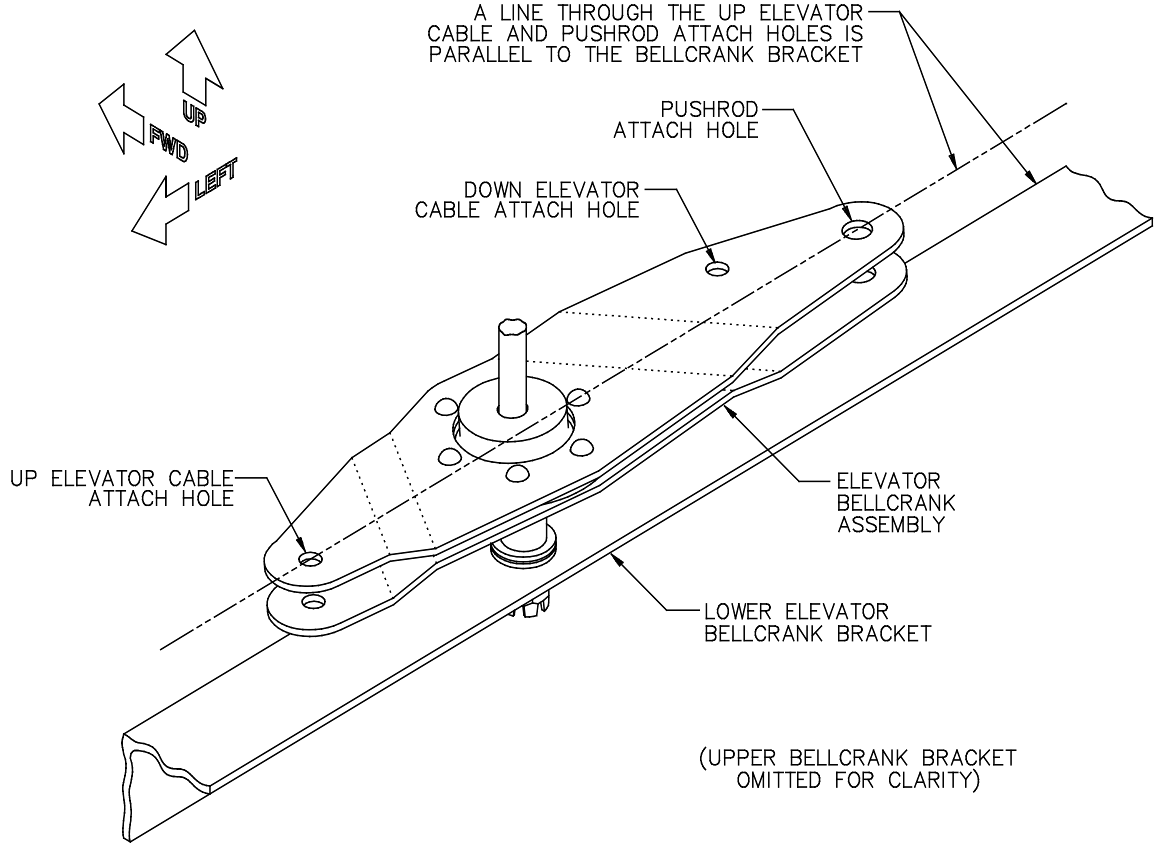

Figure 46: Elevator Bellcrank Neutral Position

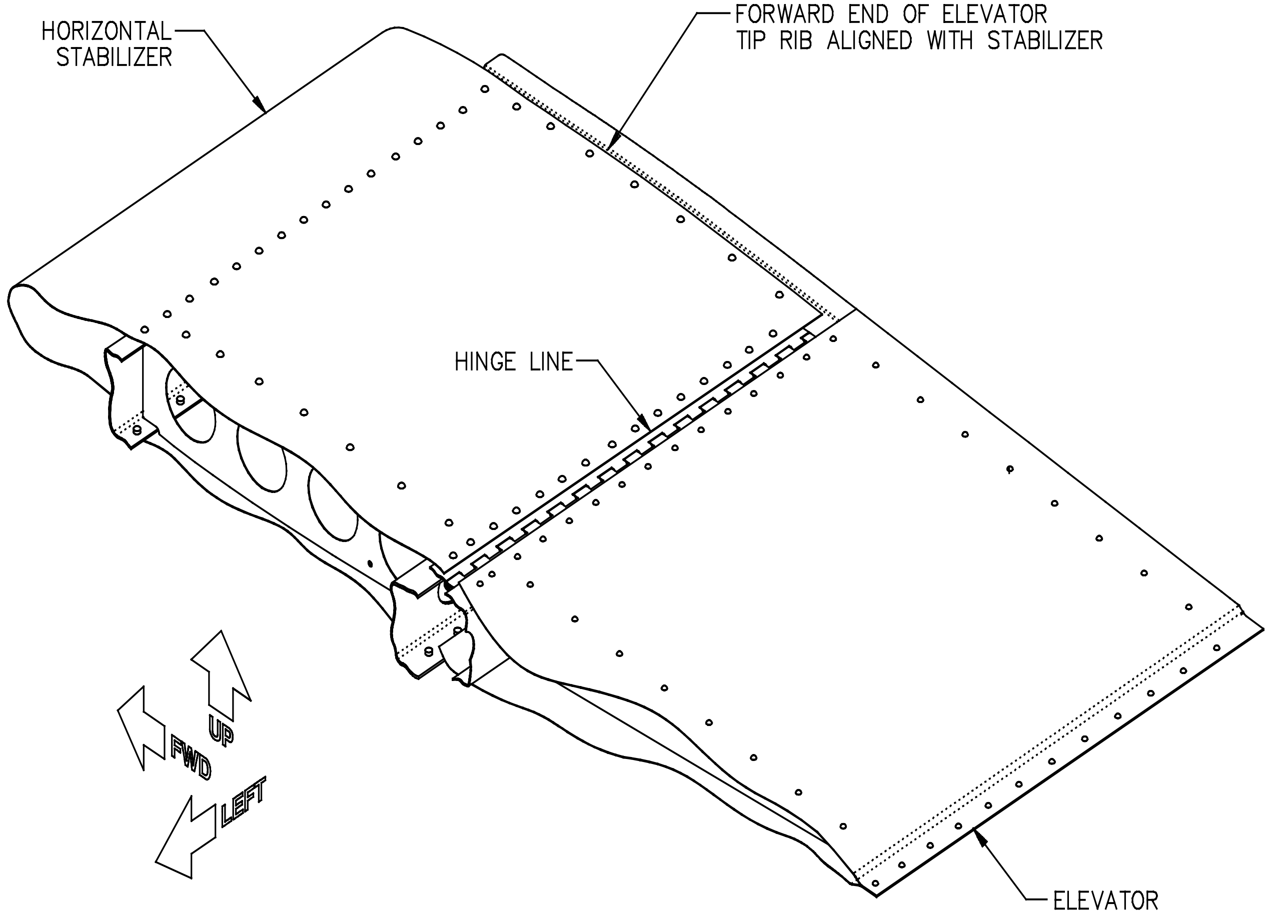

Figure 47: Elevator Neutral Position

Install the horizontal stabilizer/elevator assembly by sliding the alignment pins on the stabilizer forward spar into the bushings in the forward attach bracket bolted to Bulkhead D. Use AN4-10A **bolts** [121.1] to secure the stabilizer aft attach bracket to the nutplates installed on Bulkhead E.

Secure the elevator in the neutral position. (In the elevator-neutral position, the elevator tip ribs are aligned with the stabilizer, as shown in Figure 47.)

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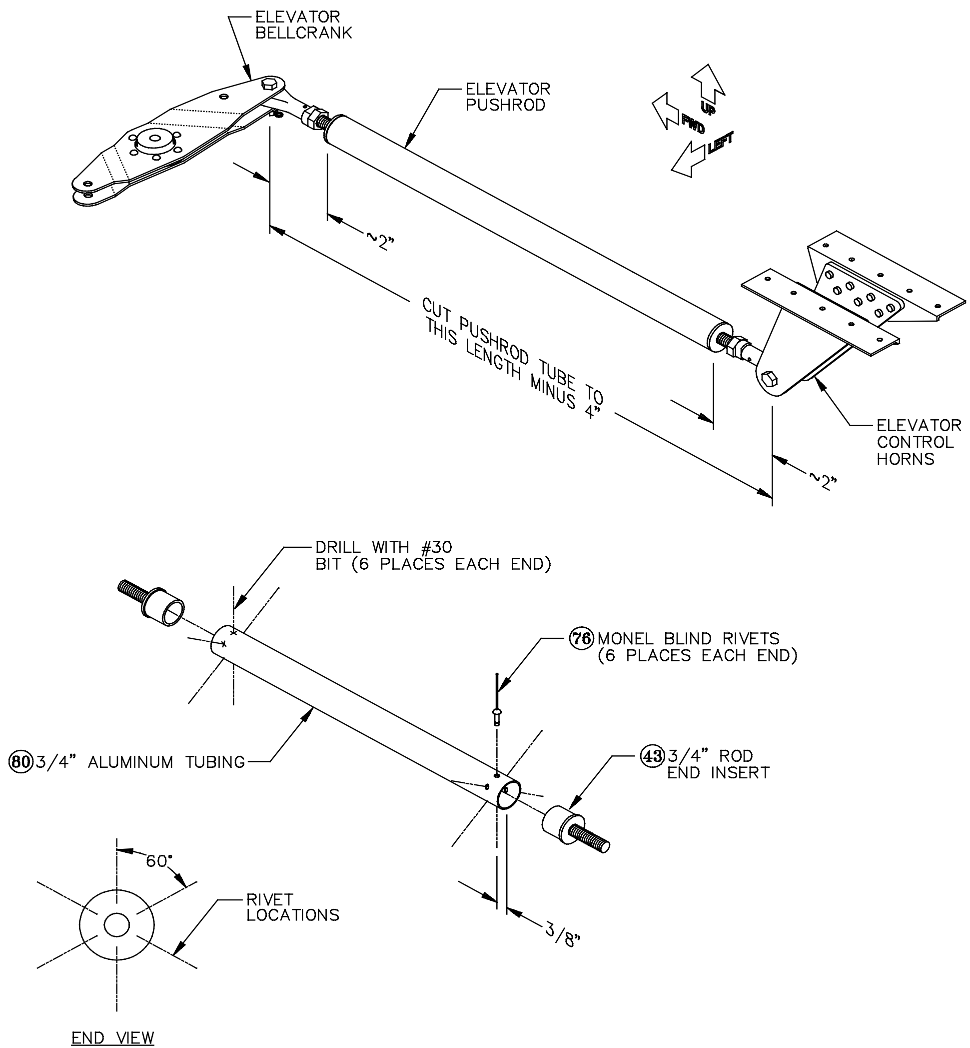


Figure 48: Elevator Pushrod Assembly

With the elevator and bellcrank in the neutral positions, measure the distance from the centers of the attach bolt holes in the elevator control horns to the center of the pushrod attach hole in the elevator bellcrank.

Hint Enlarge the holes in Bulkheads D and E, if necessary, to get a straight shot with your tape measure from the attach holes in the elevator horns to the pushrod mounting hole in the bellcrank. Insert a bolt into the hole in the bellcrank to provide a place to hook your tape measure.

Subtract **4"** from the measured distance and use hacksaw to cut the 3/4" aluminum tubing to the reduced length. (The 4" reduced length results from the fact that the rod end inserts and rod end bearings add about 2" to the length of the linkage at each end. You will then have to carefully square the ends with a file while removing saw marks. No matter how you cut the tubing, deburr the ends after cutting.

At both ends of the tube, mark the locations of six rivet holes **3/8"** from the end, spaced equidistantly around the circumference of the tube, as shown in Figure 48. The holes are spaced **60°** apart from each other (or just over **3/8"** measured around the circumference of the tube).

Insert a 3/4" rod end insert into each end of the tube and center punch the six rivet hole locations at each end with the inserts in place. Drill the six holes at each end with a **#30** bit, preferably using a drill press. Remove the inserts and deburr the holes in the parts. Corrosion-proof the tube and the inserts.

Note It is especially important to corrosion-proof the tube and the inserts where they contact each other. The parts are made from dissimilar metals (aluminum and steel), which increases the opportunity for corrosion when moisture is present.

Rivet the rod ends to the tube with six monel blind rivets at each end.

Warning Be absolutely certain that you use the correct rivets. Do not substitute aluminum blind rivets for this application. The monel rivets are a nickel alloy and provide greater shear strength to this flight-critical junction.

Completed: [ ]

Step 23: Install the Elevator Pushrod

Thread an AN316-5R **jam nut** [106] and a **rod end bearing** [23] onto each end of the elevator pushrod, as shown in Figure 49, and adjust the rod ends so that the pushrod will bolt between the attach holes in the bellcrank and the elevator horn when the bellcrank and elevator are in the neutral positions. Lock the rod end bearings in place by tightening the jam nuts against them.

Warning Each rod end bearing must be threaded onto the rod end insert's stud past the inspection hole in the bearing. Use a stiff wire inserted into the inspection hole to feel for the end of the stud. If the wire passes through the inspection hole in the bearing without contacting the rod end insert, an unsafe condition exists and the bearing must be threaded on farther.

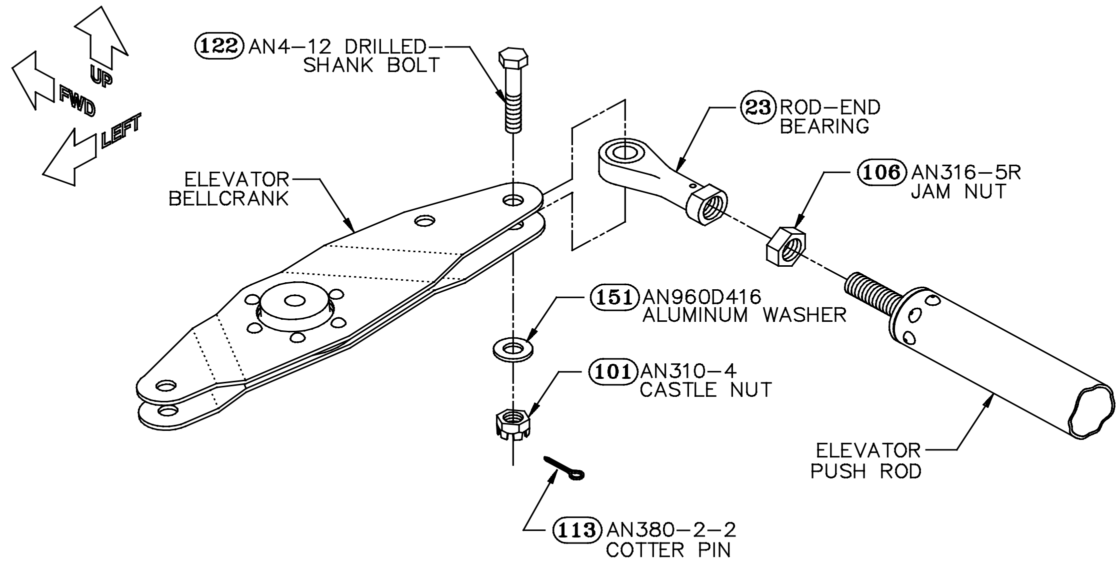
Remove the horizontal stabilizer and elevator, once again, to provide access for connecting the pushrod to the bellcrank. Use files or a drum sander on a die grinder to enlarge the holes in Bulkheads D and E, if necessary, to permit installation of the pushrod.

At the forward end, fasten the pushrod to the bellcrank with an AN4-12 **drilled-shank bolt** [122], an AN960D416 aluminum washer, an AN310-4 castle nut and an AN380-2-2 cotter pin, as shown in Figure 49.

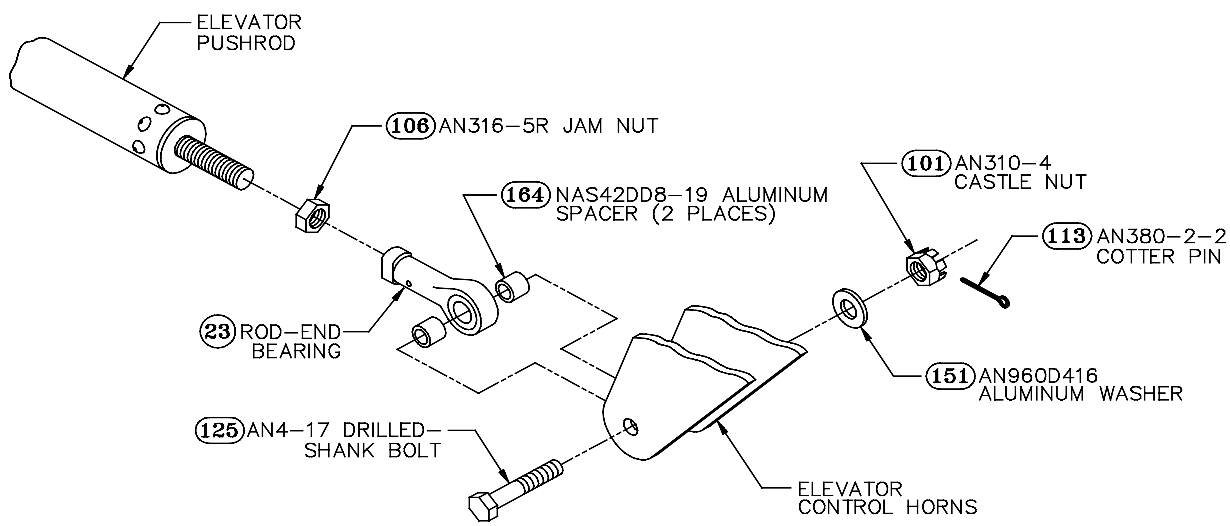
Note The AN4-12 bolt is longer than it needs to be to secure the elevator pushrod; the extra length accommodates the thickness of the elevator control stop plate, which will be fastened to the bottom of the bellcrank in "SECTION X: FINAL ASSEMBLY." For now, use extra washers as necessary to tighten the bolt.

After the elevator control cables have been completed, as described in the next step, reinstall the inter-bulkhead shearweb and the horizontal stabilizer/elevator assembly. Fasten the pushrod to the elevator control horns with an AN4-17 drilled-shank bolt [125], two NAS42DD8-19 **aluminum spacers** [164] (one on each side of the rod-end bearing), an AN960D416 aluminum washer, an AN310-4 castle nut and an AN380-2-2 cotter pin.

Completed: [ ]



FORWARD END



AFT END

Figure 49: Elevator Control Pushrod Installation

Step 24: Install the Elevator Control Cables

To reduce friction and wear, put a small dab of grease on all terminal ends of the control cables. As shown in Figure 50, fasten the strap shackle ends of the **elevator up cable** [66] and the **elevator down cable** [65] to the actuation stem of the elevator/aileron control yoke, using an AN393-19 **clevis pin** [121], an AN960-10 washer and an AN380-2-2 cotter pin. (The elevator **up** cable is about 60" long, measured from the attach holes in the strap shackle to the end of the turnbuckle end; be careful not to confuse this cable with the **aileron primary actuation cables** [71], which are about 66" long. The elevator **down** cable is about 40" long from the hole in the strap shackle to the end of the turnbuckle end. The turnbuckle ends on both elevator cables are right-hand threaded.)

Run the elevator **up** cable forward from the actuation stem, **over** the elevator cable reversing pulley (shown in Figures 22 and 23), and then aft through the fairlead at the aft end of the cage, as shown in Figure 38. Run the elevator **down** cable aft through the fairlead. (Use the proper fairleads shown in Figure 38 for the two cables.)

Thread the aft ends of the elevator up and down cables into MS21251-B5S turnbarrels [159], just like the aft ends of the forward rudder cables shown in Figure 41. Thread MS21255-5LS cable eyes [160] an equal distance into the other ends of the turnbarrels. Adjust the turnbuckles so the threads on both ends just disappear into the turnbarrels.

Note The initial turnbarrel adjustment is critical. If the ends are threaded in too far initially, there won't be enough adjustment range available later for tensioning the cables. (The cables will be tensioned during final assembly.)

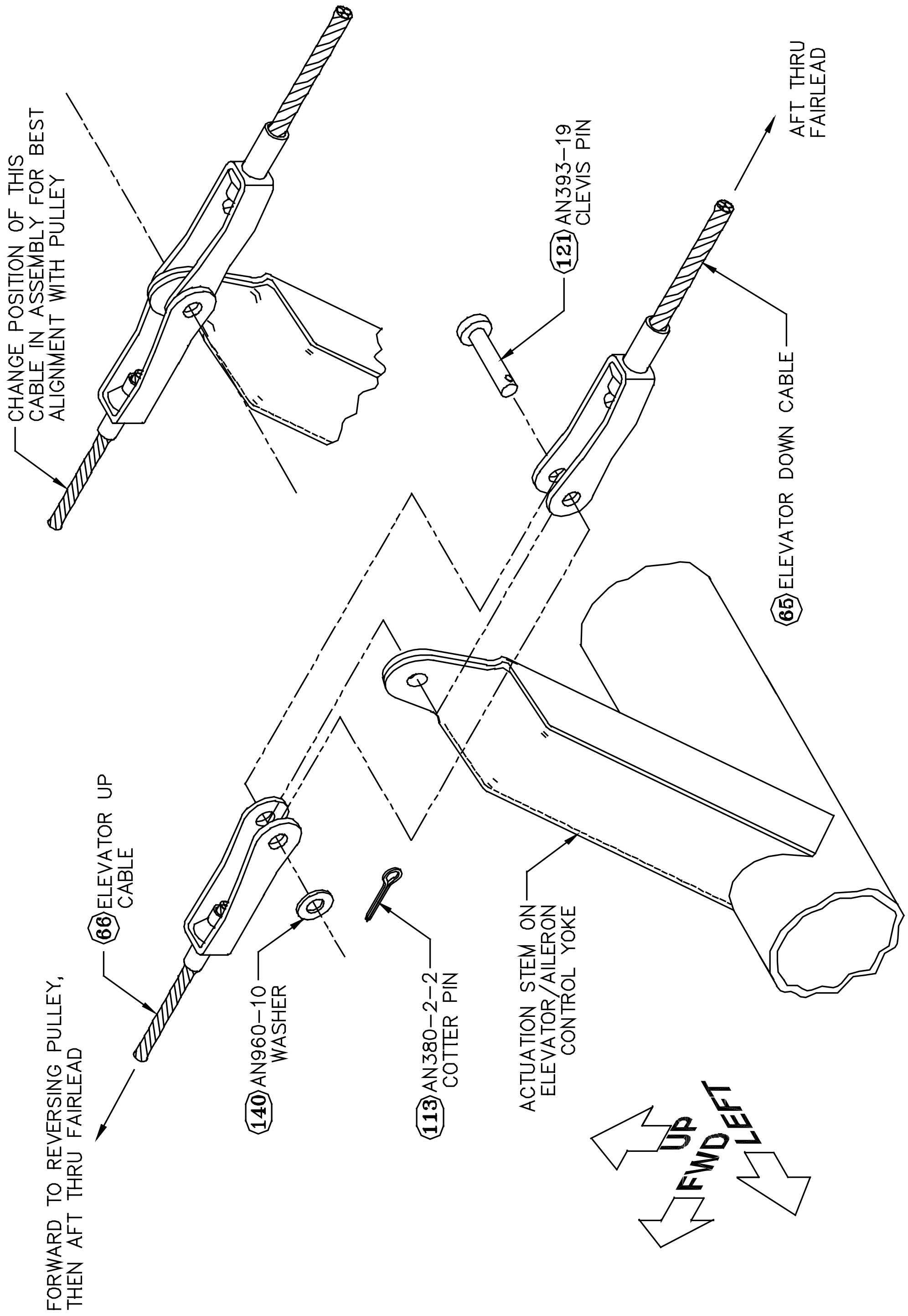
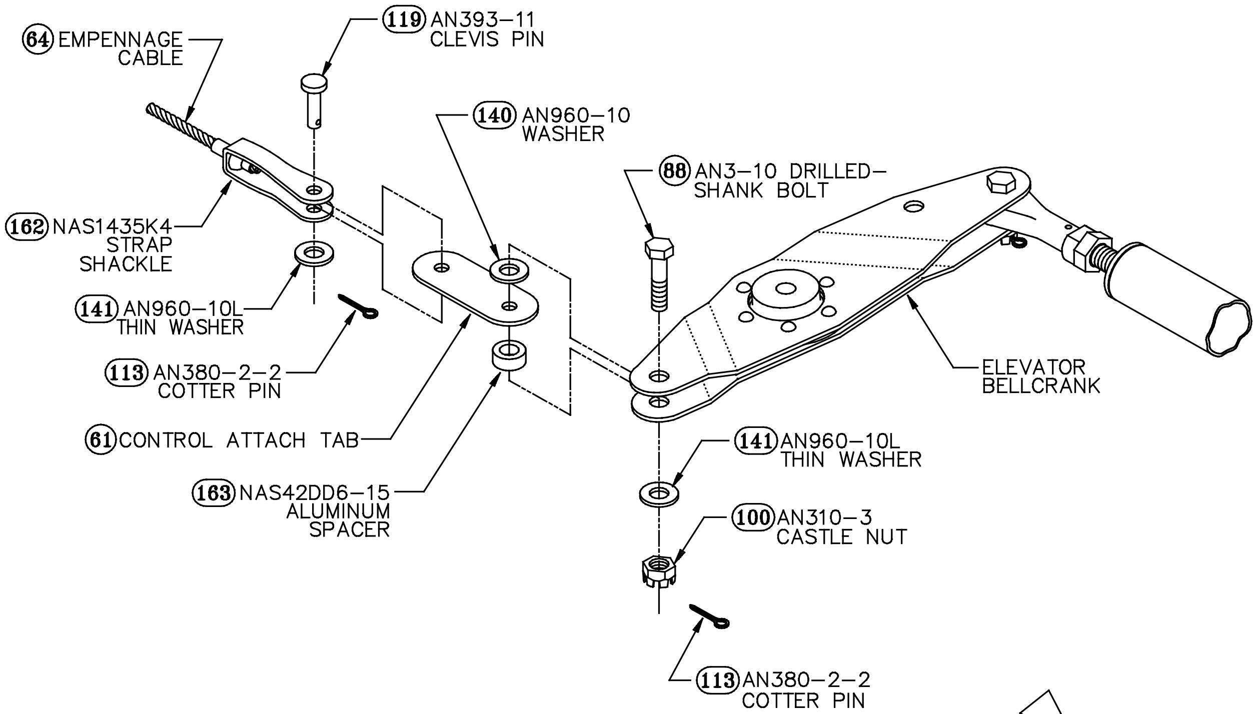


Figure 50: Forward Elevator Cable Assemblies



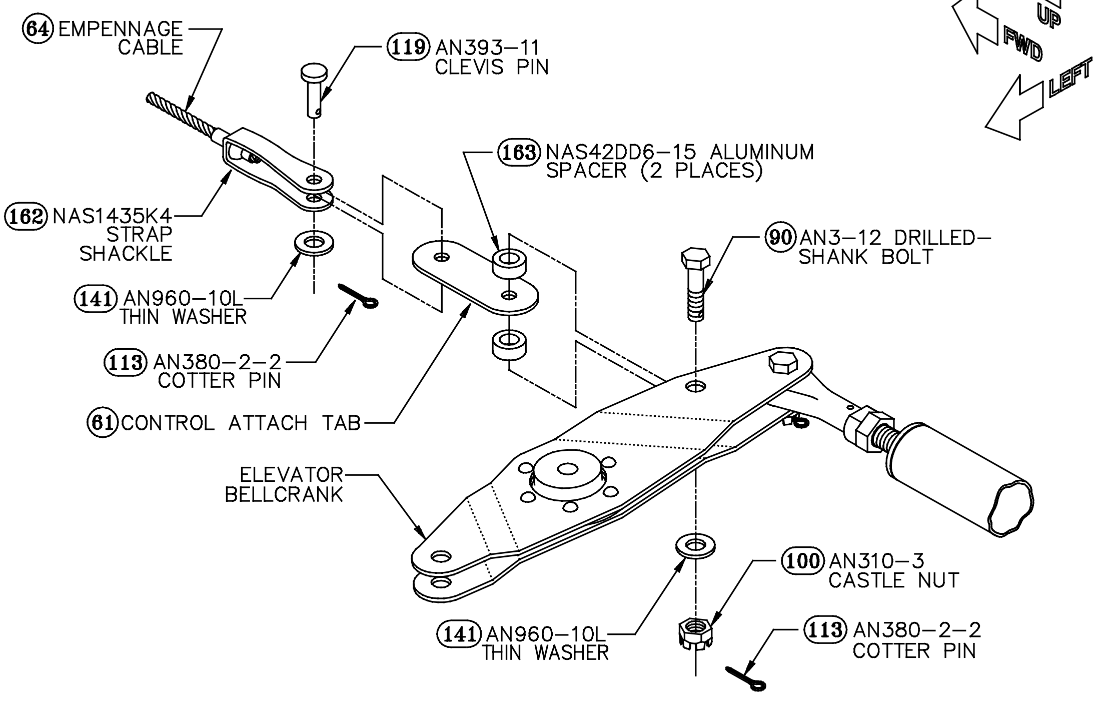


Figure 51: Aft Elevator Cable Attachment

Hint You will probably find it easier to make all the connections described in the next two paragraphs if you remove the bellcrank from the fuselage.

Use an AN3-10 **drilled-shank bolt** [88], one NAS42DD6-15 **aluminum spacer** [163], an AN960-10 washer, an AN960-10L thin washer, an AN310-3 castle nut and an AN380-2-2 cotter pin to secure a **control cable attach tab** [61] to the **left** arm of the elevator bellcrank, as shown in Figure 51. Similarly, use an AN3-12 **drilled-shank bolt** [90], two NAS42DD6-15 aluminum spacers, an AN960-10L thin washer, an AN310-3 castle nut and an AN380-2-2 cotter pin to secure a control cable attach tab to the **right** arm of the elevator bellcrank.

Note The AN3-10 and AN3-12 bolts are longer than they need to be to secure the cable-attach hardware; the extra length accommodates the thickness of the elevator control stop plate, which will be fastened to the bottom of the bellcrank in "SECTION X: FINAL ASSEMBLY." For now, use extra washers as necessary to tighten the bolts.

Slide an NAS1435K4 strap shackle onto each of the two remaining empennage cables until the swaged ball nestles in the recess in the shackle, as shown in Figure 51. Use an AN393-11 **clevis pin** [119], an AN960-10L thin washer and an AN380-2-2 cotter pin to fasten the strap shackle end of an empennage cable to each of the cable attach tabs on the elevator bellcrank.

Stretch the empennage cables forward toward Bulkhead A. Route the **down** elevator cable (the cable fastened to the **right** side of the elevator bellcrank) under the **left** pulley in the **right-hand** pair of Bulkhead A pulleys, as shown in Figure 45. Route the **up** elevator cable under the **left** pulley in the **left-hand** pair of Bulkhead A pulleys.

Pull the empennage cables forward from the Bulkhead A pulleys to the cable eyes in the aft ends of the up and down elevator cable turnbuckle assemblies. Insert an AN100C-4 thimble into each of the cable eyes in the turnbuckles.

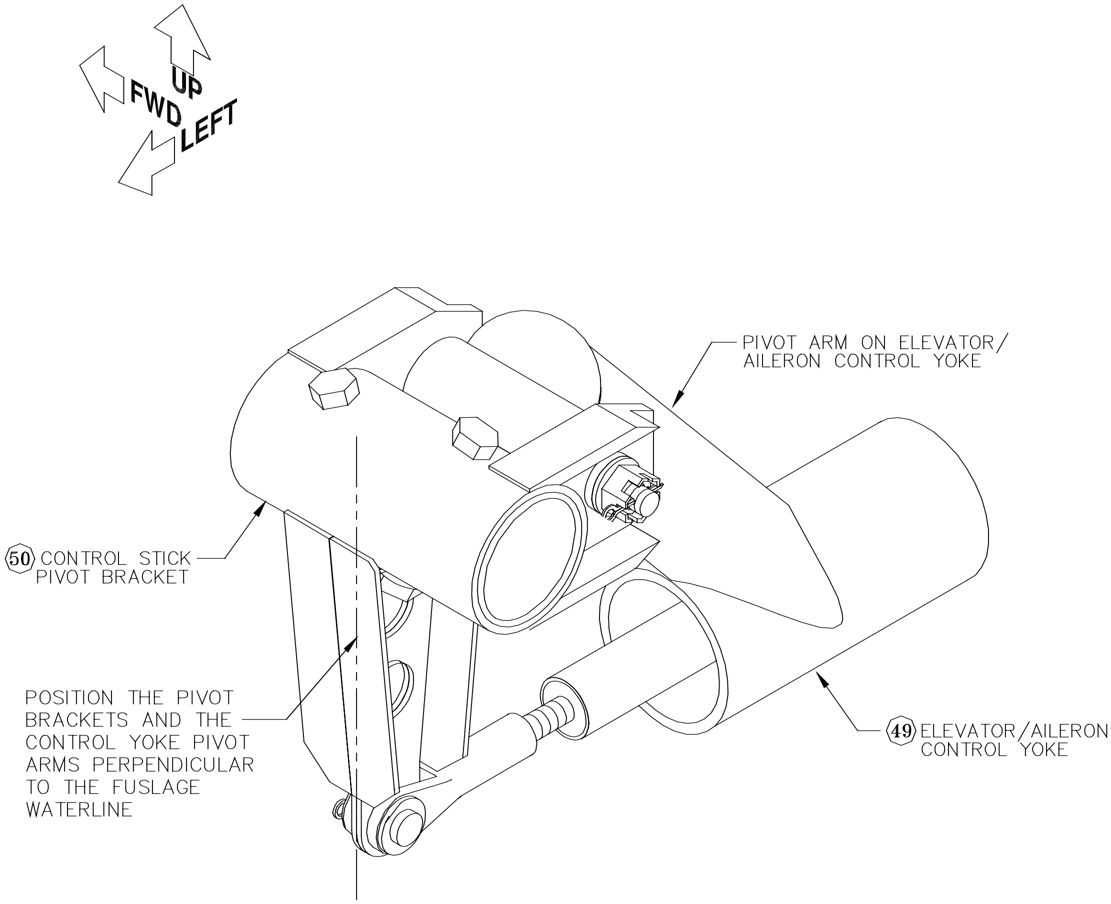


Figure 52: Control Yoke Neutral Position

Before the elevator control cables can be completed, the elevator and the elevator/aileron control yoke must be secured in their neutral positions.

In the control yoke neutral position, the control stick pivot brackets and the pivot arms of the control yoke are perpendicular to the fuselage waterline, as shown in Figure 52. Level the fuselage longitudinally using the waterline marks on the fuselage shell (refer to Step 33 in "SECTION VIII: FUSELAGE ASSEMBLY"), and then use a spirit level or a plumb bob to set the pivot arms and the pivot brackets in the vertical position.

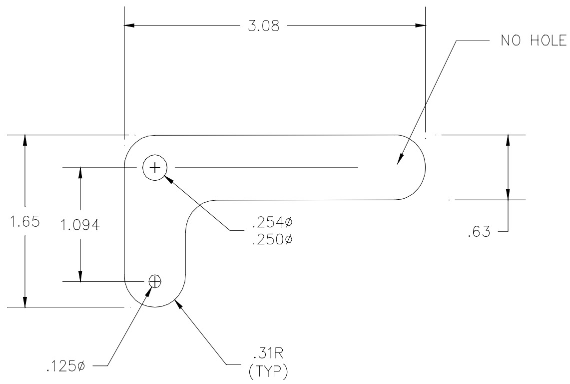
Reinstall the horizontal stabilizer/elevator assembly, and then attach the aft end of the elevator pushrod to the elevator horns, using the hardware shown in Figure 49. Secure the elevator in its neutral position by aligning the elevator tip ribs with the stabilizer and taping or clamping them in this position.

Slip a NicoPress sleeve over the forward end of each empennage cable, thread the end of the cable around the thimble in the cable eye and back through the sleeve, and pull the cable taut. Verify that the aft empennage cables have been connected to the correct turnbuckles, as shown in Figure 48, and complete the NicoPress splices as described in "SECTION II: TOOLS AND TECHNIQUES."

> **Note** The elevator control system will be checked for the specified control surface travel during final assembly when the airplane is being prepared for first flight. At the same time, the elevator cables will be adjusted to the proper tension and safetied.

Completed: [ ]

Page 55: The top figure in Figure 25 will be deleted and the reference to this cable guard in the paragraph will revised. (If you have already made your pulley guards per the steps defined in Revision A, the guards are acceptable. These newer revised guards are oriented a little better in the pulley cluster.) Figure 25 will be revised as shown:



RUDDER CABLE GUIDE PULLEY GUARD

FABRICATE TWO FROM
.040 ALUMINUM SHEET (11)

Page 56-58: The reference to "drill this up up to 1/4" diameter" in the first paragraph will be changed to "drill to 1/4" diameter". A general procedure note of how to drill the holes in the square tube will be as follows. Mark a centerline on the 1/2" square tube. Using a drill press, drill a 1/4" diameter hole on end located 1-1/4" in from the end. Insert the forward pulley bolt through the cage bushing and then through the tube and across to the other bushing. Install the AN4-45 bolt through the tabs on the cage. Swing the tube up until it contacts the AN-45 bolt and mark this location on the tube. (Note: the bolt path would actually be an arc centered about the AN4-53 bolt, so the projected contact point with the centerline of the 1/2" tube will be slightly aft of this mark by about .015".) Use a drill press to drill this hole. It is also OK to open these holes up to .265 diameter if necessary. Set the tube back in the cage (off to one side of the aft center tab and install both bolts. Use the tab to drill the tube at this location.
With regards to pulley cable retainers, the stiffer the retainer is, the more clearance you may allow between the retainer the edge of the pulley. Cotter pins and the welded brackets are your stiffest kinds. The aluminum straps should be held closer since the thin aluminum strap may deflect more that others.

Page 79-80: In Step 21, the following note will be added to the end of the first paragraph; "Note: Do not worry that the cables do not meet the rudder arms on the same angular plane." The note on the bottom of page 80 should refer to Step 7 and not step 8

Page 100-102:

Mounting the Wings to the Fuselage

At this time, the wings are mounted to the fuselage temporarily so that the aileron and flap control cables can be routed and installed.

> **Hint** We recommend resting the fuselage on its belly (adequately supported with pads to prevent damage, of course) to install the wings; this positions the wings at a more accessible height for drilling the wing struts and working on the control systems.

Step 25: Install the Inboard Wing Strut Fittings

If you don't have an arbor press, use a large C-clamp or a bench vise to press two NAS75-8-016 **plain steel bushings** [169] into a **fuselage wing strut attach fitting** [27], as shown in Figure 53.

> **Hint** Apply corrosion-proofing primer or Loctite to the outsides of the bushings and press them in while still wet; besides helping prevent corrosion on the contact surfaces between the bushings and the fitting, this will lubricate the bushings for insertion.

Insert the strut fitting into the end of the **wing strut** [26] with the pre-drilled holes, as shown. (If the strut extrusion is undersized for the fitting, the extrusion can be squeezed across it's major diameter in order to open up the inside.) Use an AN6-24A **bolt** [135] inserted through the 3/8"-diameter hole (the hole closest to the end of the strut tube) to pin the two parts together. Insert the end of a 23/64" drill bit into the second hole to align the parts. Run a .3745" reamer through the second hole from the other side, pushing the 23/64" drill bit out as you go. (A .3745" reamer is supplied with the Wing Strut Drill Jig Kit.) Be careful to keep the reamer perpendicular to the strut; have a helper assist you with alignment.

Remove the fuselage wing strut attach fitting from the wing strut and deburr the newly reamed holes in both parts.

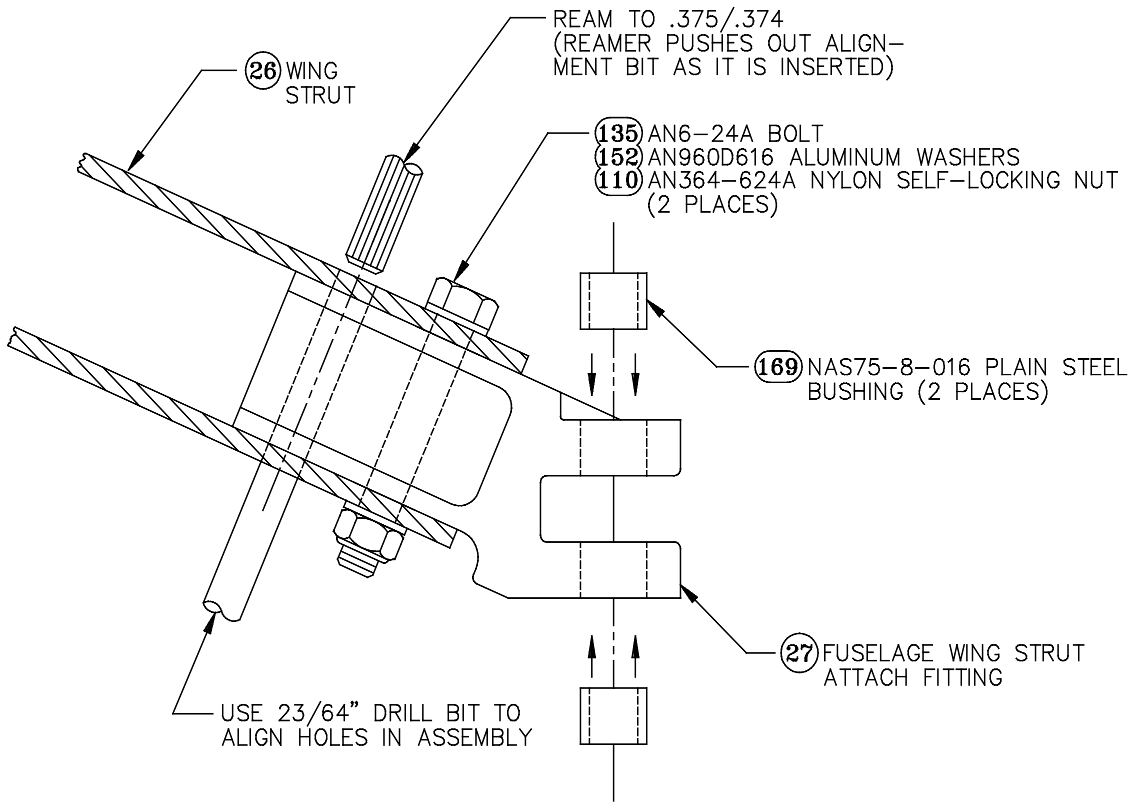


Figure 53: Fuselage Wing Strut Fitting Installation

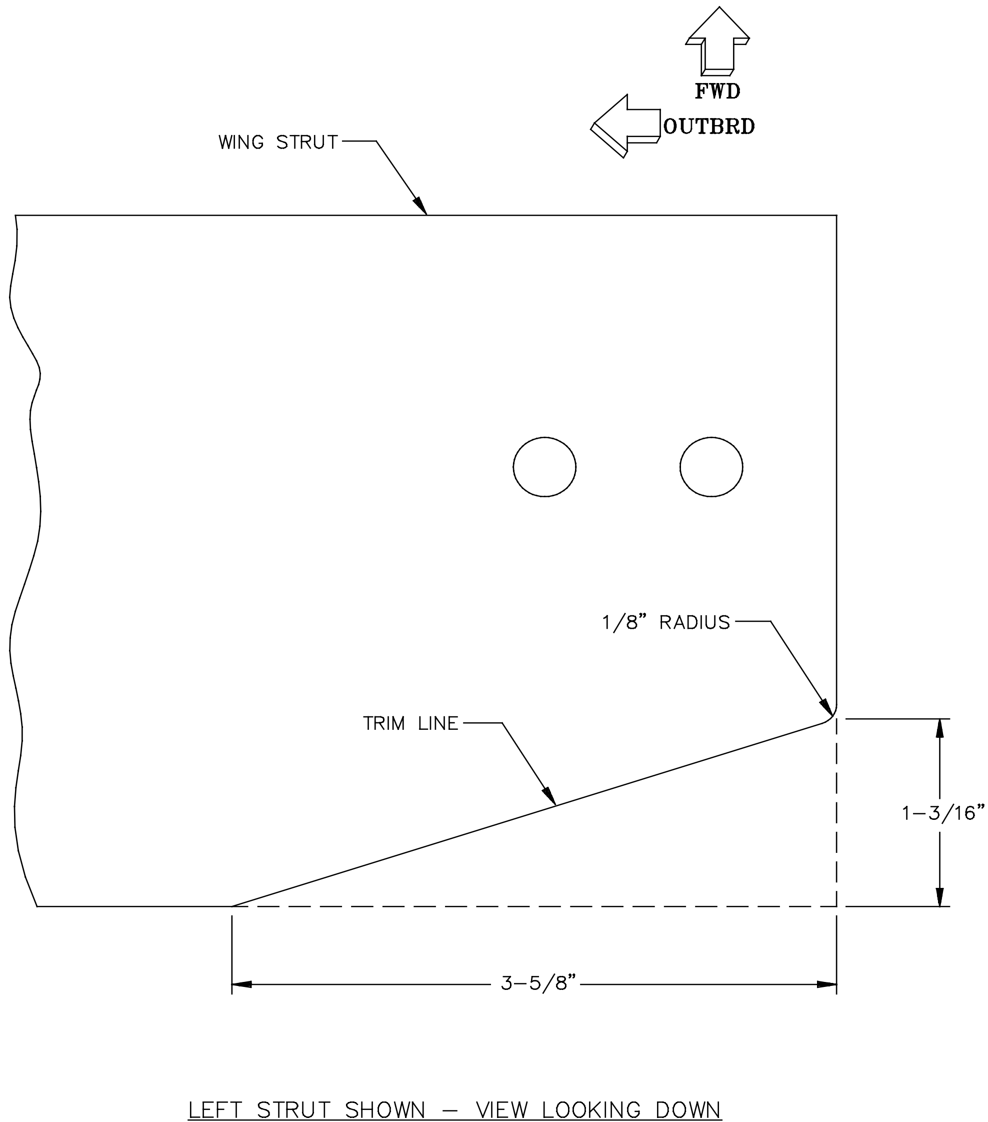


Figure 54: Trimming the Inboard End of the Wing Strut

Mark the inboard, aft corner of the wing strut for trimming, as shown in Figure 54. Use a hacksaw or a bandsaw to trim the struts outside the marked lines and then finish with a belt sander or a file. Use fine sandpaper to remove any remaining roughness. Round the angles of the finished cut to a 1/8" radius, as shown.

Note Trimming the wing struts is unnecessary if you plan never to fold the wings of your Sportsman.

Apply the corrosion protection of your choice to the wing strut and to the fuselage wing strut fitting. Then, bolt the strut fitting to the strut with AN6-24A bolts, AN960D616 **aluminum washers** [152] and AN364-624A **nylon self-locking nuts** [110], as shown in Figure 53.

Note The fuselage wing strut fittings have been anodized for corrosion resistance, so only the bolt holes that you reamed require additional protection. Do **not** use an alodine treatment on the strut fittings as this can damage the anodized finish.

If you plan to use your Sportsman as a float plane on salt water, we recommend also corrosion-proofing the **inside** of the strut. This is accomplished by pouring the corrosion-protection liquid through the strut and sloshing it around, and then discarding any excess out the end.

Repeat this step for the other wing strut, being careful to make the second strut a mirror-image of the first so that the struts will fit correctly on opposite sides of the airplane. Mark the struts "left" and "right" to help prevent confusion.

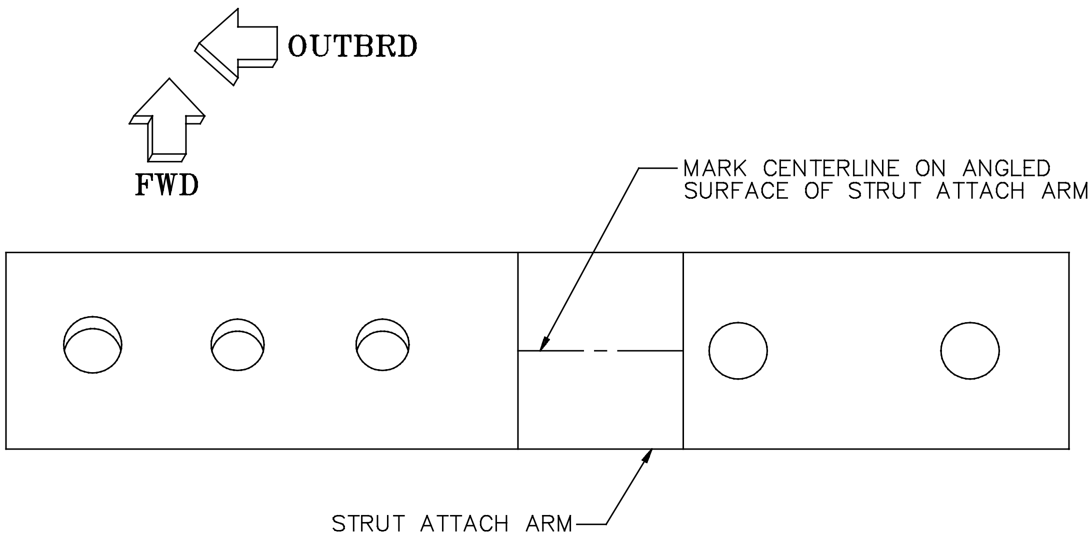
Completed: Left [ ] Right [ ]

Step 26: Mark the Bolt Centerlines on the Strut Attach Arm and the Wing Strut

The outboard end of the wing strut must be positioned correctly in the fore and aft direction relative to the strut attach arm in the wing, so that the strut can be accurately marked for drilling the attach arm bolt holes. (The strut attach arm is the fitting bolted between the strut beams in the wing. Refer to Steps 21 and 22 in "SECTION VI: WING ASSEMBLY.") In this step, you will mark the wing strut and the strut attach arm with reference lines that will be used as a guide for alignment.

Use a felt-tip pen to mark the bolt hole centerline on the **upper**, **outboard** end of the strut **1-3/4"** aft of the strut leading edge, as shown in Figure 55. Also, mark the centerline on the angled, **upper** surface of the strut attach arm in the wing. When you install the strut, you will align the centerline marked on the strut with the centerline marked on the strut attach arm.

Completed: Left [ ] Right [ ]



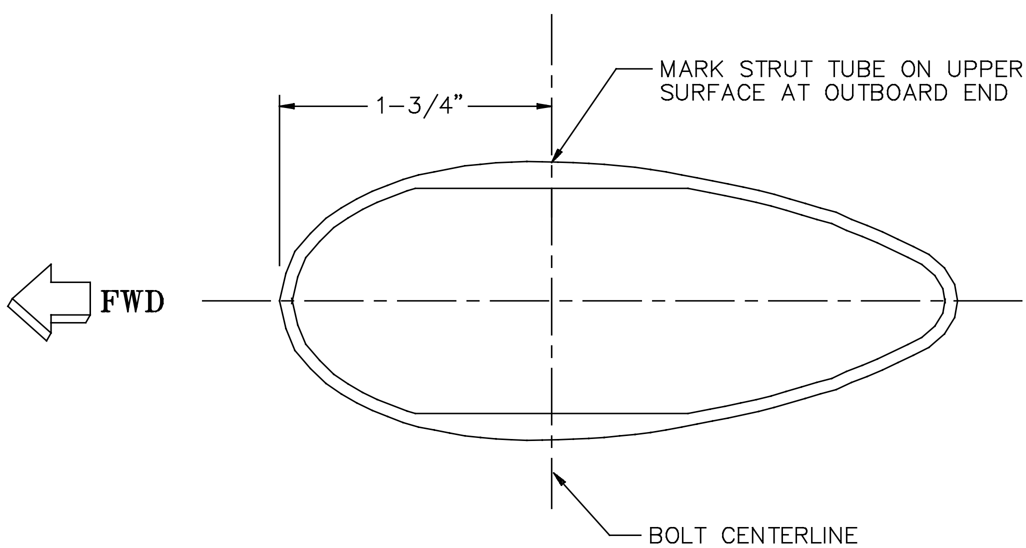


Figure 55: Marking Bolt Centerlines on the Strut Attach Arm and the Wing Strut

Step 27: Trim the Openings in the Wing Root Areas of the Fuselage Shell

When the fiberglass fuselage shells were mated to the cage, slots were cut in the wing root areas of the shells to accommodate the alignment jigs. These slots must be enlarged at this time so that the wing spars can be inserted through them for attachment to the cage.

Continue the slots cut in Step 15 of "SECTION VIII: FUSELAGE ASSEMBLY" down to the inside surface of the lower skin in the airfoil-shaped wing root area of the shell on each side, as shown in Figure 56. Also, increase the width of the slots as necessary to accommodate the full thicknesses of the spar webs, and cut slots in the chordwise direction to accommodate the spar flanges and portions of the root rib doublers.

You can make a template of your actual wing root and lay this over the fiberglass wing root or use the wings themselves.

Completed: Left [ ] Right [ ]

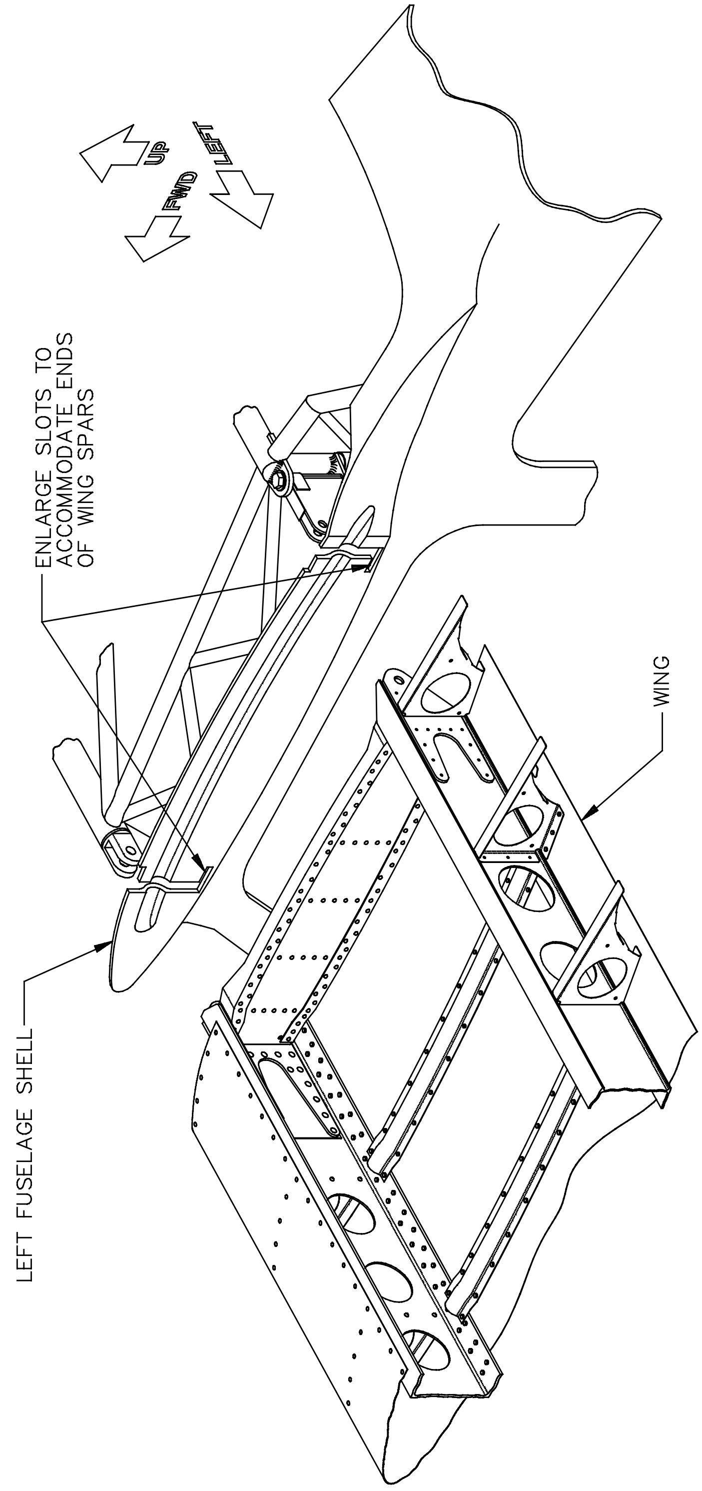


Figure 56: Enlarging the Spar Slots in the Fuselage Shell

Step 28: Mount the Wings to the Fuselage

Note In order to complete the procedures in this section, you will need the Wing Strut Drill Jig Kit (P/N 981-03000-01) available for rent from Glasair Aviation. The drill jig and its use is described in detail in Step 32, below.

Caution Be sure you have plenty of help to mount the wings. Trying to accomplish this without adequate assistance can result in damage to the airframe or injury to you or your helpers. Fabricate or procure stands of some sort (tall, padded sawhorses or step ladders of the correct height, for example) to support the wings while setting the wing dihedral and fitting the wing struts (procedures that will be described in the following steps).

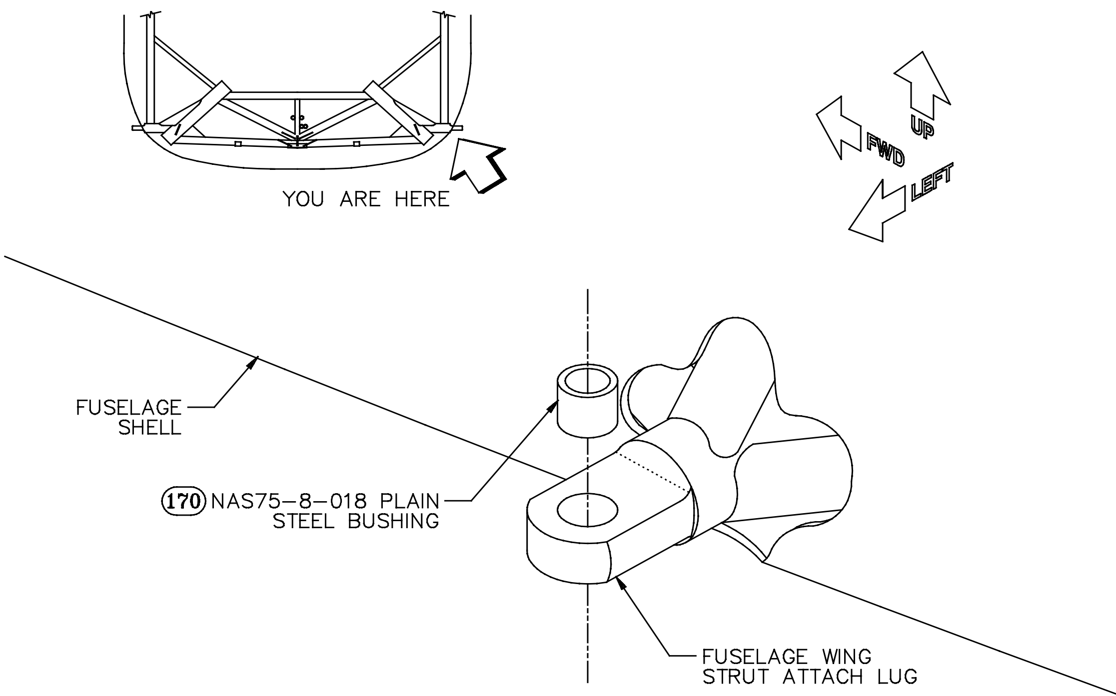


Figure 60: Pressing the Bushing into the Fuselage Wing Strut Attach Lug

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Use a 1/2" bolt and nut (hardware-store quality is fine) with a stack of washers on either side to press an NAS75-8-018 **plain steel bushing** [170] into the fuselage wing strut attach lug on each side of the fuselage cage. This has already been done on the Jumpstart fuselages. Remove any powder coat and use Loctite.

Have your helpers lift the wing into position while you carefully guide the ends of the forward and aft spars into their mounting lugs on the fuselage cage, as shown in Figures 61 and 62. Enlarge the slots in the wing root area of the fuselage shell as necessary.

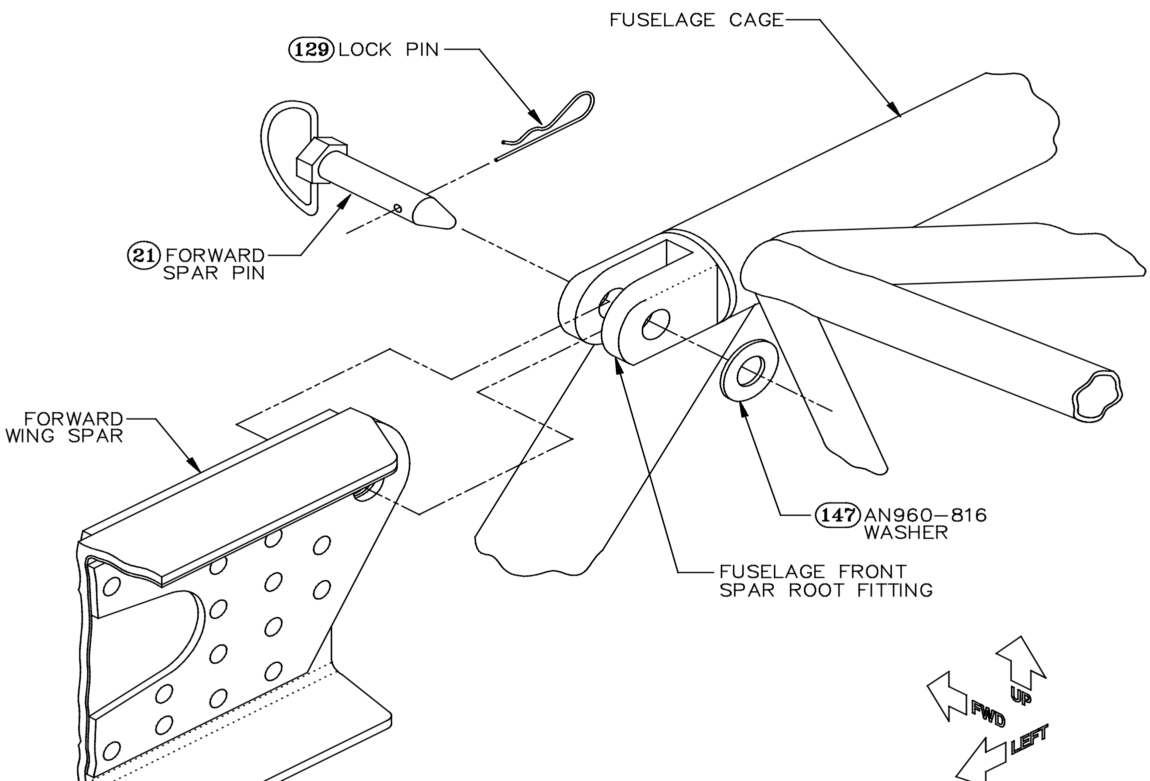

Figure 61: Forward Spar Attachment to Fuselage Cage

Pin the forward spar to the fuselage cage with the **forward spar attach pin** [21], as shown in Figure 61; pin the aft spar to the wing pivot on the fuselage cage with an AN8-15 **drilled-shank bolt** [136], as shown in Figure 62. Install both the pin and the bolt from the **forward** sides of their respective fittings.

Note A light coat of grease will ease insertion of the spar attach pins and bolts.

At this time, there is no need to install the washers, nuts and cotter pins shown in Figures 61–63. The weight of the wing is sufficient to retain the mounting pins and bolts for this temporary wing installation. All the necessary washers, nuts and safety pins will be installed during final assembly.

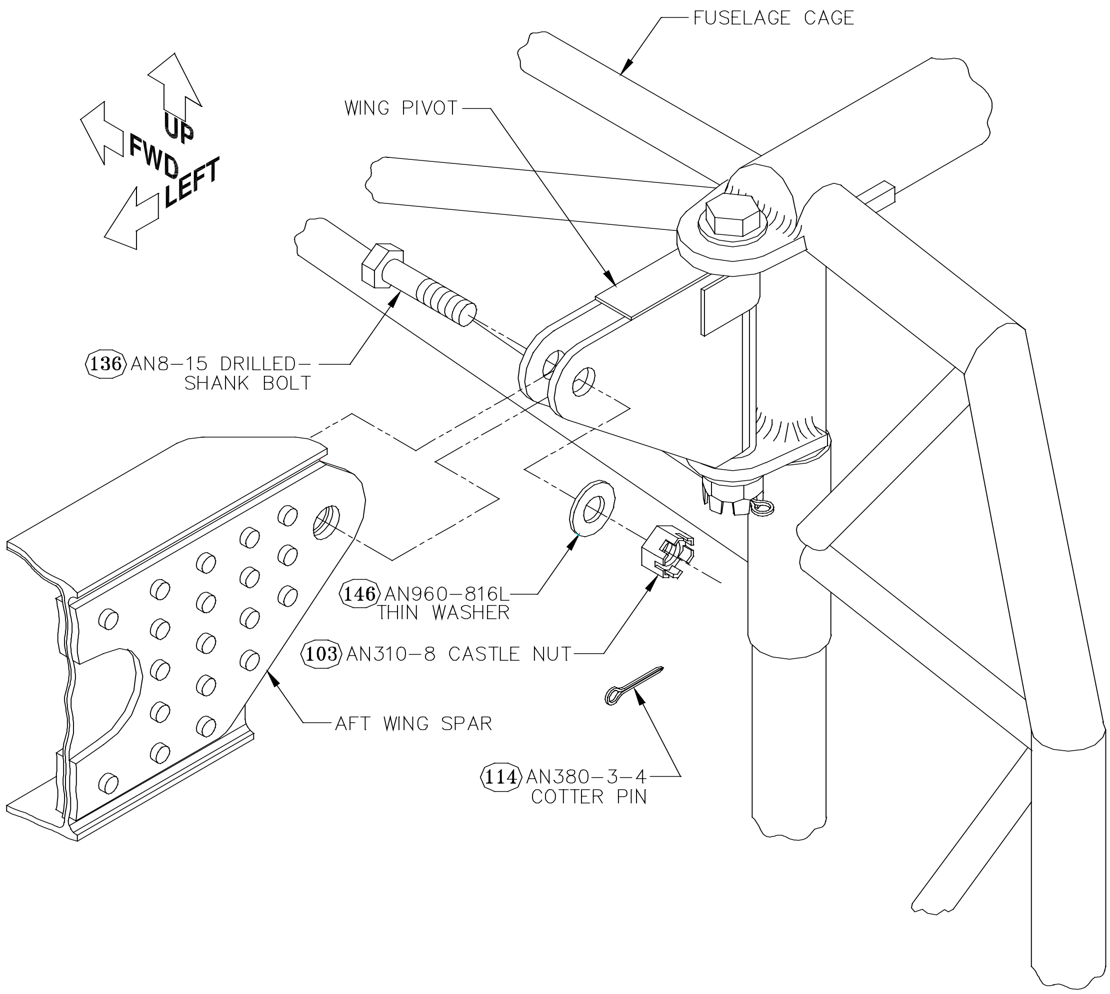

Figure 62: Aft Spar Attachment to Fuselage Cage

With your helpers supporting the wing, slip the outboard end of the wing strut over the inboard end of the strut attach arm, which is bolted between the two halves of the strut beam in the wing. Then, align the fitting on the inboard end of the strut with the attach lug on the fuselage cage, and pin the fitting to the lug with an AN8-22 **drilled-shank bolt** [137], as shown in Figure 63. The washers, nut and cotter pin shown in the figure can be installed or omitted for now at your option.

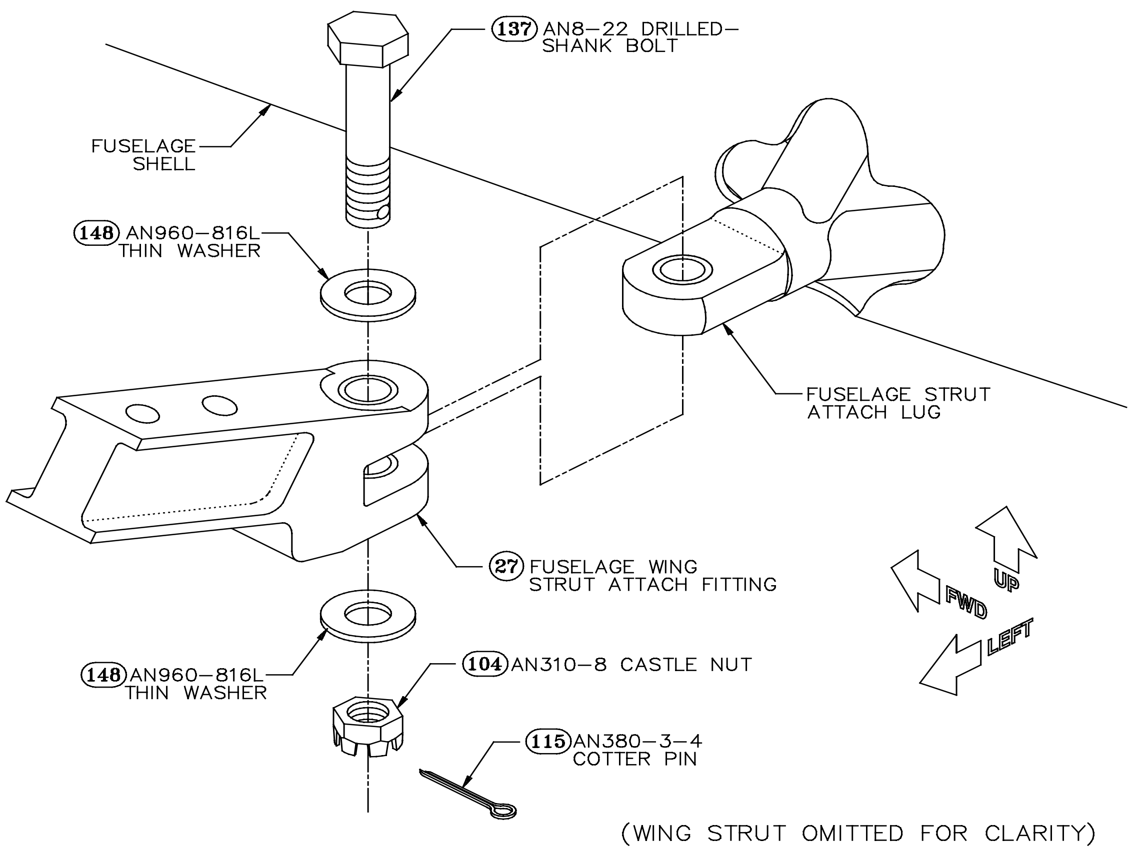

Figure 63: Wing Strut Attachment to Fuselage Lug

Note Moderate force may be required to install the bolt that secures the wing strut to the fuselage. As with the other wing attach pins, a light coat of grease will help. Also, sight through the holes in the two parts to make sure they are in close alignment before trying to insert the bolt. You can use a rubber mallet or a lead-filled plastic hammer to tap the bolt into place; heavy hammer blows should not be necessary. If the wing strut attach fitting seems to be grossly out of alignment with the fuselage attach lug, verify that the correct strut attach arm was installed between the strut beams in each wing. Refer to Step 21 in "SECTION VI: WING ASSEMBLY" for procedures to identify the left and right strut attach arms.

In some instances you may need to encourage your wing strut into alignment by twisting on the strut in order to get the strut fitting in alignment with the fitting on the fuselage.

Support the first wing securely with a tall, padded stand, and repeat for the other wing.

Caution Since the outboard ends of the wing struts are not secured to the attach arms in the strut beams, the wings **must** be supported to prevent damage to the strut attach arms or the ends of the struts. Place your supports directly under the front spar and a rib to prevent deformation of the wing skins.

Completed: Left [ ] Right [ ]

Step 29: Set the Dihedral Angle of the Wings

Level the fuselage laterally, using the same technique that you have been leveling the airplane thus far.

> **Note** You should be using the same lateral leveling method throughout your construction project. You are trying to end up with an airplane with flying surfaces set to some angle relative to a datum so it performs well in the air and looks level on the ground.

Use a digital level to set each wing at a **1.5°** dihedral angle, as shown in Figure 64. (If you have a transit, you can set the wing dihedral by positioning the wing tips **4-21/32"** higher than the wing roots. Or stretch a string from wing tip to wing tip, and measure down from the string **4-21/32"** at the wing roots.) Support each wing securely at this angle.

Typically you will find that after drilling things will settle on the lower side. We have found that by setting out and drilling for 1.6°, after the wing settles on the bolts and fittings, the dihedral will end up closer to the desired **1.5°.**

> **Note** It may be necessary to trim the outboard end of the wing strut so that the wing can be lowered to the correct dihedral angle without the strut contacting the strut beam assembly in the wing. If necessary, disassemble and trim just enough from the end of the wing strut to achieve the specified dihedral. If trimming is necessary, be careful to make the cut square to the length of the strut tube. A chop saw with a sharp wood-cutting blade is a quick way to shorten the wing struts. Use light oil or wax on the blade to reduce galling and then thoroughly deburr the finished cut. To remove the wing strut, undo the lower fitting first, and then pull the strut off the upper fitting.

Completed: Left [ ] Right [ ]

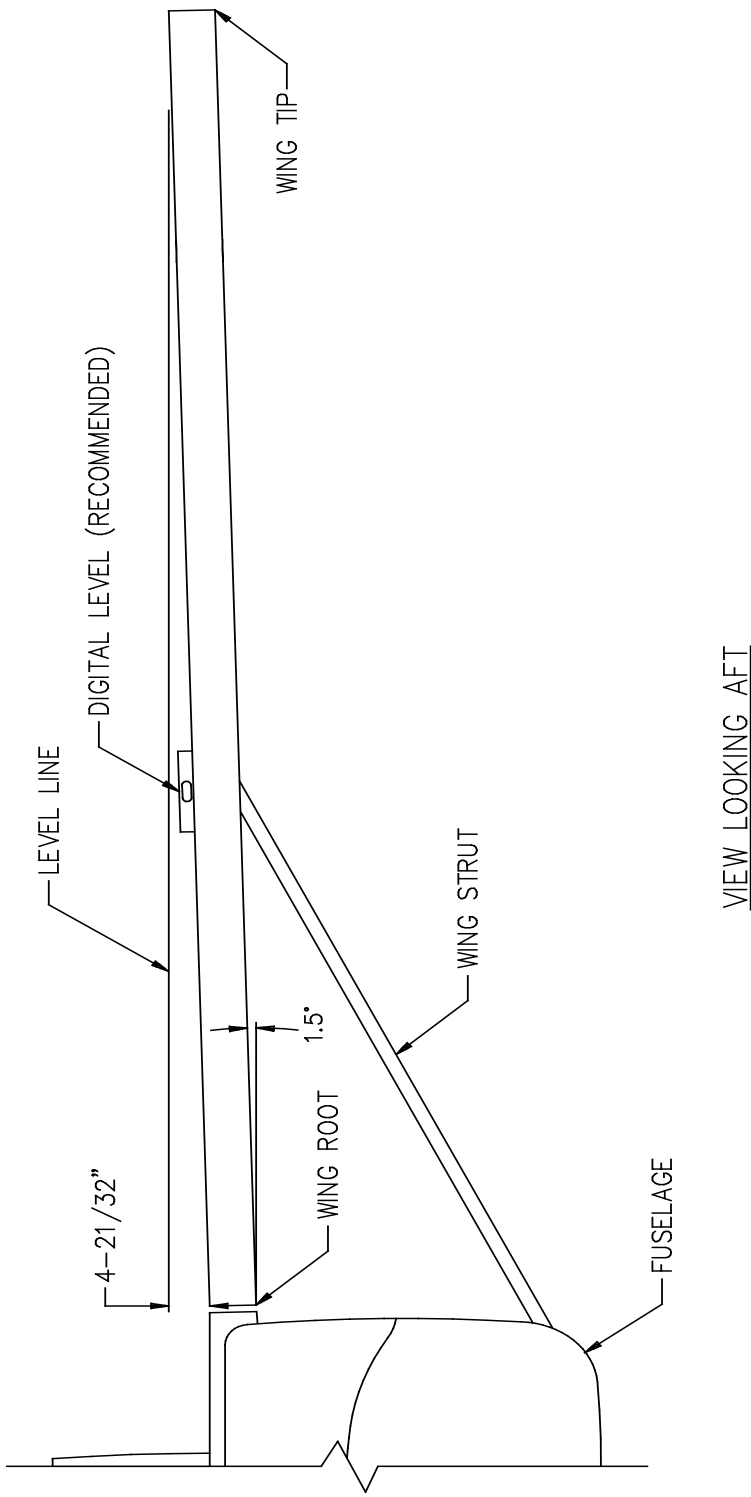

Figure 64: Setting the Wing Dihedral

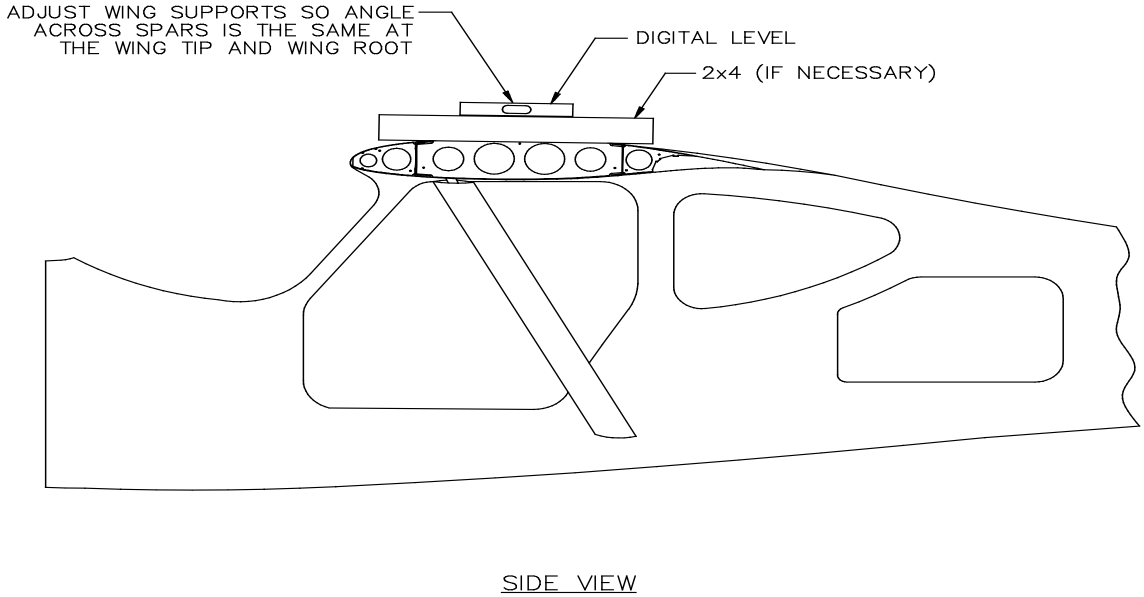

Figure 65: Checking for Wing Twist

Step 30: Remove Twist from the Wings

Without the upper wing skins riveted on, the wings are free to twist slightly. Any twist present in the wings must be removed at this time because wing twist can affect the accuracy of the measurements you will be making in the next step.

To check for wing twist, use a digital level or a protractor level to measure the angle of the aft spar relative to the forward spar **just outboard of the root rib** (Main Rib 1), as shown in Figure 65. (If your level is not long enough to span the distance between the two spars, rest it on a scrap length of 2 X 4.) Then repeat the angle measurement **just inboard of the tip rib** (Main Rib 6). Adjust the wing supports as necessary, moving them forward or aft, **until the angle at the tip is the same as the angle at the root**. Repeat for the other wing.

Obviously, any adjustment you make to the wing supports can change the dihedral angle that you set in the previous step, so go back and repeat that step if necessary. When you are satisfied that both wings are set to the proper dihedral angle (1.5°) and that neither wing is twisted, proceed to the next step.

Completed: Left [ ] Right [ ]

Step 31: Mark the Wing Struts for Drilling

With the wing dihedral angle set at 1.5°, you now must drill two bolt holes through the outboard end of the wing strut that are exactly aligned with the existing bolt holes through the strut attach arm in the wing. The wing strut drill jig will be used to drill the bolt holes, as described in the next step, but, to position the jig for drilling, you first need to transfer the location of the outboard bolt hole in the strut attach arm to the outside surface of the strut. Since the hole in the strut attach arm is hidden by the strut, transferring its location must be done by indirect measurement of the distance X, as described below.

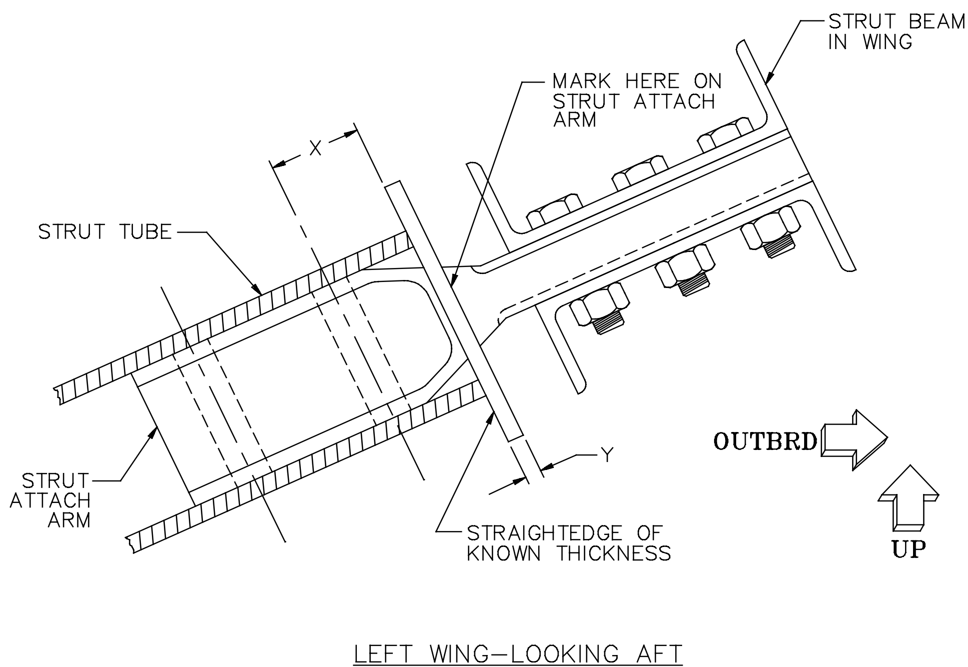

Figure 66: Marking Strut Attach Arm at End of Wing Strut Tube

A) Move the outboard end of the strut fore and aft as necessary until the bolt hole centerlines marked on the strut and the strut attach arm in Step 27 are aligned. Then mark the end of the wing strut tube onto the **forward** side of the wing strut attach arm, as shown in Figure 66. To do this, hold a rigid straightedge of known thickness, Y, against the end of the strut tube and, using a **very fine-point** felt-tip pen (like the Pilot "Razor Point II"), mark along the outboard side of the straightedge onto the strut attach arm.

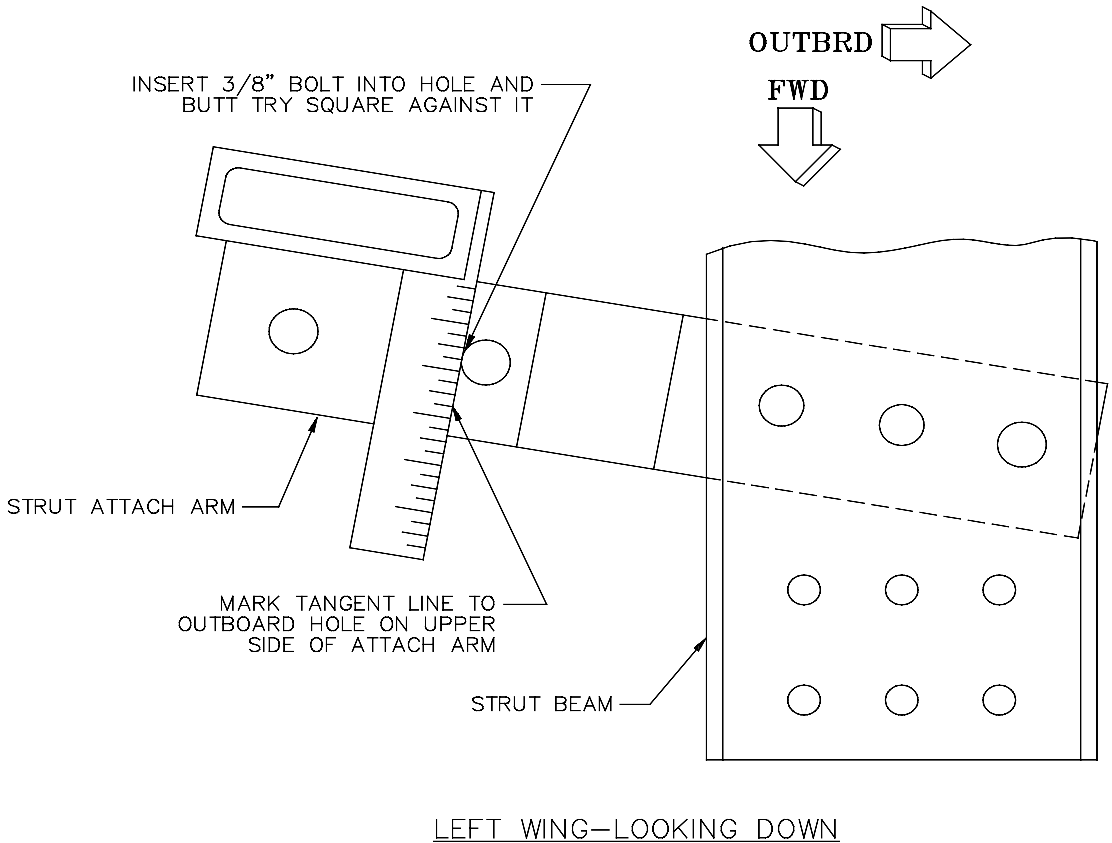

Figure 67: Marking Edge of Hole on Attach Arm

B) Remove the wing strut. Using a small tri-square, make a mark across the **upper** surface of the strut attach arm tangent to the **inboard** side of the **outboard** wing strut attach hole, as shown in Figure 67. To make the mark, insert an AN6 (3/8") bolt into the hole and then butt the tri-square up against the shank of the bolt. Use a fine-point felt-tip pen to mark the tangent line on the **outboard** side of the tri-square blade, as shown.

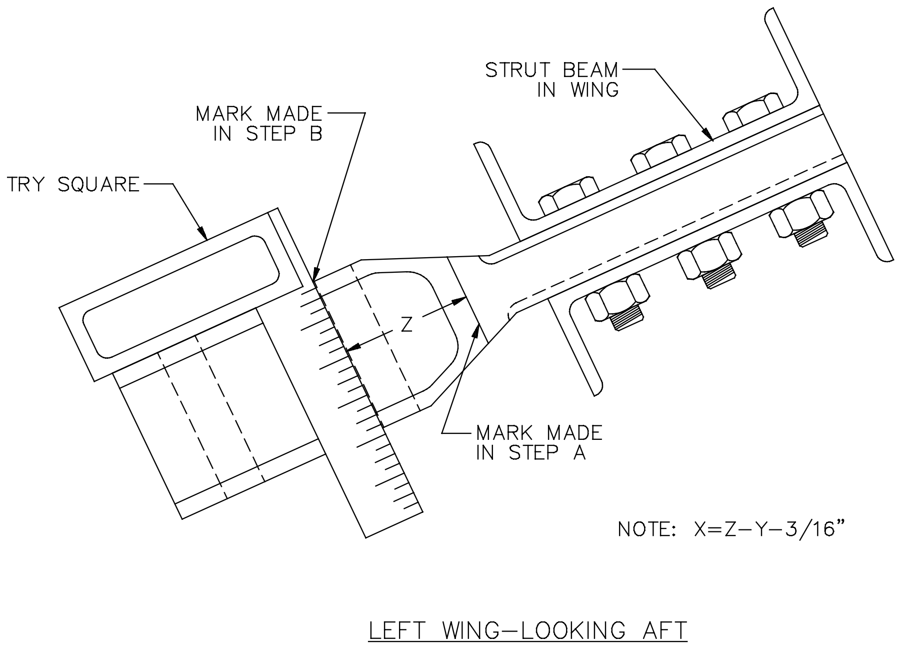

Figure 68: Measuring Between Marks Made in Steps A and B

C) Hold your tri-square on the **forward** side of the strut attach arm (where the mark in Step A was made), with the edge of the blade on the mark made in Step B, as shown in Figure 68. Measure the distance, Z in Figure 68, from the mark made in Step A to the edge of the blade, being careful to measure **parallel** to the length of the strut attach arm, as shown. **Subtract** from Z the thickness, Y, of the straightedge used to make the mark in Step A, and then **subtract 3/16"** (.187", half the hole diameter) from the result. The final result, X, is the distance from the end of the strut tube to the **center** of the outboard strut attach hole in the strut attach arm.

Hint Although this measurement can be made in place, it may be worthwhile to remove the strut attach arm from the wing. Use your own judgment.

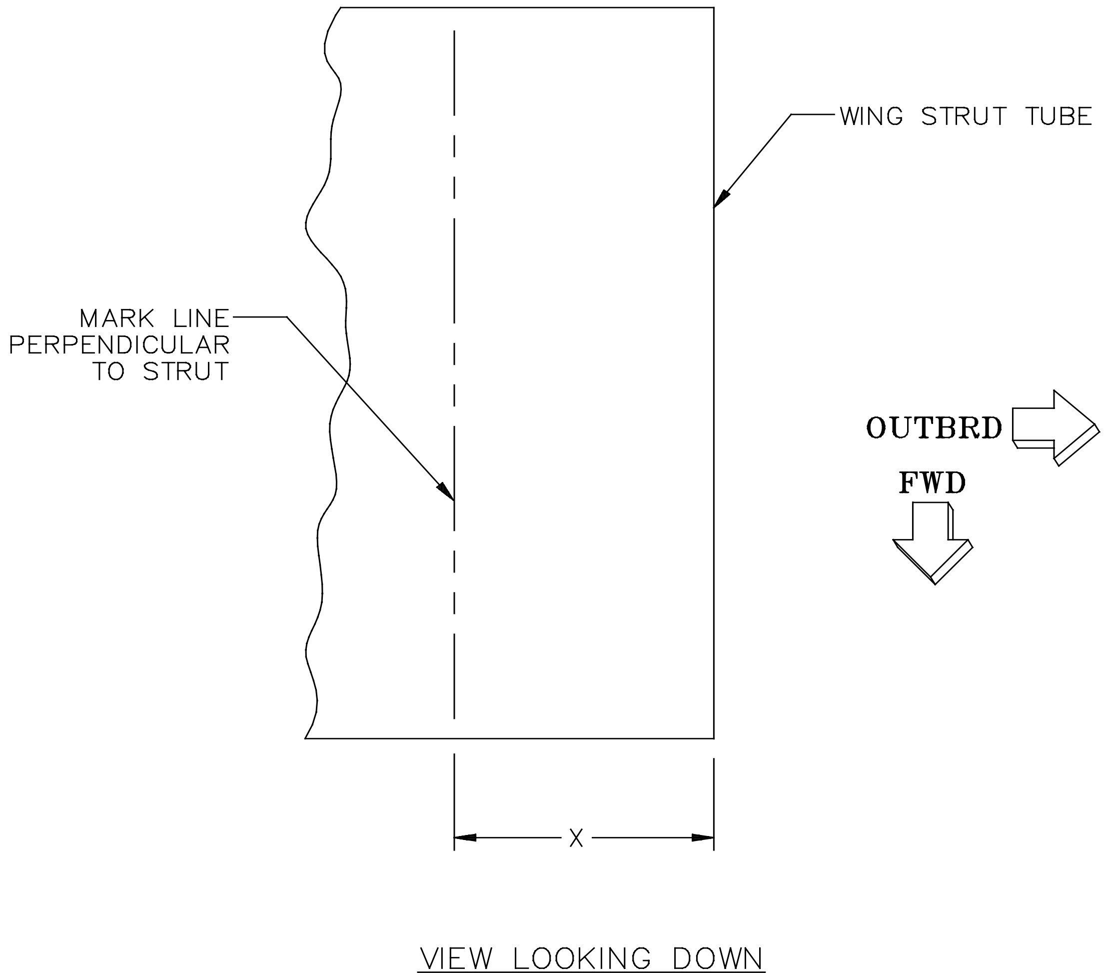

Figure 69: Marking the Distance Determined in Step C onto the Wing Strut

D) Measure from the **outboard** end of the wing strut the distance X determined in Step C, and mark a line onto the **upper** surface of the strut perpendicular to the length of the strut, as shown in Figure 69. Use a fine-point felt-tip pen to make the mark.

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Step 32: Drill the Outboard Ends of the Wing Struts

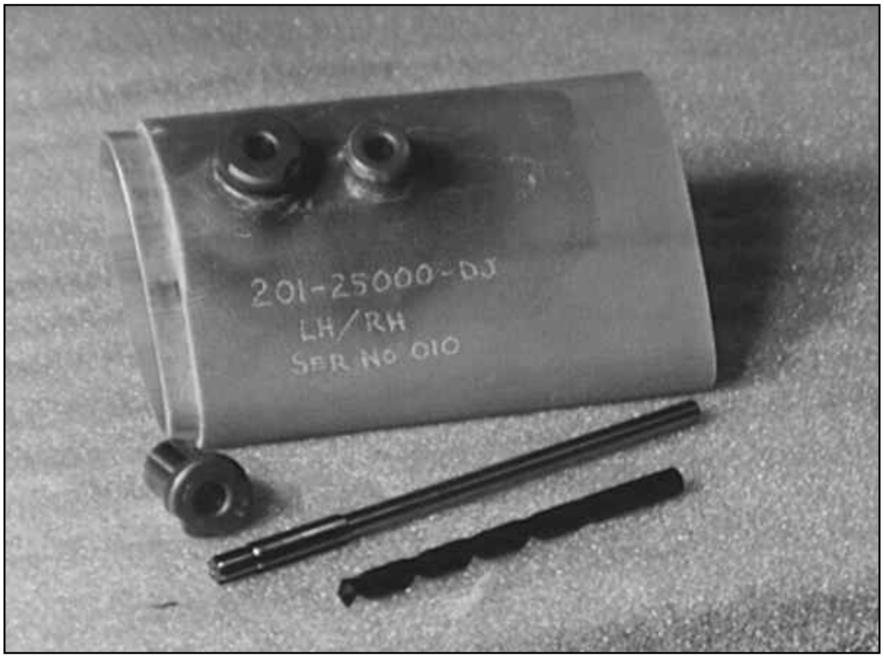

Figure 70: Wing Strut Drill Jig

Drilling the outboard ends of the wing struts requires the use of a **wing strut drill jig** (available on a rental basis from Glasair Aviation, LLC). Without the drill jig, it would be nearly impossible for the average homebuilder (and difficult even for an experienced machinist) to locate the holes correctly and to drill them straight and in proper alignment with the center of the strut attach arm. The jig consists of a fiberglass sleeve molded to slip over the end of the wing strut, with a pair of drill bushings on each side of the sleeve. The inboard drill bushings are 11/32" in diameter and are permanently bonded into the jig. The outboard drill bushings are removable; an 11/32"-diameter and a 3/8"-diameter insert are supplied for the outboard bushings. Also supplied with the jig are an 11/32" drill bit, a 3/8" (.3745") step reamer, and a length of 11/32" drill rod (not shown in Figure 70).

Note The drill jig is shipped with a short section of wing strut inside it. Remove this before using the jig, but replace it when you are finished. Keep the short section of wing strut inside the jig during shipment and storage to help the jig retain its shape.

Caution Before installing the jig, deburr the end of the strut and make sure the strut and the drill jig are free of drill chips, shavings and other debris. To help slide the drill jig onto the strut, you can lubricate it or try squeezing the jig in the chordwise direction (applying force to the leading and trailing edges of the jig sleeve). You can also use a block of wood and a hammer to tap the **end** of the drill jig sleeve, as shown in Figure 71, but **DO NOT hammer on the drill bushings or their receptacles.**

Slip the drill jig over the end of the strut and position it so that the line marked in Step 32d is centered as closely as possible under the **outboard** hole in the drill jig. As Figure 71 shows, the end of the jig **without** the bushings goes **inboard**.

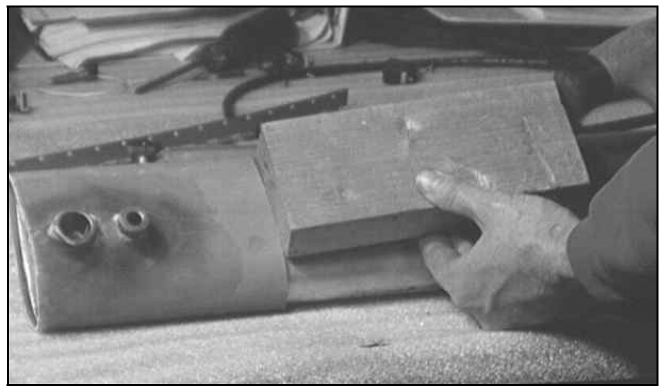

Figure 71: Adjusting the Position of the Drill Jig

31D ?

Mount the removable **11/32"** drill bushing into the receptacle for the **outboard** hole in the wing strut drill jig. Then insert the 11/32" drill bit into the drill bushing until the drill point contacts the strut, as shown in Figure 72, and twist the drill bit with your fingers to make a small mark.

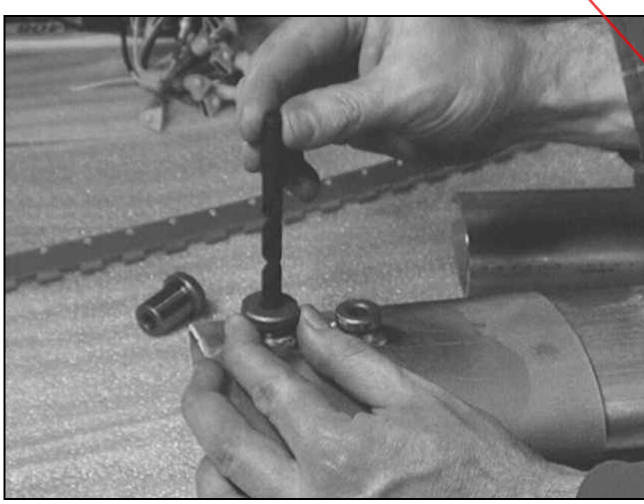

Figure 72: Marking the Hole Center

Remove the drill bit and the bushing and note the distance, if any, between the line marked in Step 32d and the drill bit mark just made; this is the distance you need to move the drill jig on the strut to bring the center of the drill bushing into alignment with your mark. Shift the position of the drill jig as necessary and repeat the drill bit test. Continue in this manner until the drill bit mark is centered on the line marked in Step 32d. When satisfied, clamp the fiberglass portion of the drill jig securely to the strut. A suggested clamping method, using vise-grip pliers, is shown in Figure 73 (pad the vise-grip jaws with small blocks of wood to prevent damage to the jig or the strut).

31D ?

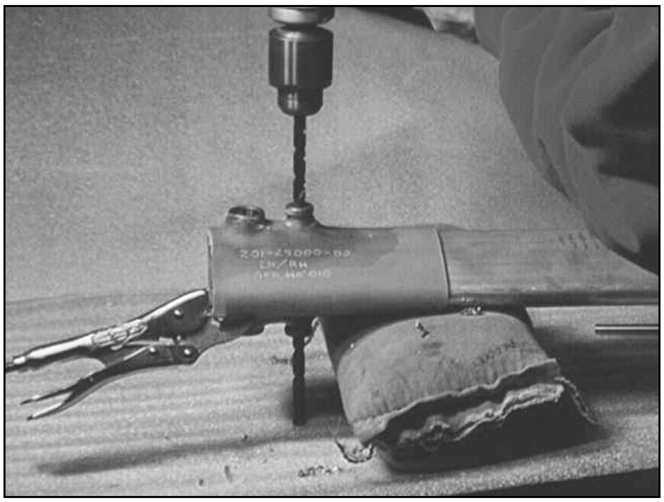

Figure 73: Drilling the Inboard Holes

With the jig now clamped in position, the **inboard** holes will be drilled first. Use the supplied 11/32" drill bit guided by the **inboard** drill bushing (the permanent bushing) to drill through **one side** of the wing strut.

Note Do not attempt to drill all the way through both sides of the strut from one side. Use some light oil (preferably cutting oil) on the drill bit, both to help the bit cut into the strut's metal and to lubricate the bit's rotation in the bushing.

Insert the 11/32" drill rod into the first hole to maintain alignment, as shown in Figure 73, and drill the **inboard** hole on the other side of the strut using the permanent drill bushing on the other side.

Now you can drill the **outboard** holes. Insert the **11/32"** drill bushing into the receptacle for the **outboard** hole and clamp it to keep it from rotating (one way to do this is shown in Figure 74: lightly lock a pair of vise-grip pliers onto the bushing and let the pliers rest against the 11/32" drill rod that is holding the jig's alignment with the inboard holes). Drill the outboard holes, one side at a time; you will have to shift the 11/32" drill bushing to the receptacle on the other side to drill the second outboard hole.

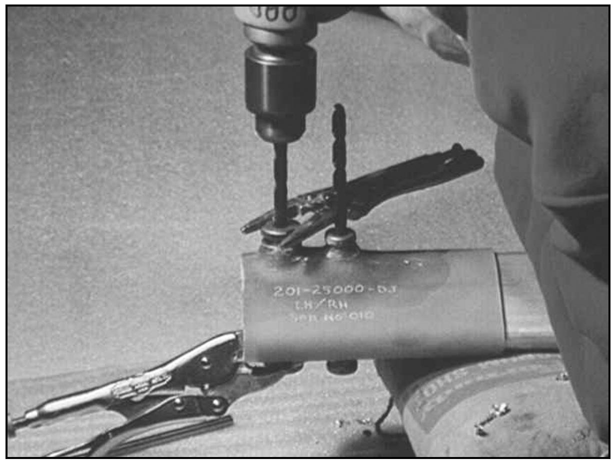

Figure 74: Drilling the Outboard Holes

Replace the 11/32" drill bushing in the outboard receptacle with the **3/8"** bushing, and use the 3/8" (.3745") step reamer to enlarge the outboard holes through the strut. As you did when drilling, ream each side of the strut using the bushing on that side; don't ream all the way through both sides at the same time. Be careful to hold the reamer perpendicular to the strut while reaming. Have a helper assist you by sighting the alignment of the reamer.

Note Leave the **inboard** holes at 11/32"-diameter; these will be reamed to final size (.3745") after the strut is reattached to the strut attach arm in the wing.

Remove the drill jig from the wing strut.

With the strut attach arm bolted between the strut beams in the wing, slide the outboard end of the wing strut over the strut attach arm and pin the inboard end of the strut to the fuselage strut attach lug using the AN8-22 bolt. Secure the outboard end of the strut to the strut attach arm using an AN6-24A bolt inserted through the **outboard** hole in the assembly. Insert the 11/32" drill rod through the inboard hole in the assembly from the **lower** side to properly align the parts for reaming. Run the 3/8" (.3745") step reamer through the inboard hole from the **upper** side, pushing the 11/32" drill rod out as you go. Since you are now reaming all the way through both the wing strut and the strut attach arm, be especially careful to keep the reamer perpendicular to the strut.

Remove the wing strut and deburr the holes in the strut and the strut attach arm. Apply the corrosion protection of your choice to the attach arm and the inside of the strut.

> **Note** The wing strut attach arms have been anodized for corrosion resistance, so only the bolt holes that you reamed require additional protection. Do **not** use an alodine treatment on the strut attach arms as this can damage the anodized finish.

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Step 33: Trim the Outboard End of the Strut *(Optional)*

Note As long as the end of the wing strut does not contact the strut beam assembly in the wing, there is no real need to trim the strut as described here. Especially if the length to be trimmed off the strut is just a small fraction of an inch, the weight saved may not be worth the trouble of trimming. Use your own judgment to decide whether or not to trim the wing strut.

Mark a line around the entire circumference of the strut **3/4" outboard** of the line marked in Step 32d (the center of the outboard attach hole), being careful to make the mark square to the length of the strut.

Caution The 3/4" dimension is a **minimum**. The end of the strut must not be trimmed closer than 3/4" from the **center** of the outboard hole.

Trim the strut at the mark, as shown in Figure 75. Trim outboard of the line first, using a hacksaw or bandsaw, and then file and sand back to the line to remove saw marks. Make sure the finished edge is smooth and thoroughly deburred.

Completed: Left [ ] Right [ ]

Step 34: Bolt the Wing Strut to the Wing

Reinstall the wing strut. Pin the outboard end of the strut to the strut attach arm in the wing, using two AN6-24A bolts as shown in Figure 75. (This is still a temporary installation, so there's no need to install the washers and nuts at this time.) Pin the inboard end to the fuselage fitting with an AN8-22 bolt.

Note If the AN6 bolts feel loose in their holes, substitute NAS close-tolerance bolts (not supplied).

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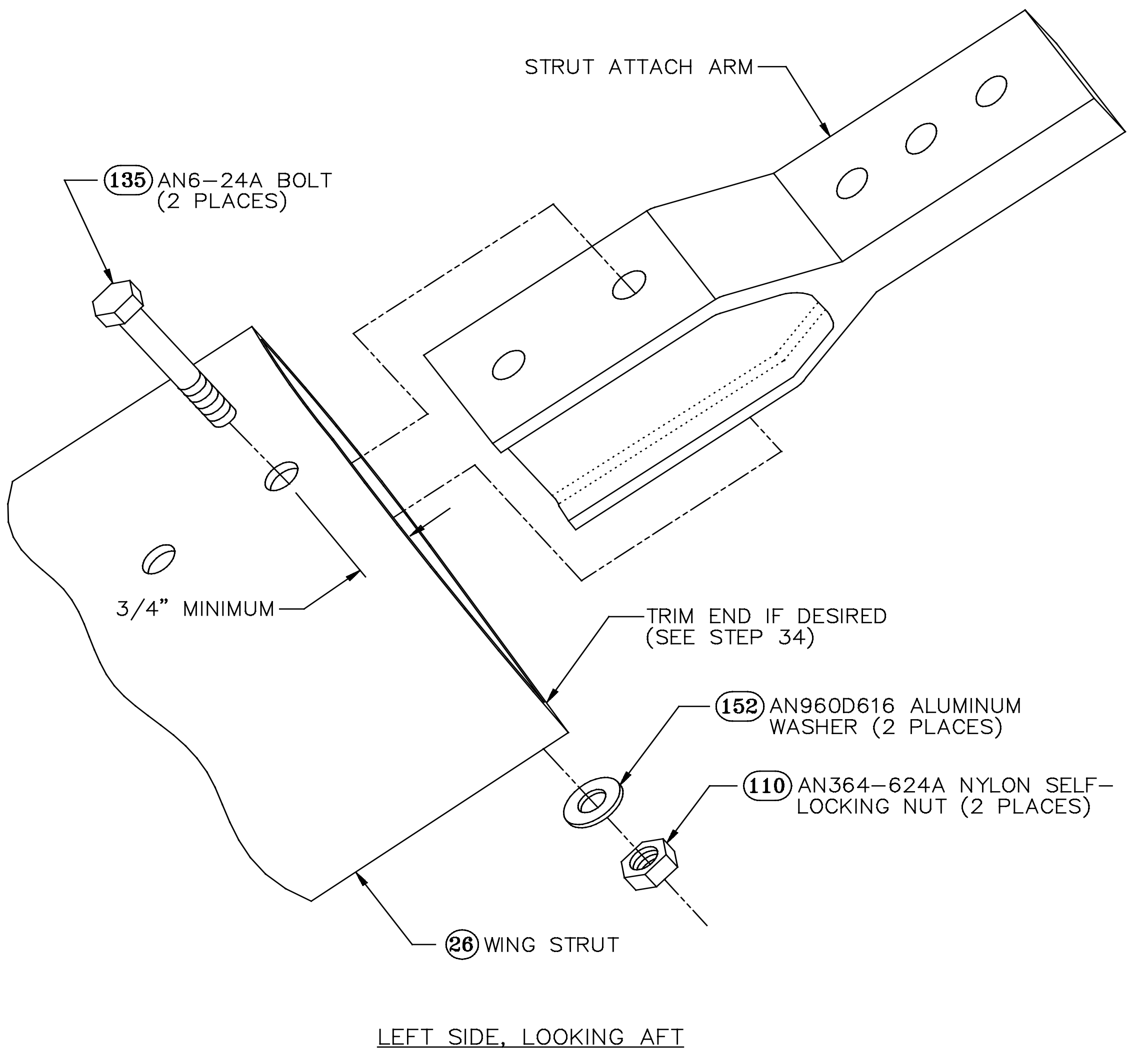

Figure 75: Wing Strut Attachment to Strut Attach Arm

MOUNTING THE FLAPS TO THE WING

Step 35: Mount the Flap to the Flap Tracks

For each flap, pack four flap track **roller bearings** [1] with a light grease, using just enough to coat all the rollers. Avoid using too much, because excess grease acts as a magnet for dirt. Insert a **clamp-up bushing** [25] into each roller bearing.

Have a helper support the flap in position, with the centers of the mounting holes in the flap-track guide arms aligned with the slots in the flap tracks. Place a roller bearing/clamp-up bushing assembly into each slot in each flap track and then place a **nylon flap track bushing** [13] over the clamp-up bushing on each side of the bearing, as shown in Figure 76. Insert an AN3-12 drilled-shank bolt through the guide arms and the clamp-up bushing. Adjust the grip of the bolt with AN960D10 aluminum washers, as necessary, and secure the bolt with an AN310-3 castle nut. Tighten the nut firmly to clamp the clamp-up bushing so that the only movement is between the bearing and the bushing. At final assembly, the nut will be secured with an AN380-2-2 cotter pin, but leave the cotter pin out for now as the flaps will be removed again after the cables have been installed. Install two bearing assemblies at each flap track, one in each slot.

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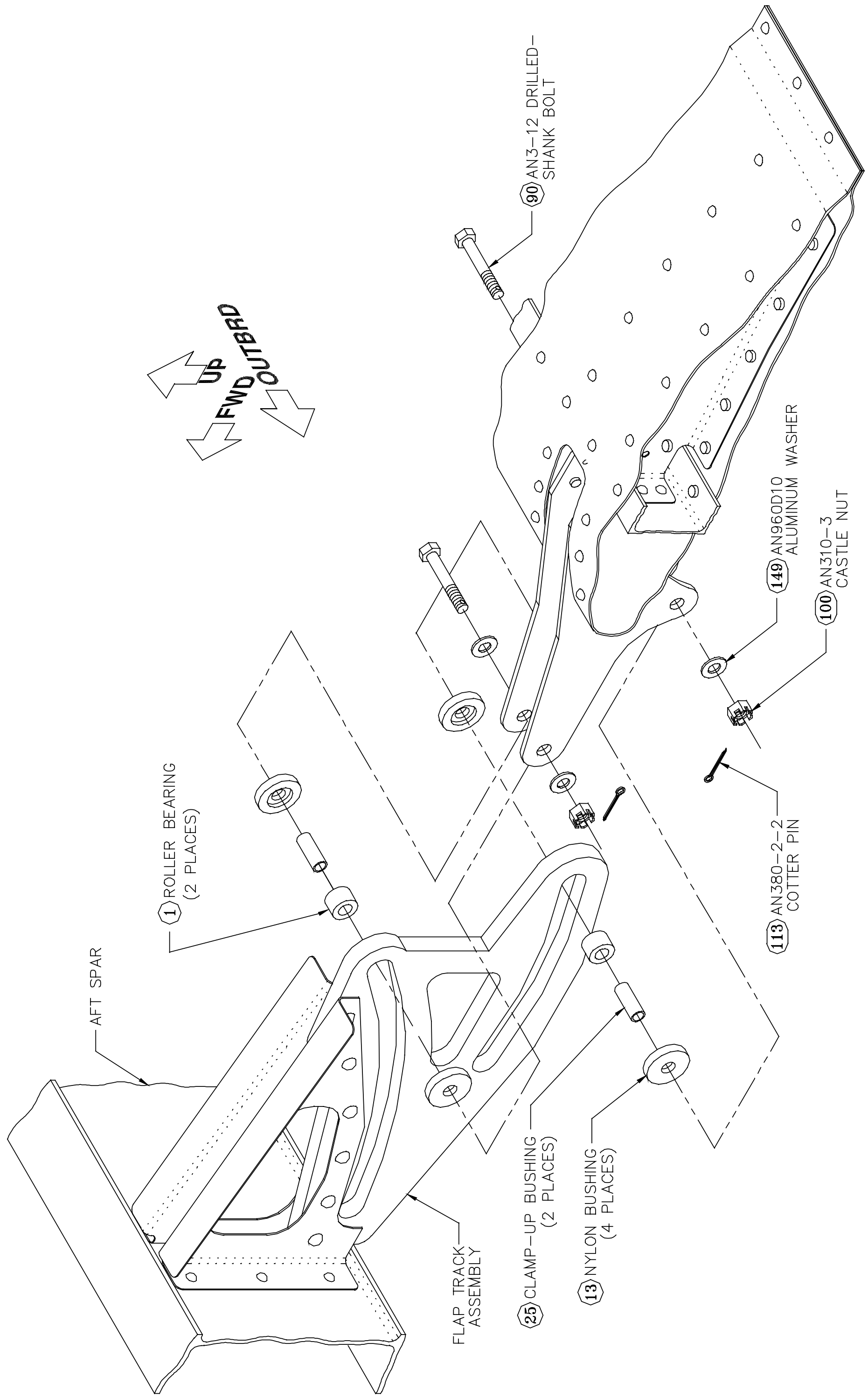

Figure 76: Flap Track Bearing Assemblies

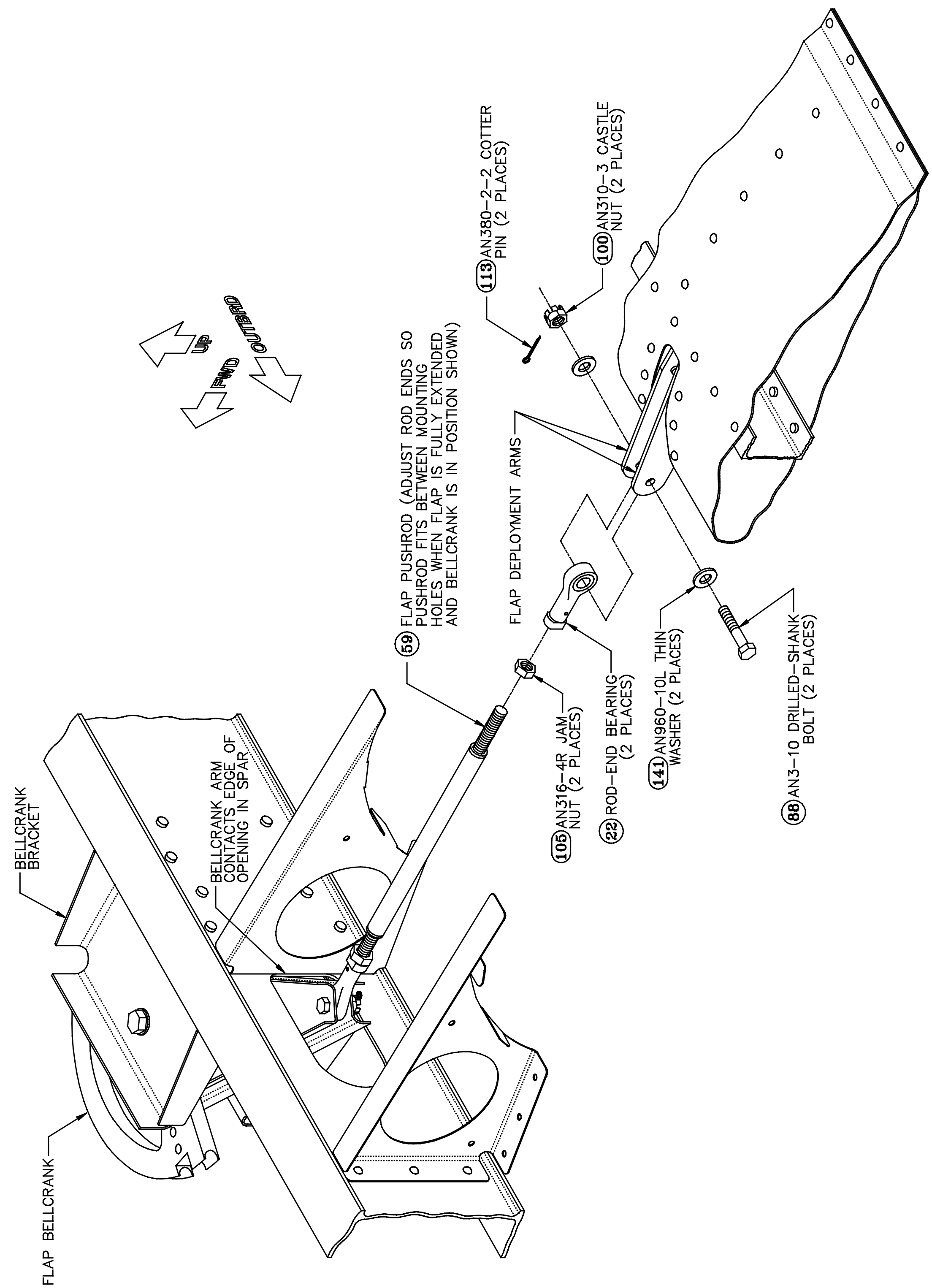

Figure 77: Flap Pushrod Installation

Step 36: Install the Flap Pushrod

Thread an AN316-4R jam nut and a **rod end bearing** [22] onto each end of the **flap pushrod** [59], as shown in Figure 77.

Move the flap to the fully extended position with the roller bearings at the aft ends of the slots in the flap tracks. Also, move the flap bellcrank arm as far aft as possible so that it contacts the edge of the cutout in the spar. Adjust the length of the pushrod by threading the rod ends in or out until they will fit between the attach holes in the bellcrank arm and the flap deployment arms. Secure the rod ends by tightening the jam nuts firmly against them.

Warning Verify that the rod end bearings are threaded onto the pushrod past the inspection holes in the rod ends. As was done for the elevator linkage, insert a piece of safety wire into the inspection holes to check that the rod ends are threaded on far enough.

Bolt the pushrod assembly between the end of the bellcrank arm and the deployment arms, using an AN3-10 drilled-shank bolt, AN960-10L thin washers, an AN310-3 castle nut and (at final assembly) an AN380-2-2 cotter pin at each end of the pushrod. Insert washers (not shown in Figure 77) between the rod ends and the insides of the mounting arms at both ends, as needed, to eliminate axial play.

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MOUNTING THE AILERONS TO THE WINGS

Step 37: Mount the Aileron to the Aileron Hinges

Use a **9/32"** drill bit to enlarge the holes in eight AN970-3 large washers (four for each wing). These washers will be used as hinge bearing retainers for the aileron hinges.

Mount the ailerons to the aileron hinge arms, as shown in Figure 78. The AN960-416L thin washers and then the modified AN970-3 large washers go right next to the hinge arms on each side; the thin washers keep the large washers from rubbing on the hinge arm when the pivot bolt is tightened. At the **outboard** hinge, use an AN4H14A **drilled-head bolt** [131] and an AN960D416 aluminum washer to secure the aileron. Install an NAS42DD8-13 **aluminum spacer** [165] on the outboard side of the hinge arm and AN960-416 washers on the inboard side, as needed, to prevent lateral movement of the aileron. At the **inboard** hinge, use an AN4H20A **drilled-head bolt** [132] and an AN960D416 aluminum washer to mount the aileron, with an NAS42DD8-43 **aluminum spacer** [167] on the outboard side of the hinge arm and AN960-416 washers as shims. The inspection openings in the lower surface of the aileron provide access for inserting the hinge bolts.

Note If the inboard end of the aileron interferes with the outboard end of the flap, or if the aileron hinge arms interfere with the interiors of the slots in the aileron, adjust the lengths of the spacers and the positions of shim washers, as needed, to move the aileron in the spanwise direction to achieve free movement. File or belt sand spacer(s) to final length, if necessary.

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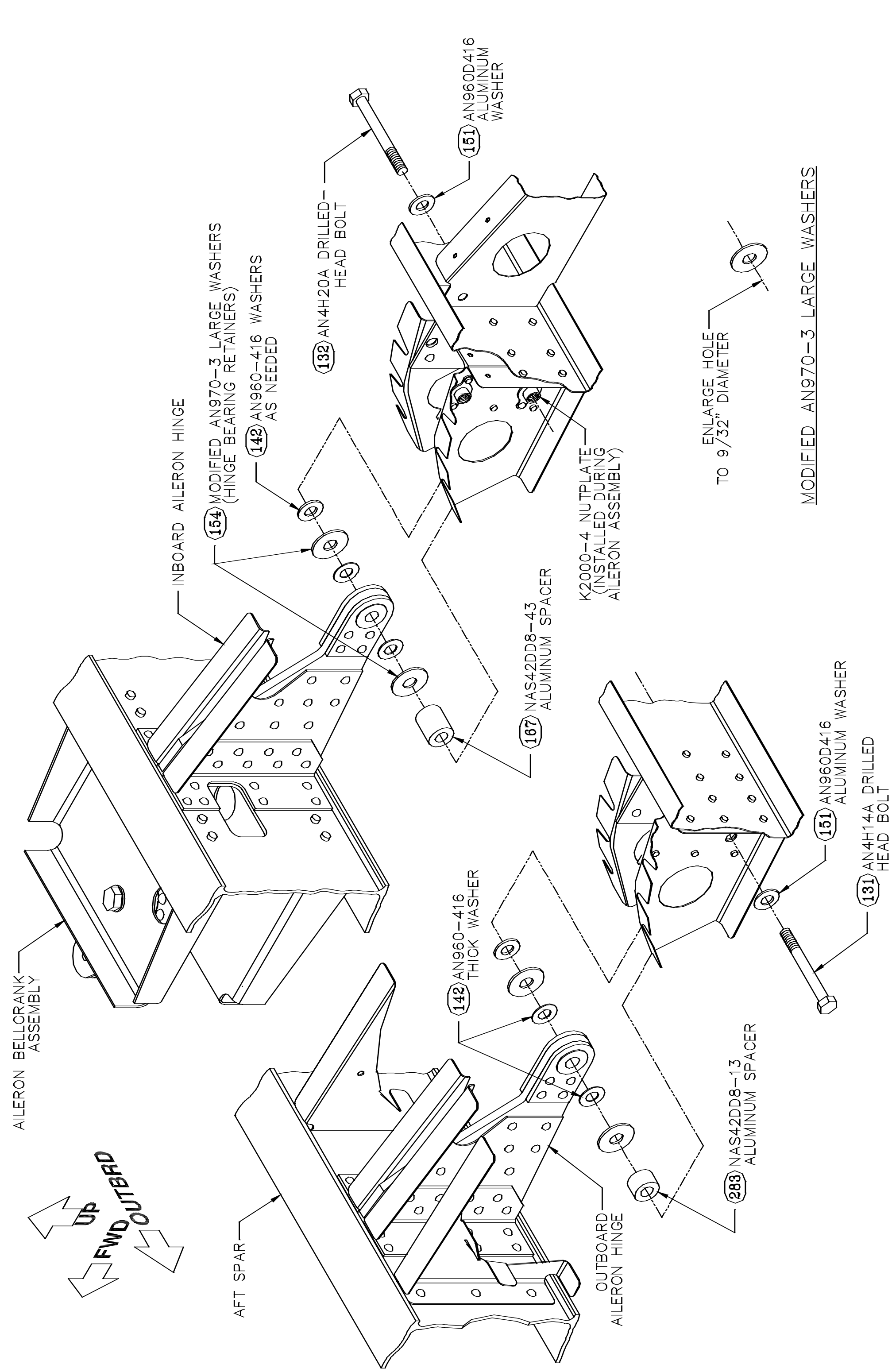

Figure 78: Mounting the Aileron to the Hinges

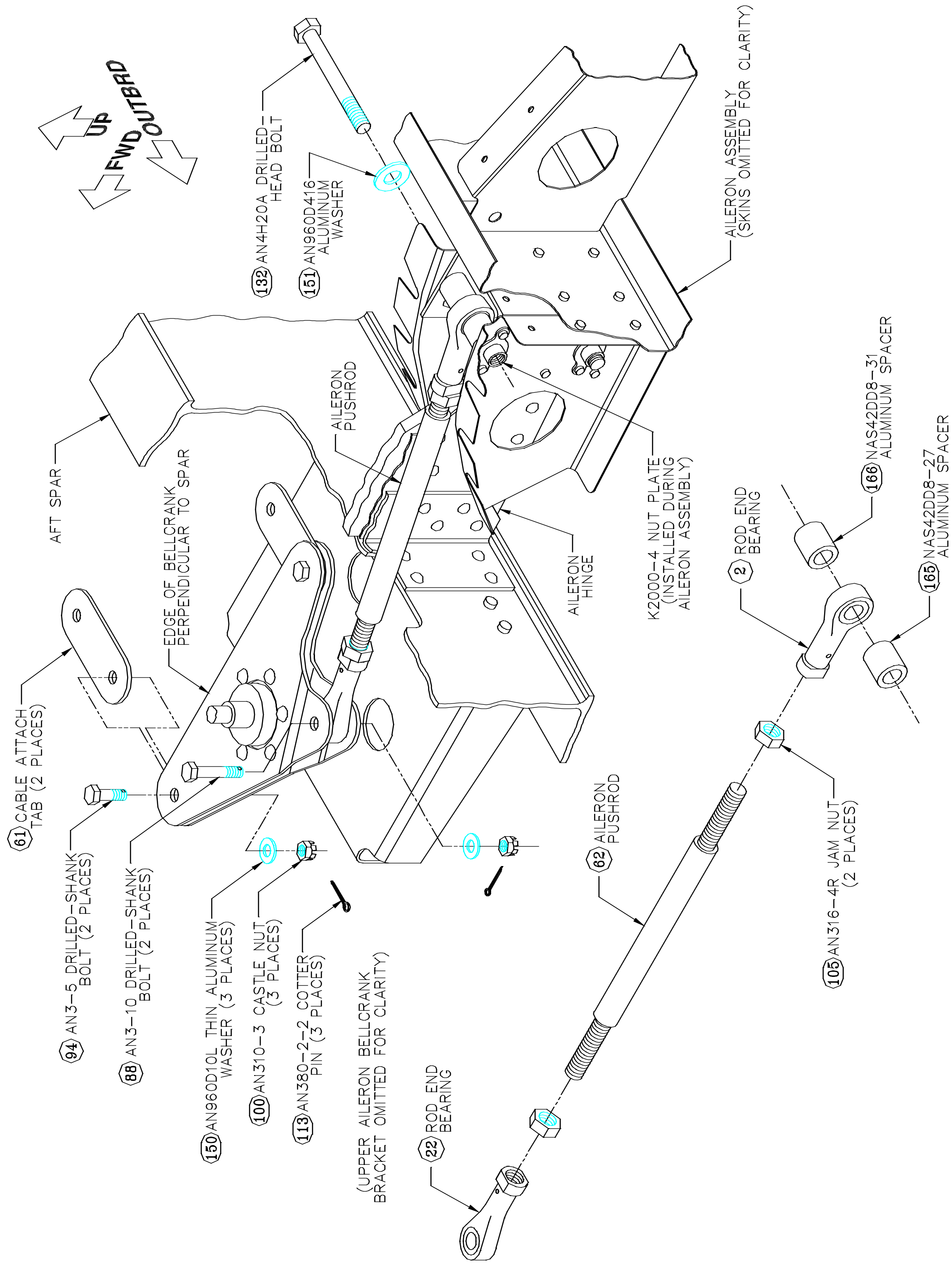

Figure 79: Aileron Pushrod and Cable Attach Tab Installation

Step 38: Install the Aileron Pushrod and Cable Attach Tabs

Thread an AN316-4R jam nut onto each end of the **aileron pushrod** [62]. Thread a 1/4" bolt-diameter **rod end** [2] onto the aft end of the pushrod; thread a 3/16" bolt-diameter rod end [22] onto the forward end of the pushrod, as shown in Figure 79.

Support the aileron in the neutral position—even with the flap when the flap is fully retracted (you can use tongue depressors and small C-clamps to clamp the aileron trailing edge to the flap trailing edge). Then, move the aileron bellcrank to the neutral position—with the inboard edge of the bellcrank perpendicular to the spar. Adjust the length of the pushrod by threading the rod ends in or out until they will fit between the attach holes in the bellcrank and the aileron. Verify that each rod end is threaded onto the pushrod past the inspection hole, and adjust as necessary. When satisfied, secure the rod ends by firmly tightening the jam nuts against them.

Bolt the forward end of the pushrod between the bellcrank arms, using an AN3-10 drilled-shank bolt [88], an AN960D10 aluminum washer and an AN310-3 castle nut. (At final assembly, the nut will be secured with an AN380-2-2 cotter pin.) Bolt the aft end to the aileron with an AN4H20A drilled-head bolt [132], one NAS42DD8-31 **aluminum spacer ,** one [165] NAS42DD8-27 **aluminum spacer,** [166] and an AN960D416 aluminum washer, as shown.

> **Note** As with the aileron hinges, adjust the sizes and positions of the spacers and insert shim washers, as needed, to eliminate any interference between the pushrod and the sides of the slot in the aileron.

Secure a control cable attach tab to each end of the aileron bellcrank with an AN3-5 **drilled-shank bolt** [94], an AN960D10L thin aluminum washer, an AN310-3 castle nut and an AN380-2-2 cotter pin, as shown in Figure 79. The attach tabs fit **between** the two halves of the bellcrank. As usual, apply a light coat of grease to all moving parts.

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FLAP CONTROL CABLES INSTALLATION

Step 39: Fabricate the Inboard Cable Guide

The aileron and flap cables pass through the inboard flap track attach ribs. A plastic guide is needed in this location to keep the cables from wearing the ribs. Cut a **4"** length of the 5/16" X 1" **polyethylene block** [9] to form the inboard cable guide. Trim one end at a **72°** angle, as shown in Figure 80, so that the piece can rest between the ribs on the upper side of the inboard flap track with the angled end against the aft spar.

Place the cable guide in position and mark the outline of the cutout in the flap track rib onto the guide. Drill **#30** holes through the flap track ribs and the cable guide in the two positions shown. Remove the guide and trim it **1/4"** above and inside the marked rib cutout line. Deburr the holes in the flap track ribs.

Reinstall the cable guide and secure it in place with 1/8" aluminum **blind rivets** [10].

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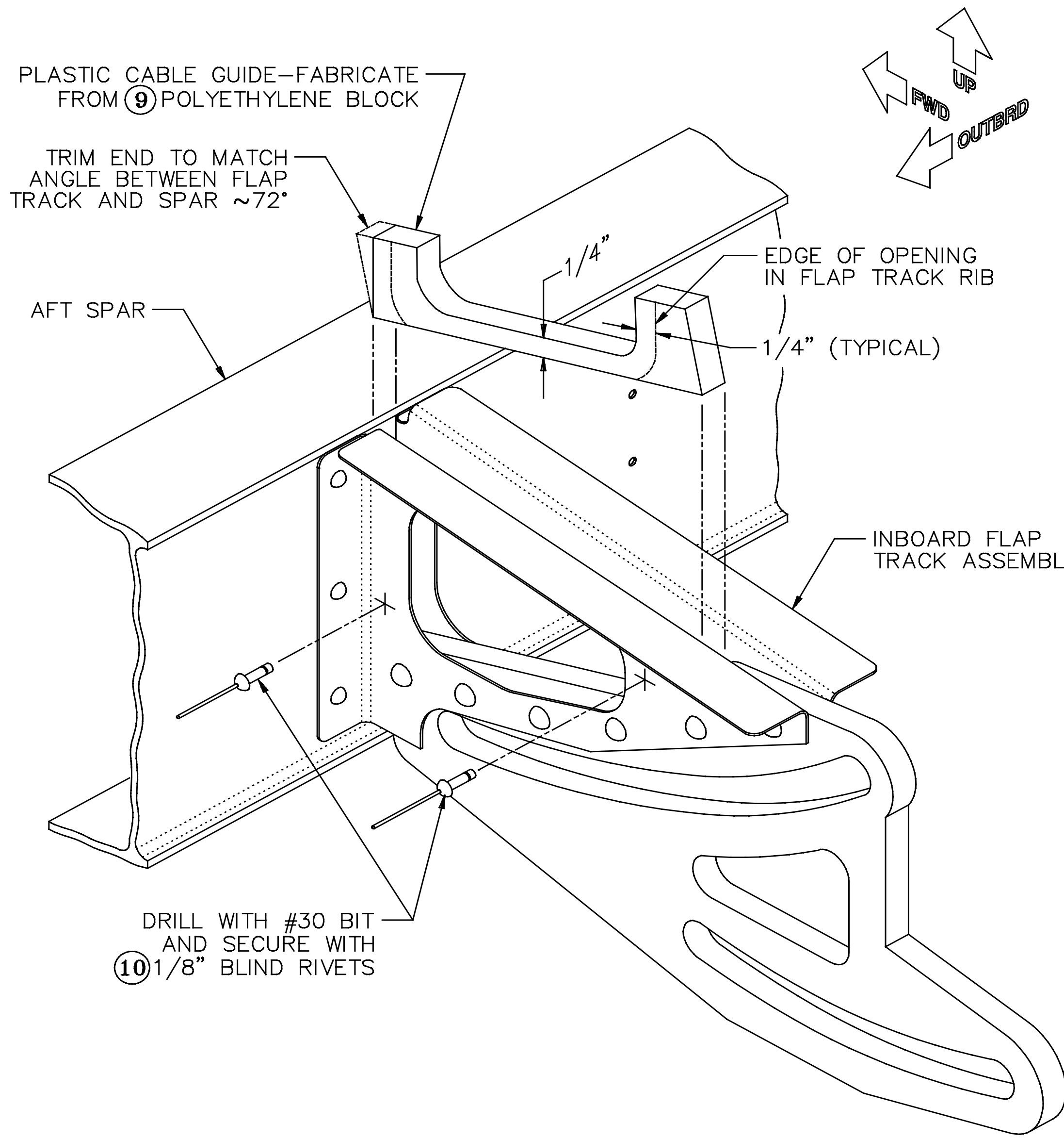

Figure 80: Inboard Cable Guide

Page 140:

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Step 40: Route the Flap Deployment Cable

Insert the ball end of a **flap final deployment cable** [69] into the notch in the **left** flap bellcrank located between the flap bellcrank arms, as shown in Figure 81. (The flap final deployment cable has a swaged ball on one end and a left-hand-threaded turnbuckle end on the other; it is 107" long from the swaged ball to the end of the turnbuckle stud.) Secure the ball end in the bellcrank notch with a **cable retainer clip** [24] fastened with AN3-7A **bolts** [99], AN960D10L thin aluminum washers and AN364-1032A nylon self-locking nuts. The washers and nuts fit into the cutout made in the lower bellcrank arm when the bellcrank was assembled. (See the flap cable schematic, Figure 82, for cable nomenclature and an overview of flap cable routing.)

Route the final deployment cable from the bellcrank through the **outboard** cable hole in the aft spar, over the **lower** flap cable guide pulley, through the cutout in the inboard flap track ribs, across the fuselage centerline, over the **forward** pulley in the **right-side** crossover pulley cluster in the fuselage (you'll have to remove the crossover pulley from its mounting bolt temporarily to fit the swaged end of the cable over the pulley) and down toward the lower, outboard flap pulleys on the **right** side of the fuselage cage (these are the pulleys shown in Figure 36). Connect a **flap primary cable** [67] to the final deployment cable by threading the swaged turnbuckle ends of both cables equal distances into an MS21251-B5S turnbarrel. (The flap primary cable is 60" long; one end has a right-hand-threaded turnbuckle end and the other end is bare. Of the three flap primary cables supplied, two will be used as the left and right primary deployment cables and the third will be used as the right wing primary retraction cable.) Route the bare end of the flap primary cable over the **forward** pulley in the lower, outboard flap pulley cluster and then over the **top** pulley in the center, right-side cluster. Finally route the cable forward toward the actuator arm on the flap handle.

Repeat for the **right** wing flap deployment cable, which is a mirror-image of the left. The right flap deployment cable routes from the bellcrank across the fuselage centerline to the crossover pulleys on the **left** side of the fuselage. In a later step, the primary deployment cables from both sides will be spliced together between the flap handle and the center flap pulleys, and one of the cables will be secured to the flap actuator arm.

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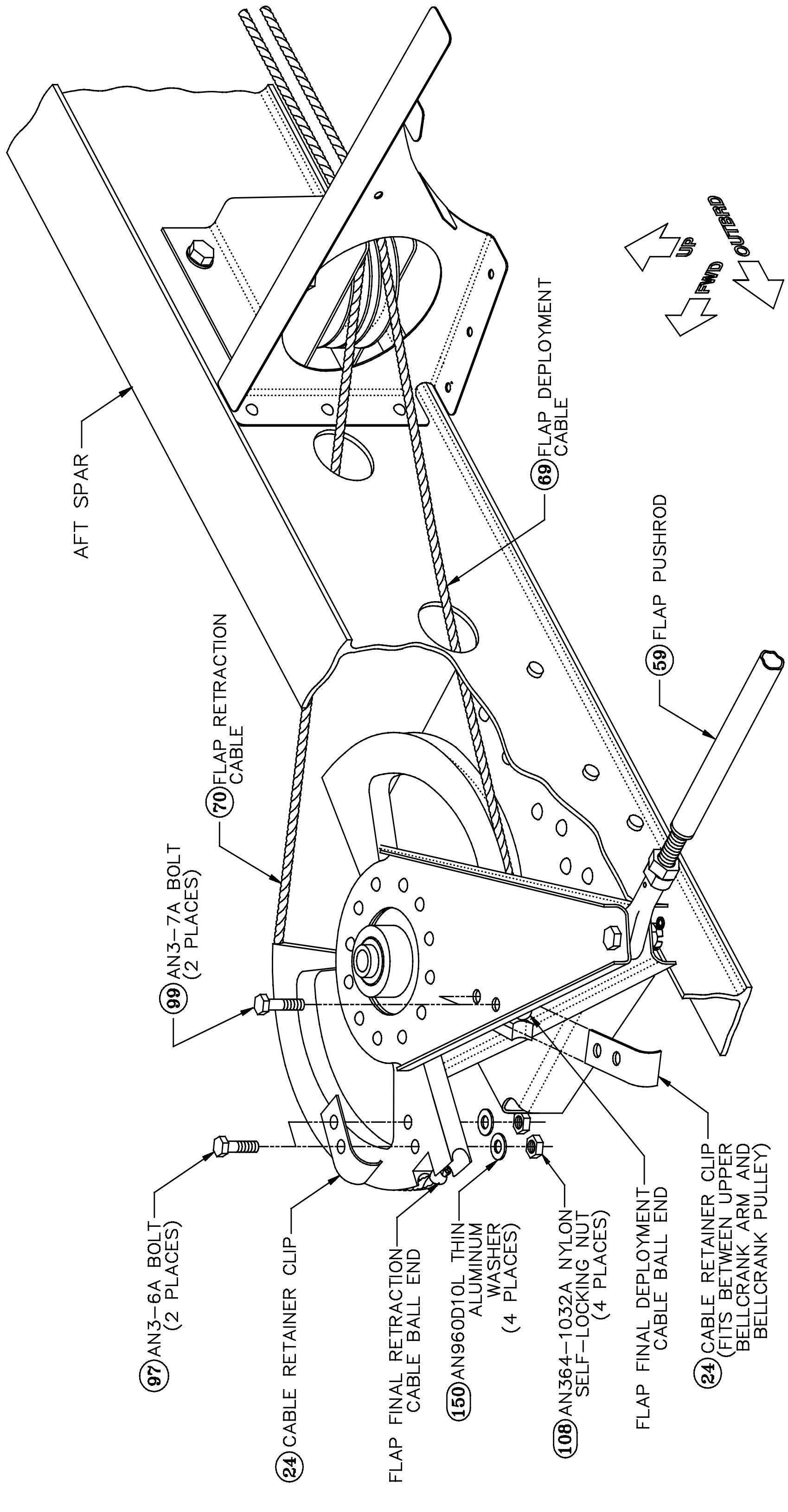

Figure 81: Flap Cable Attachment to the Flap Bellcrank

Step 41: Route the Flap Retraction Cable

Insert the ball end of the **flap final retraction cable** [70] into the remaining notch in the left flap bellcrank, as shown in Figure 81. Secure the cable end in the bellcrank notch with a cable retainer clip fastened with AN3-6A bolts, AN960D10L thin washers and AN364-1032A nuts. (The flap final retraction cable is 116" long from the swaged ball to the end of the turnbuckle end; the turnbuckle end has left-hand threads.)

Route the final retraction cable through the **inboard** cable hole in the aft spar, over the **upper** flap cable guide pulley, through the cutout in the inboard flap track ribs, across the fuselage centerline, over the **center** pulley in the **right-side** crossover pulley cluster in the fuselage and down toward the lower, outboard flap pulleys on the **right** side of the fuselage cage. Connect the **flap primary retraction cable** [68] to the final retraction cable by threading the swaged stud ends of both cables equal amounts into an MS21251-B5S turnbarrel. (The flap primary retraction cable is 90" long; one end has a right-hand-threaded turnbuckle end and the other end is bare.) Route the bare end of the primary retraction cable over the **aft** pulley in the lower, outboard flap pulley cluster and then around the **lower** pulley in the center, right-side cluster. Slide a NicoPress sleeve over the flap primary retraction cable, route the cable forward to the underside of the flap cable reversing pulley in the forward pulley group, and then up and over the pulley and back to the forward side of the actuator arm on the flap handle. Slide a second NicoPress sleeve over the end of the cable.

Repeat a mirror-image installation for the right wing, with one exception. For the right wing, you will fasten a **flap primary cable**, instead of a **flap primary retraction cable**, to the flap final retraction cable. (The flap primary cable is the same as used for the primary deployment cables. We will hereafter refer to this flap primary cable as the “right wing primary retraction cable.”) The right wing primary retraction cable will fasten to the left wing primary retraction cable with a NicoPress splice between the flap cable reversing pulley and the lower center pulley cluster. Refer to the schematic, Figure 82, for clarification.

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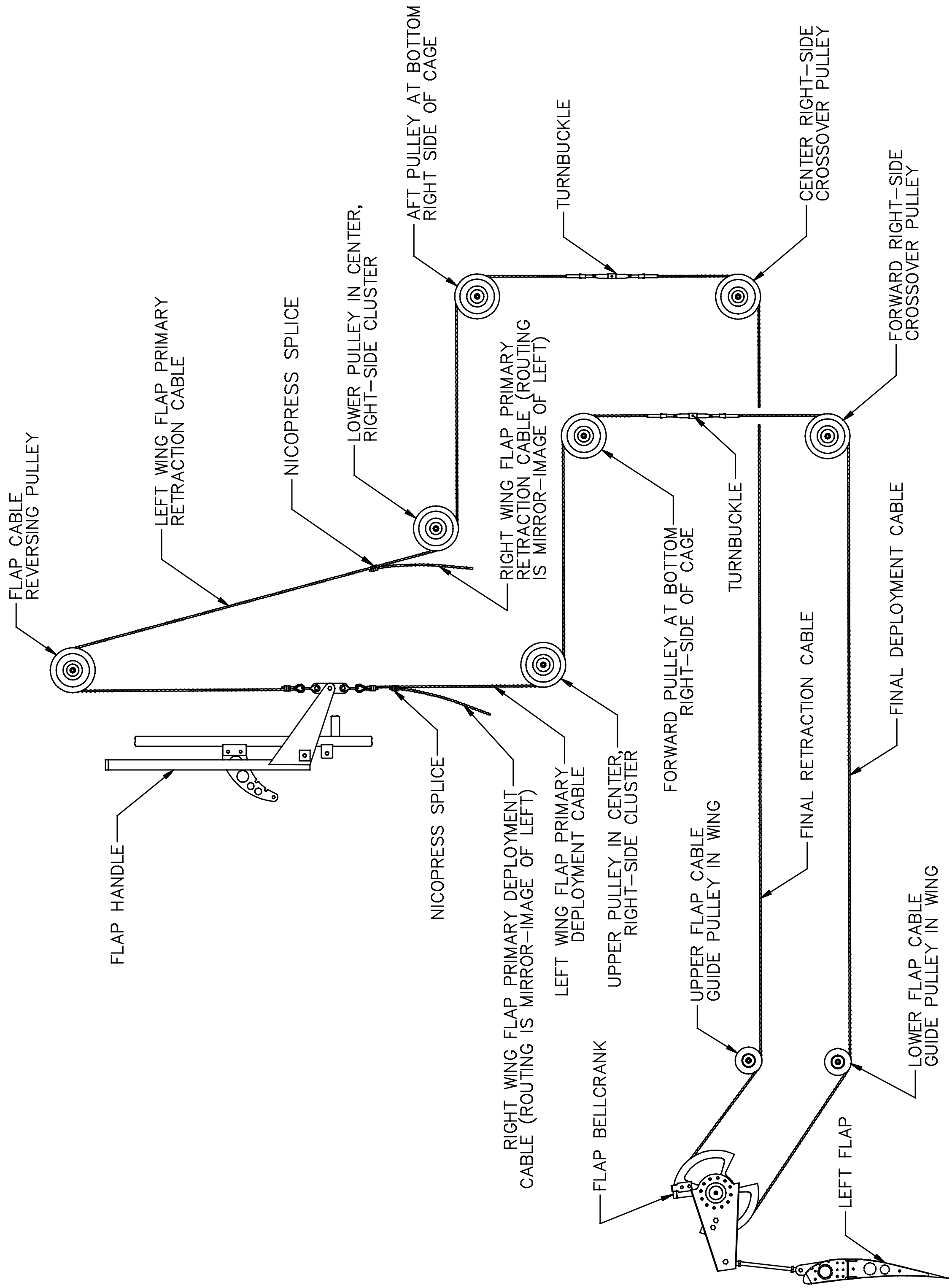

Figure 82: Flap Cable Schematic

Step 42: Complete the Flap Cables

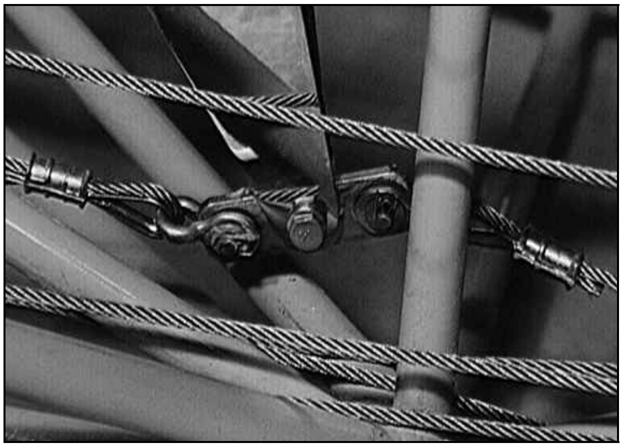

Figure 83: Cable Attachment to Flap Actuator Arm

Fabricate the flap cable attach tab from the **.090" X 3/4" X 6" steel sheet** [14], as shown in Figure 84. Since the flap handle actuator arms are angled slightly, form a slight S-bend in the cable attach tab to align the ends of the tab parallel to the fuselage centerline. Form the S-bend by clamping each end of the tab in a vise (one end at a time) and striking the tab with a hammer. Deburr the tab, as usual, and apply corrosion-proofing.

Bolt the cable attach tab between the two sides of the flap actuator arm, using an AN3-5 drilled-shank bolt, an AN960-10L thin washer, an AN310-3 castle nut and an AN380-2-2 cotter pin.

Insert an AN100C-4 cable thimble into each of two AN115-21 shackles and secure one of the shackles to each end of the cable attach tab with an AN393-11 clevis pin, an AN960-10L thin washer and an AN380-2-2 cotter pin, as shown in Figure 84.

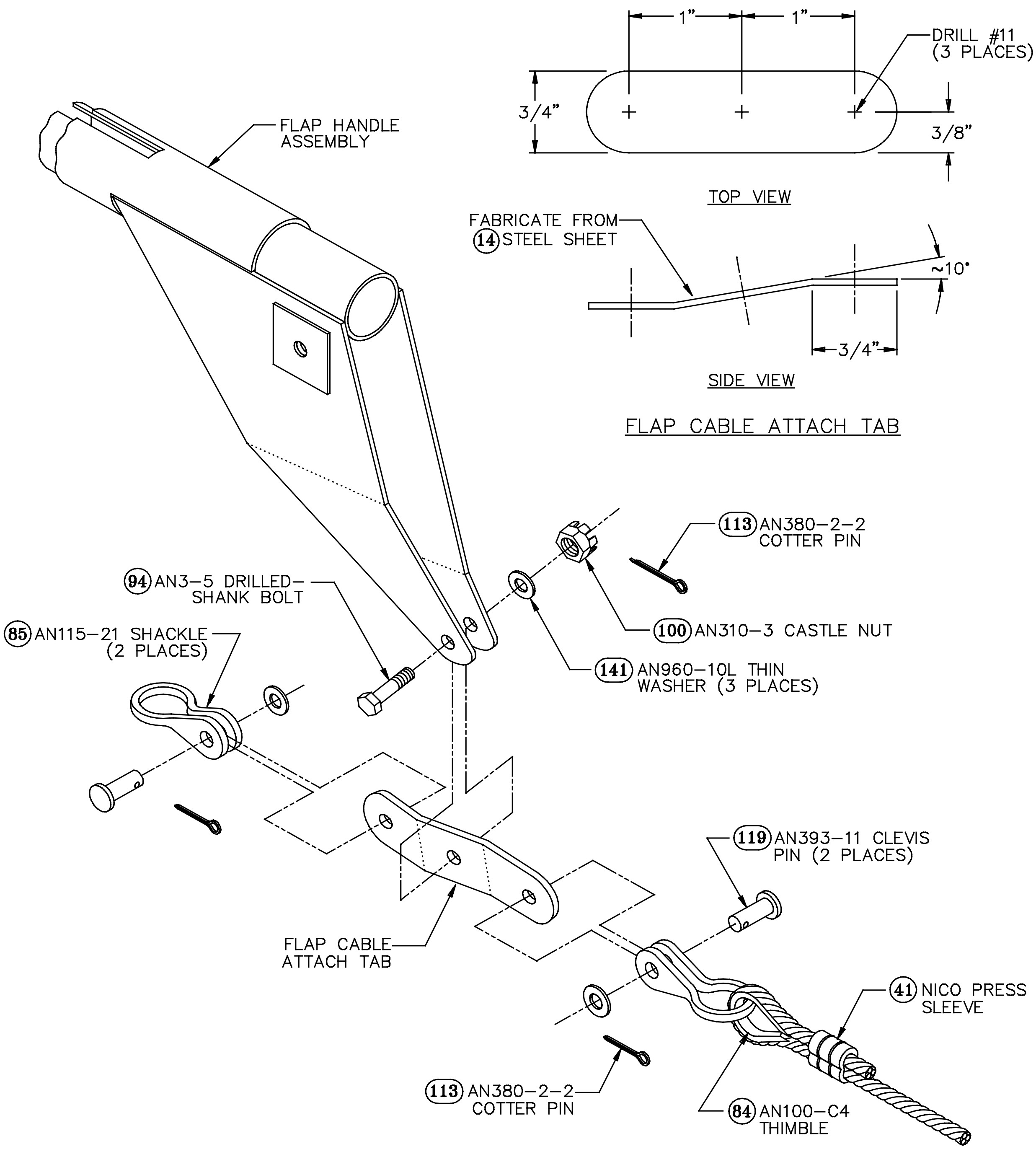

Figure 84: Flap Cable Attachment to Flap Handle

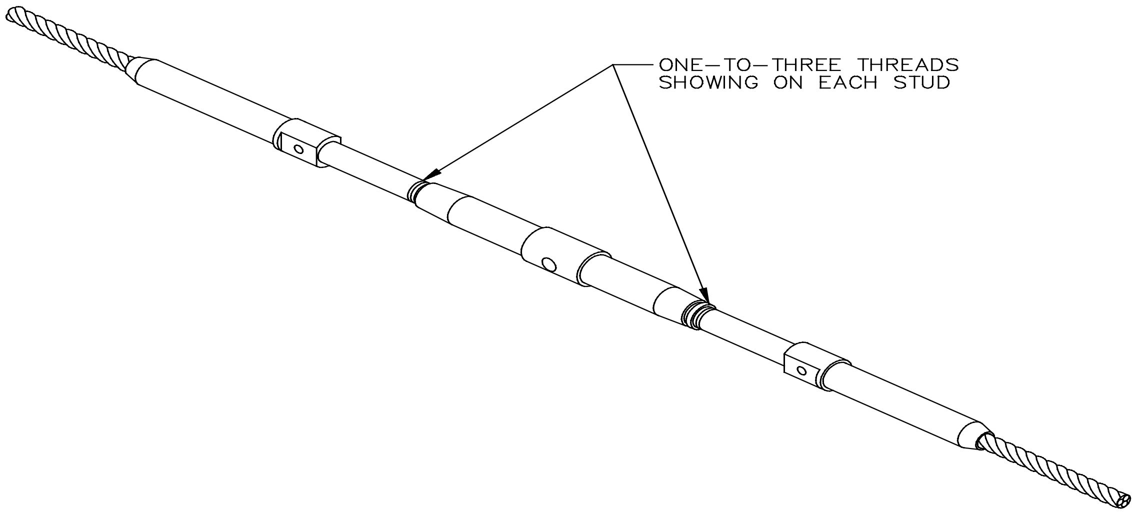

Figure 85: Initial Turnbuckle Adjustment

Adjust the turnbuckles in all four flap cables so that one-to-three threads of the turnbuckle end of each cable are showing past the end of the turnbarrel.

Move both flaps to the fully **retracted** position (all roller bearings at the forward ends of the slots in the flap tracks) and hold them there with lengths of duct tape between the flaps and the wings. Move the flap handle to the flaps fully retracted position, pushing the handle down until the pin in the plunger locks into the lowest notch in the ratchet plate.

Loop the left wing primary retraction cable over the thimble in the forward end of the flap cable attach tab and then back through the NicoPress sleeve, as shown in Figures 82 and 86. Pull the cable tight, making sure that it is properly seated in all of the pulleys, and secure the free end to itself with a 1/8" cable clamp placed close to the NicoPress sleeve.

Insert the end of the right wing primary flap retraction cable through the other NicoPress sleeve installed on the left wing primary retraction cable. Pull the right wing cable tight and use a second 1/8" cable clamp to secure the cable to the left wing primary cable close to the diagonal tube in the fuselage keel, as shown in Figure 86 (this splice is also shown directly above the fuselage cage attach tab at the lower edge of Figure 87).

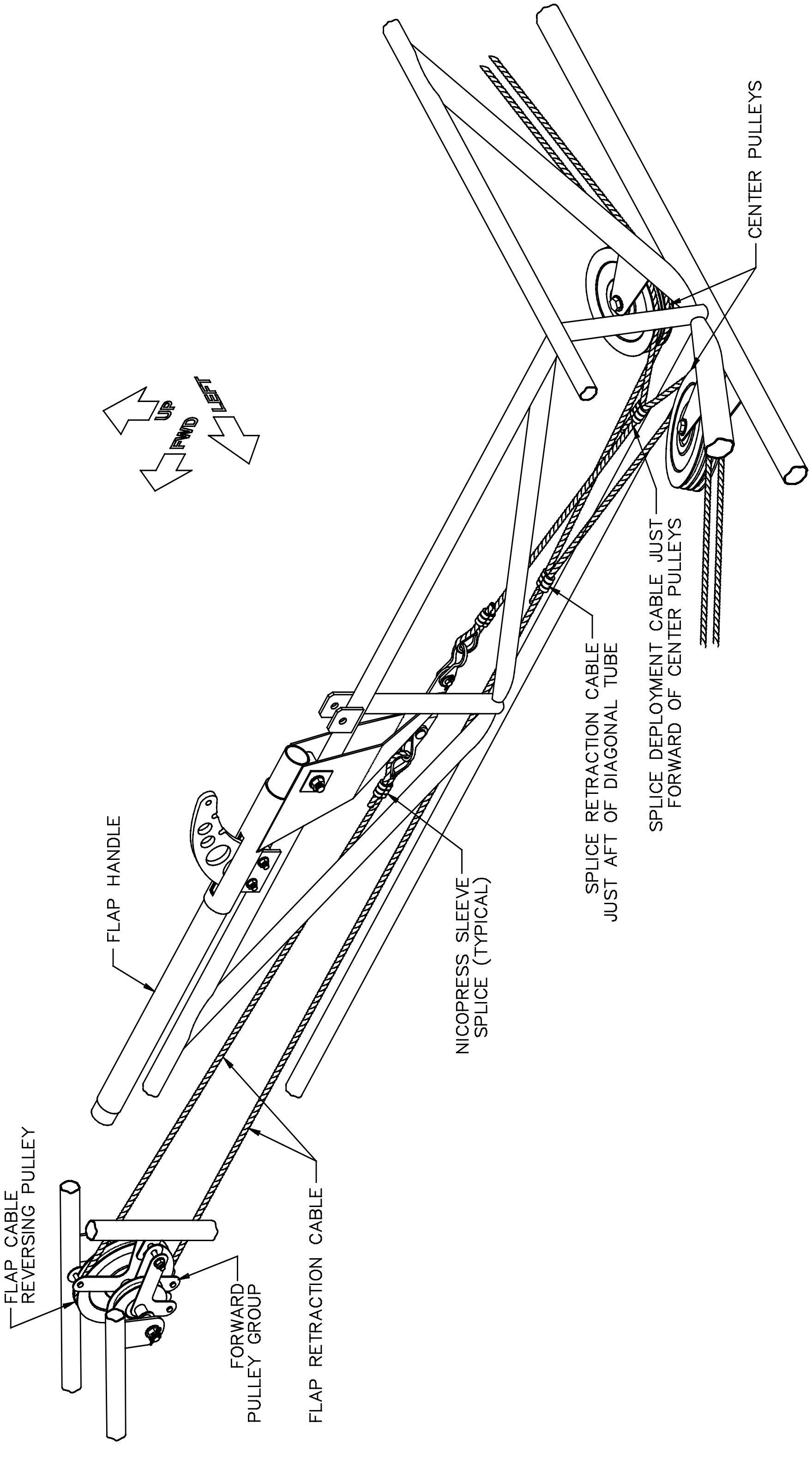

Figure 86: Flap Cable Completion

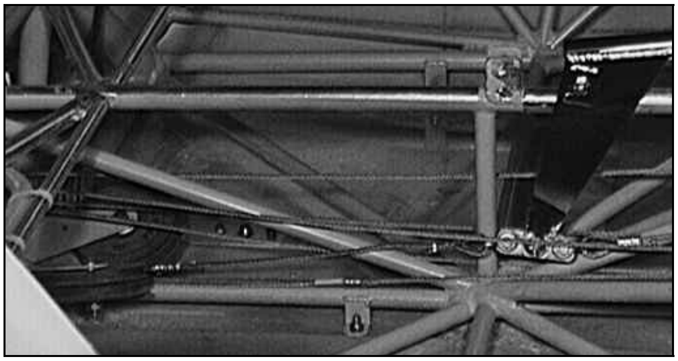

Figure 87: Flap Cable Installation in Fuselage

Slide **two** NicoPress sleeves over the left wing primary flap **deployment** cable. Loop the cable over the thimble in the **aft** end of the flap cable attach tab, and then back through the forward NicoPress sleeve. Pull the cable tight and secure its free end to itself with a 1/8" cable clamp placed close to the NicoPress sleeve. Insert the end of the right wing primary flap deployment cable through the other NicoPress sleeve on the left wing deployment cable, and slide the NicoPress sleeve aft to a position just forward of the lower center pulleys, as shown in Figures 86 and 87. Pull the right wing primary cable tight and use a second 1/8" cable clamp to secure it to the primary flap deployment cable just forward of the NicoPress sleeve.

Un-tape the flaps from the wing, and test the flap actuation by moving the flap handle up and down. Adjust the position of the NicoPress splice where the left and right **deployment cables** join so that it is as far from the lower center pulleys as possible when the flaps are retracted, yet doesn't contact the diagonal cage tube aft of the flap handle when the flaps are fully extended. Adjust the position of the NicoPress splice where the left and right **retraction cables** join so that it is as close as possible to the diagonal cage tube, without contacting it, when the flaps are retracted. (Both splices could actually be slightly farther forward than shown in Figures 86 and 87).

> **Note** It is normal for the cables to rub on the fuselage cage in several locations. This will be rectified during final control system rigging in "SECTION X: FINAL ASSEMBLY."

When satisfied with the cable routing, use the procedures described in "SECTION II: TOOLS AND TECHNIQUES" to complete the NicoPress splices and to cut the free ends of the cables to final length, both at the thimbles where the cables attach to the flap handle tab and where the cables from the two wings splice together.

Final rigging of the flap cables and adjustment of cable tension will be accomplished in "SECTION X: FINAL ASSEMBLY" after the wings are installed for the final time.

Completed: [ ]

Aileron Control Cables Installation

Step 43: Fabricate the Aileron Cable Guides

Cut two **4"** lengths of the supplied 5/16" X 1" polyethylene block, as shown in Figure 88, to make the inboard and outboard aileron cable guides. Drill the two **11/32"** diameter holes through the guides at the locations shown.

The inboard cable guide installs above the flap cable guide pulley bracket, as shown in Figure 90; the outboard cable guide fits between the outboard flap track ribs, as shown in Figure 89.

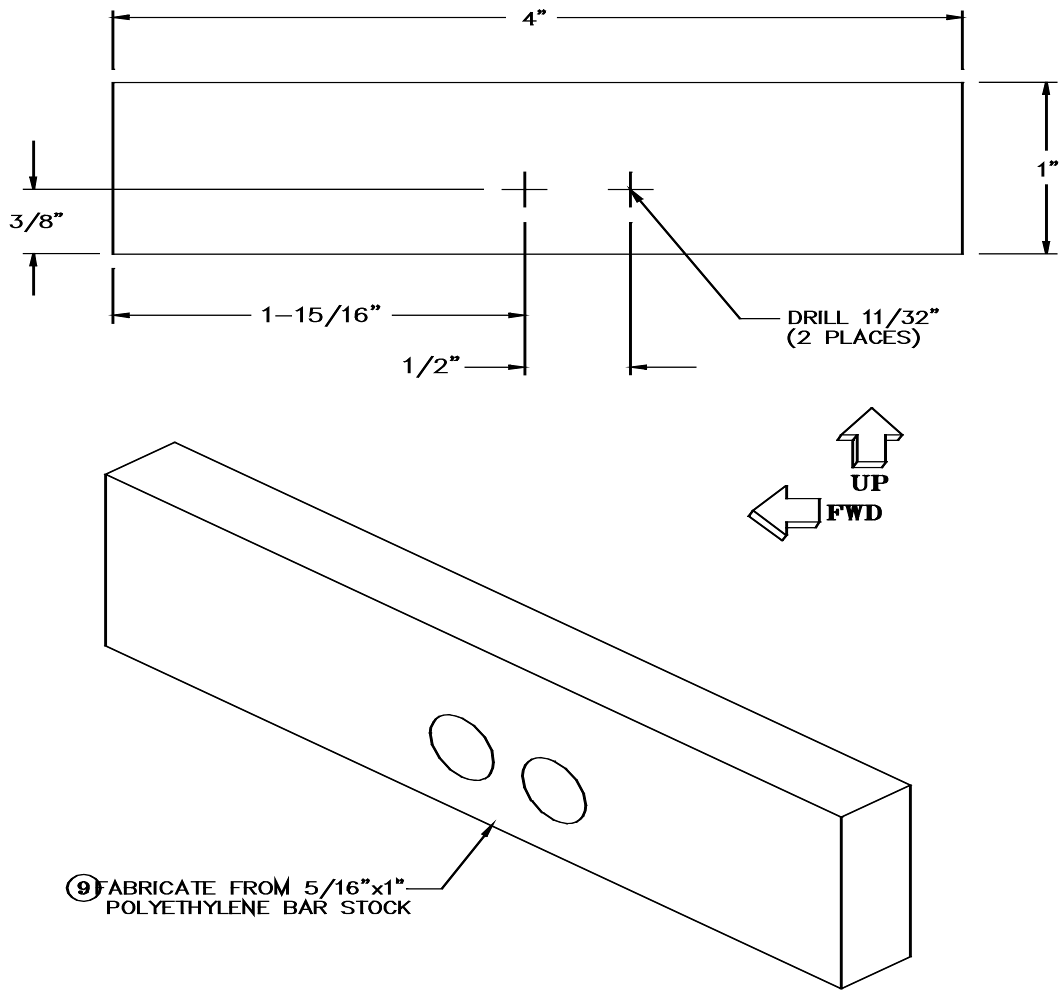

Figure 88: Aileron Cable Guides

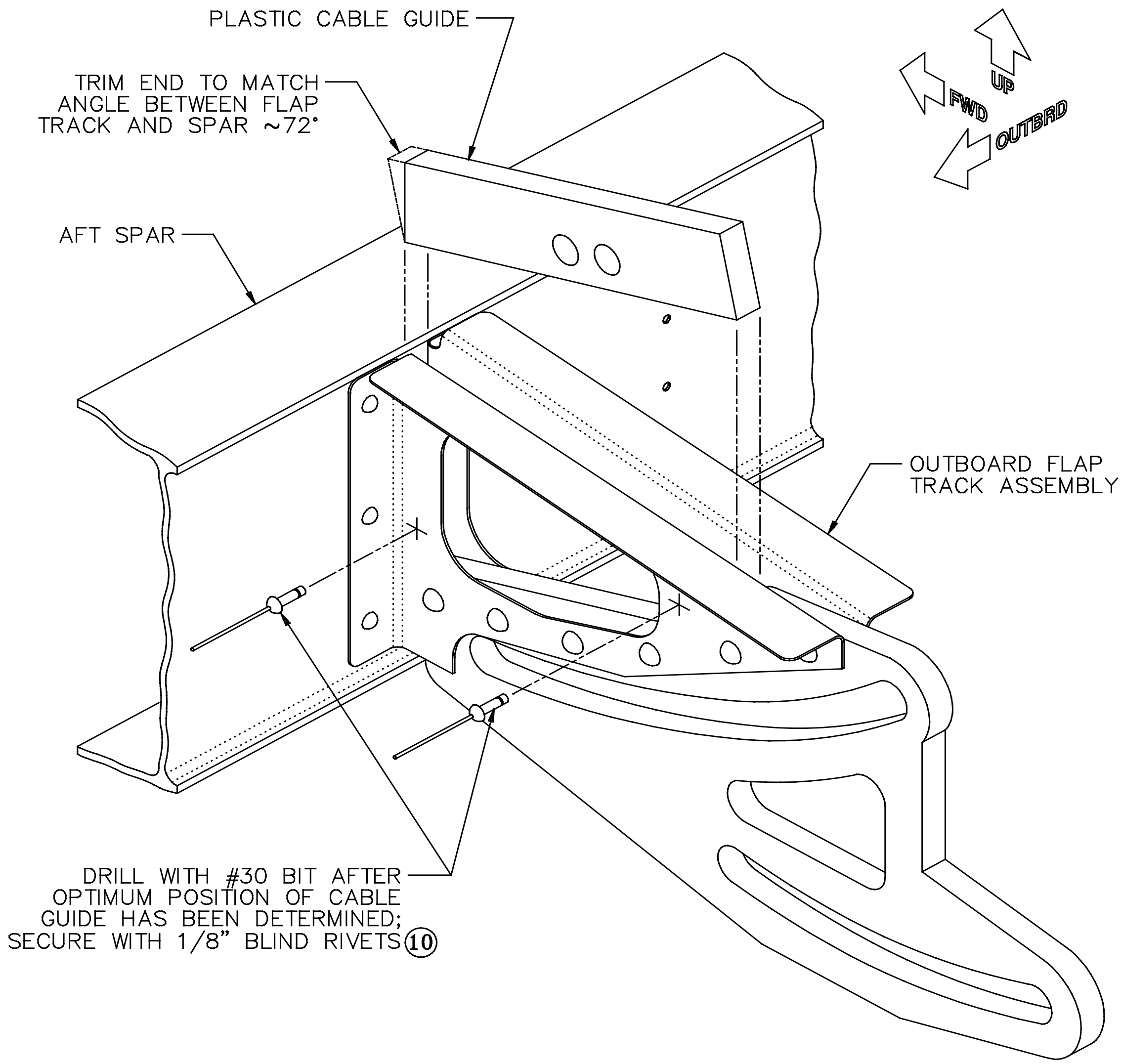

Figure 89: Outboard Aileron Cable Guide Installation

Trim the forward end (the end with the greater distance to the first hole, as shown in Figure 88) of the **outboard** aileron cable guide at a **72°** angle to fit between the upper side of the flap track and the aft side of the aft spar. Slide the outboard guide between the ribs of the outboard flap track assembly, as shown in Figure 89.

✔

Note Do not drill the mounting holes through the cable guides at this time. The mounting holes will be drilled and the guides will be secured with blind rivets after the optimum positions of the guides have been determined.

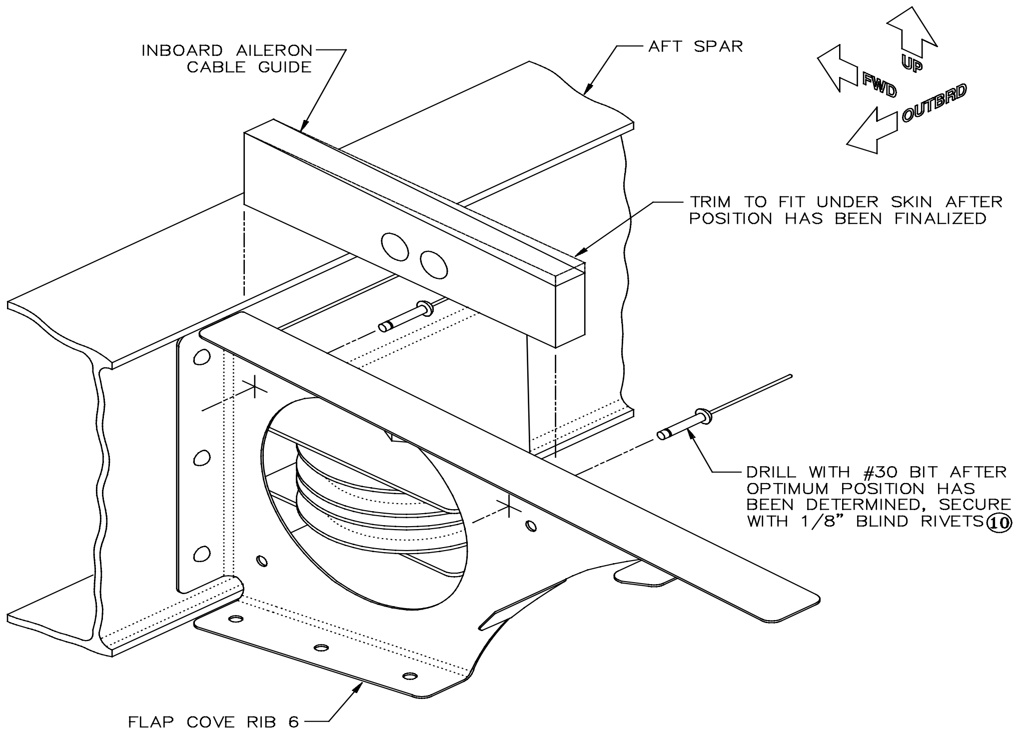

Figure 90: Inboard Aileron Cable Guide Installation

Position the inboard aileron cable guide above the flap cable guide pulley assembly, as shown in Figure 90, and tape it in place temporarily. Again, wait to drill the mounting holes until after the cables have been routed and the optimum positions of the guides have been determined.

Repeat this step for both wings.

Completed: Left [ ] Right [ ]

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Step 44: Route the Aileron Control Cables

Note Refer to the aileron cable schematic, Figure 93, for cable nomenclature and a general overview of cable routing.

AN115-21 Cable Shackles have been in extremely short supply for all of aviation. If your kit is short shipped, the AN115-32 and the AN394-15clevis pin is an acceptable alternative if necessary.

For each of the four cable attach tabs [61] on the aileron bellcranks, slide an AN100C-4 cable thimble over an AN115-21 shackle and secure the shackle to the tab with an AN393-11 clevis pin, an AN960-10L thin washer and an AN380-2-2 cotter pin.

Secure the ailerons, the aileron bellcranks and the control stick pivot brackets in their neutral positions.

Hint The ailerons are in the neutral position when their trailing edges are aligned with the lower surface of the flap (flaps fully retracted). Use wide masking tape or duct tape to secure the flaps in the fully retracted positions and then clamp the aileron trailing edges to the flaps with tongue depressors and tape. Since you adjusted each aileron pushrod to fit between the bellcrank and the aileron when both were in the neutral position, securing the aileron in the neutral position should automatically place the bellcrank in the neutral position, also. If the bellcranks are not in the neutral positions (inboard edges perpendicular to the aft spar web), adjust the lengths of the **aileron pushrods** to achieve this condition. To center the control stick pivot brackets, the 18" interconnect rod length should fall directly below the control stick pivot point, which is also 18". Secure the interconnect rod with a pair of vise-grip pliers (padded with tongue depressors) clamped onto the rod at each end of the elevator/aileron control yoke.

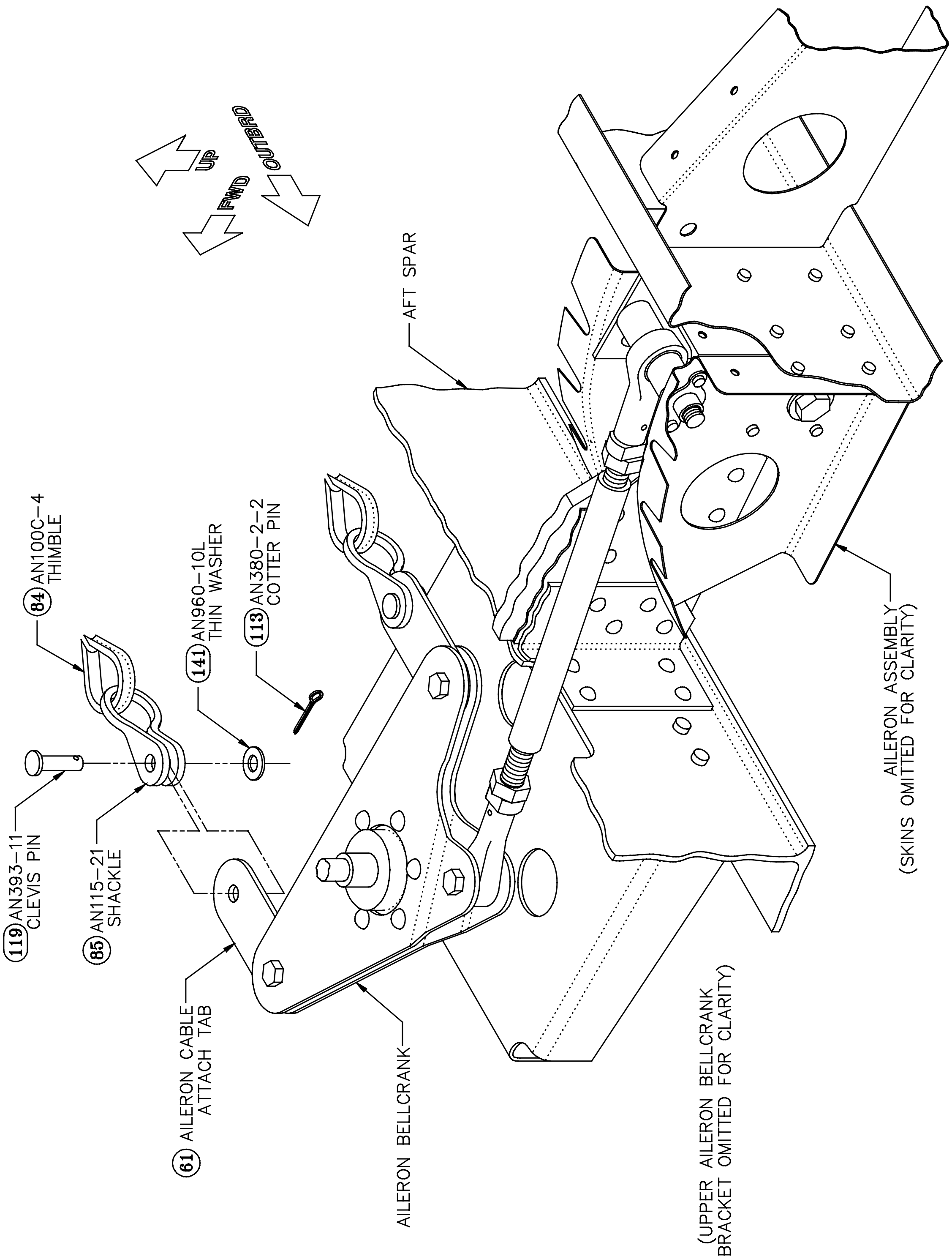

Figure 91: Shackle Attachment to Aileron Control Cable Attach Tab

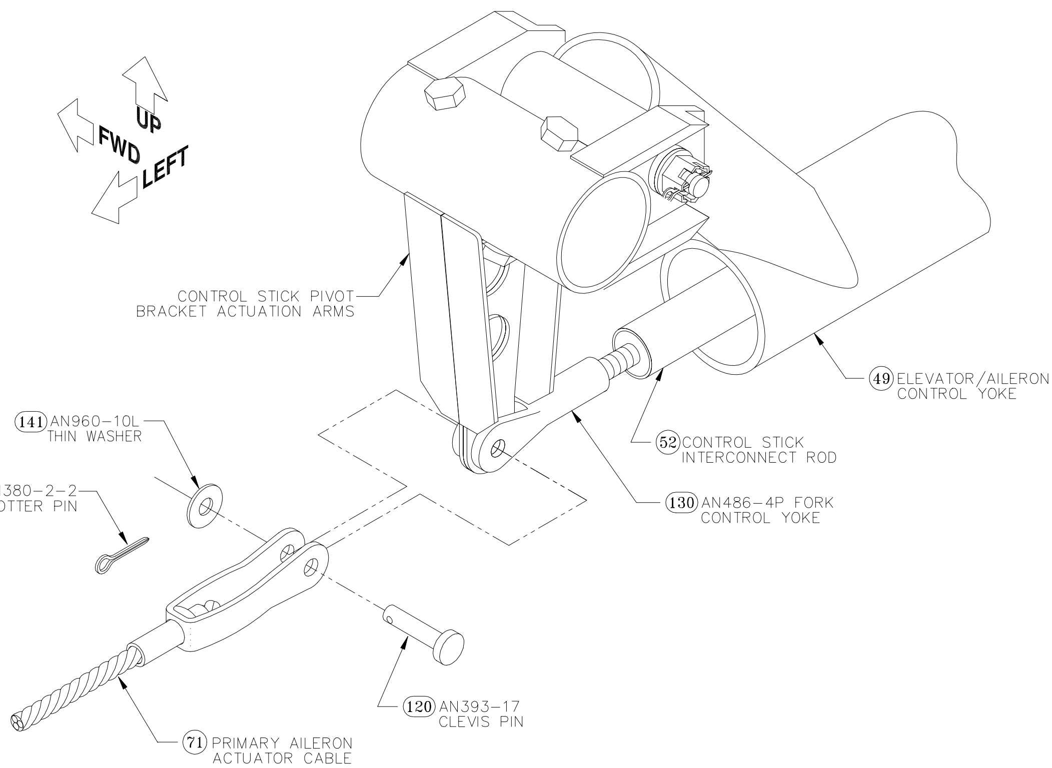

Figure 92: Aileron Control Cable Attachment to Control Stick Assembly

Fasten the shackle end of a **primary aileron actuation cable** [71] to each end of the control stick interconnect rod, as shown in Figure 92, using the same AN393-17 clevis pin that secures the interconnect rod to the control stick pivot bracket. (The primary aileron actuation cable is 66" long from the attach hole in the strap shackle to the end of the swaged turnbuckle end, which has right-hand threads. You will have to spread the arms of the strap shackle on the cable slightly so the shackle will fit over the end of the fork on the interconnect rod.) Secure the clevis pin with an AN960-10L thin washer and an AN380-2-2 cotter pin. Route each cable outboard, around the forward side of the lower forward aileron pulley, aft to the underside of the lower aft aileron pulley and up toward the upper crossover pulleys.

Fasten a **secondary aileron actuation cable** [72] to each primary actuation cable by threading the swaged ends of the two cables into an MS21251-B5S turnbarrel. (The secondary aileron actuation cable is 186" long; one end has a left-hand-threaded turnbuckle end and the other end is bare.) Adjust the turnbuckle so that one-to-three threads show beyond the end of the turnbarrel on each side, as shown in Figure 85.

Route each secondary aileron actuation cable up to the outboard side of the **aft** pulley in the upper crossover pulley cluster. From the upper crossover pulley cluster, each cable travels inboard across the fuselage centerline to the opposite wing. Route the cables through the openings in the inboard flap track ribs and through the **forward** holes in both the inboard and the outboard aileron cable guides. Route each cable over the **lower** inboard aileron guide pulley, through the spar to the **lower** outboard guide pulley and from there to the **aft** arm of the aileron bellcrank. Refer to the aileron cable schematic, Figure 93.

Slide a NicoPress sleeve over the end of the cable. Loop the cable over the thimble in the shackle in the cable attach tab and back through the NicoPress sleeve. Pull the cable tight and slide the sleeve up tight against the thimble. Use a 1/8" cable clamp to clamp the free end of the cable to itself.

[illegible]

ADVANCE NOTICE OF REVISION

[illegible]

Section III: Tools and Techniques:

[illegible] er the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior grey primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone.

[illegible]n IV: Stabilizer Assembly

Page 28: Future runs of the 302-00001-01 skins will come with a 4.45" diameter access hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without it. The hole is positioned on A/C centerline and 8.25 inches forward of the lower trailing edge of the skin. The 201-33001-01 and 201-33002-01 cover and backup ring will be used. Refer to the installation procedure in Step 67 and 68 in the Systems section of the manual. Use (4) K1000-08 and (4) AN526-R86 screws to secure the cover.

Section V: Elevator Assembly

Pages 99: A Note will be added to this page telling the customer to check the trailing edge fit between the two surfaces. If the trim tab needs to be moved forward, it is acceptable to trim/sand off approximately 1/16" from the hinge halves to allow the hinge to nest deeper inside the rear elevator spar.

Section VI: Wing Assembly

Page 3: Part number 602-06001-01/02 should be 602-06001-**03/04**

Page 43: The following will be added to Figure 18: Transfer the rivet pattern on BL69 to the adjoining rib. You should have the skins riveted to both of these ribs on the upper and lower surfaces.

Section VII: Aileron and Flap Assembly

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Connect the **left aileron crossover cable** [73] to the **right aileron crossover cable** [74] by threading the swaged ends of the two cables into an MS21251-B5S turnbarrel until one-to-three threads of the studs are showing at each end of the turnbarrel. (The left aileron crossover cable is 152" long with one bare end and one right-hand threaded turnbuckle end; the right crossover cable is 168" long with one bare end and one left-hand threaded turnbuckle end.)

Route both crossover cables from the fuselage centerline outboard through the openings in the inboard flap track ribs and through the **aft** holes in both the inboard and the outboard aileron cable guides to the inboard aileron cable guide pulleys in their respective wings. Route each cable over the **upper** inboard guide pulley, through the spar to the **upper** outboard guide pulley and from there to the **forward** arm of the aileron bellcrank. **Position the turnbarrel halfway between the fuselage centerline and the left side of the fuselage.**

> **Note** The turnbarrel is positioned off-center so that it will not interfere with the center fuselage cable guide, which will be installed later, during final assembly. The turnbarrel's off-center position is the reason that the left cable is shorter than the right.

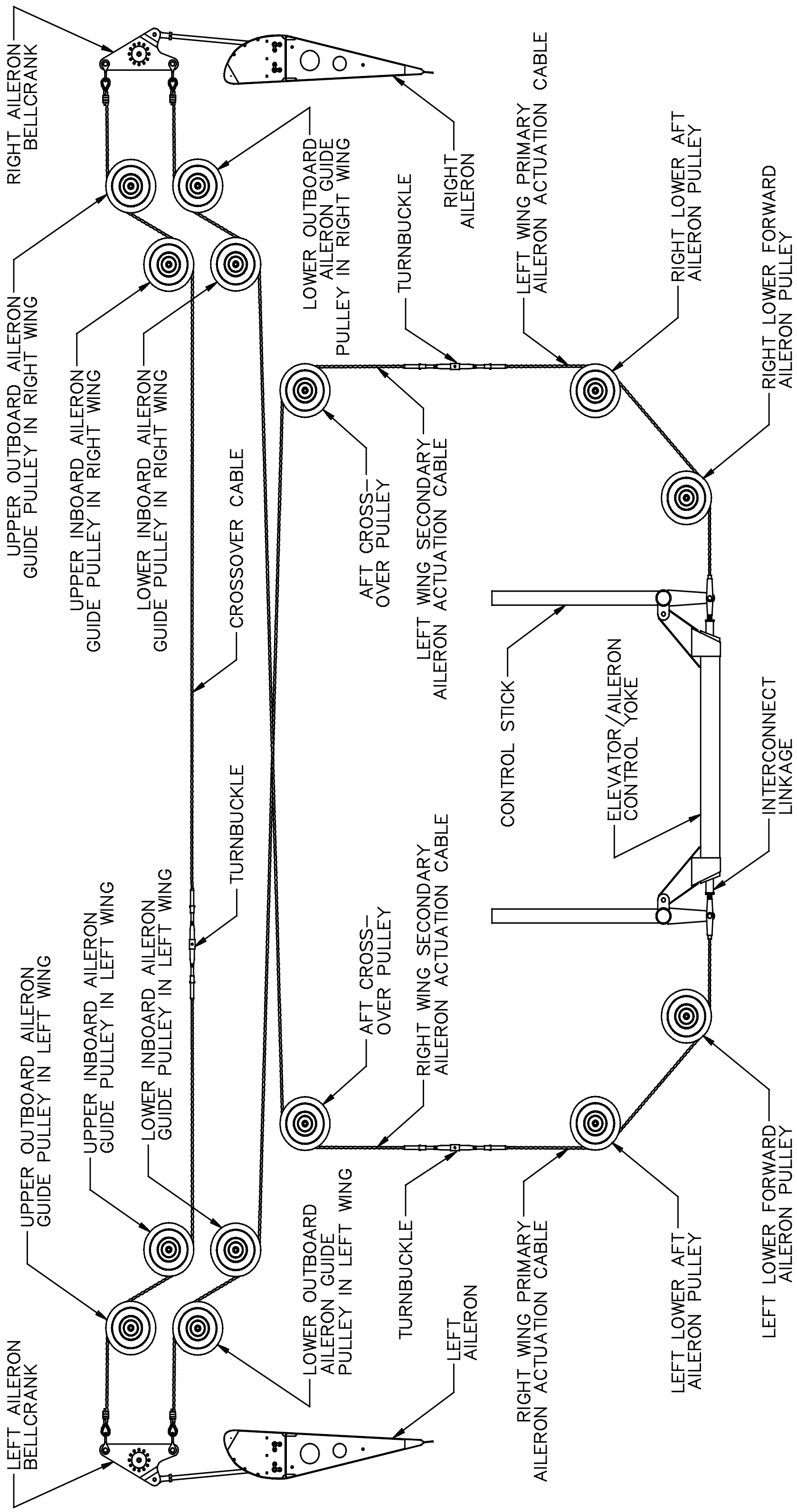

Figure 93: Aileron Cable Schematic

Secure each crossover cable to the cable attach tab in the forward aileron bellcrank arm using the same hardware and procedures as for the secondary actuation cables, which were secured to the aft bellcrank arm.

Make sure that the ailerons and the aileron bellcranks are still in the neutral positions and that the turnbarrel for the crossover cable is positioned halfway between the fuselage centerline and the left side of the fuselage. Verify that, with the ailerons in the neutral positions, the aileron interconnect tie rod is centered with respect to the elevator/aileron control yoke so that the control stick pivot brackets are both at the same angle relative to vertical (the 18" dimension on the interconnect rod and the control stick pivot are point are vertically aligned.) If necessary, adjust the left and right aileron actuation cables to produce this condition (shorten one cable and lengthen the other the same amount).

> **Note** Adjust the actuation cables by changing the positions of the temporary cable clamps where the cables connect to the aft arms of the bellcranks. **Do not** change the cable length by adjusting the turnbuckles. After the cables are tensioned, there must be no more than three threads of each cable end showing beyond the end of the turnbarrel. Threading the turnbuckle out to lengthen a cable at this time could prevent meeting this requirement later. Leave the turnbuckles with one-to-three threads showing at each end. The number of threads showing will be reduced when the cables are tensioned.

Finally, check that the cables are properly seated in all the pulleys in the system, and make sure that there is no excessive slack.

Completed [ ]

Step 45: Make the Aileron Travel Stop and Set Deflections

Two travel stops (one in each wing) will need to be fabricated and installed on the aileron bellcrank brackets as seen in Figure 93.4. Since the aileron linkage is a closed loop system and the left and right ailerons move in opposite directions, only the down travel will be limited for each aileron.

Begin by cutting two 3" pieces of 1" x 1" x .063 aluminum angle from the supplied stock that was not used in the Fuselage Section. Fabricate the stop brackets as shown in Figure 93.1, making one left hand and one right hand. Because the 1/4" nutplate is not mounted in the center of the 3" angle, a left and right hand must be made. Use an AN4-5A bolt for the stop.

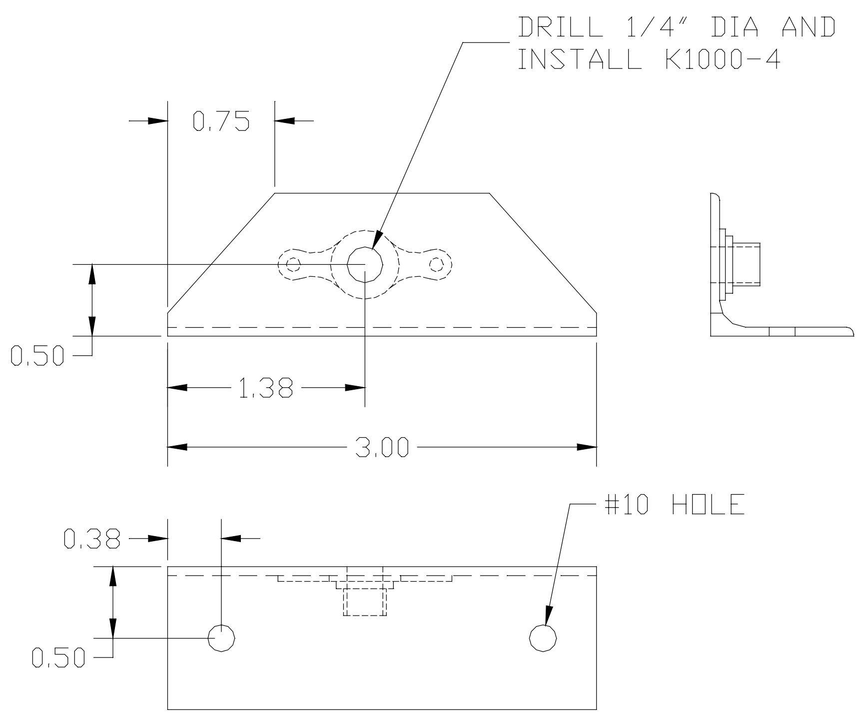

Figure 93.1 Aileron travel stop bracket

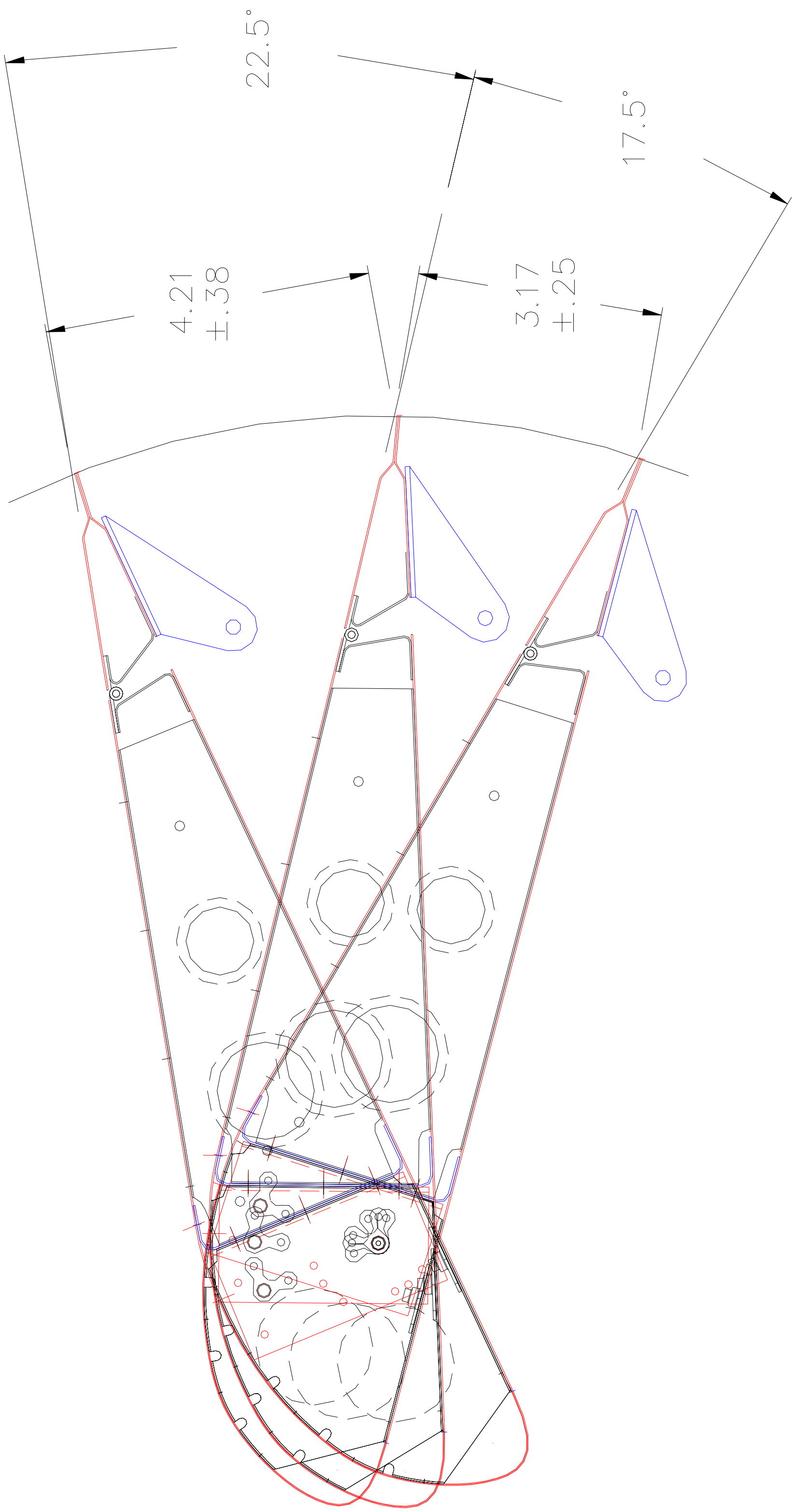

Figure 93.2: Setting the Aileron Travel

The required travel for the ailerons is **22.5° up ±2.5°** and **17.5° down ±1°.** As long as both ailerons obtain the desired **17.5° down,** the up travel will be less restrictive since there is no way to adjust it without affecting neutral or the down travel.

Because of the aileron hinge configuration, you can't use the bevel gauge method for checking travel that you used for the rudder in Step 60 of "SECTION VIII: FUSELAGE ASSEMBLY." Instead, make two aileron travel gauges (one for the left wing and one for the right), as shown in Figure 93.3, to check the travel.

Make each gauge from a thin sheet of plywood or stiff cardboard. Fix the gauge to the flap so it won't move when you are actuating the ailerons. You will be making some marks on the gauge so secure it well. Additionally, the aileron servo tab and the aileron trim tab (optional) must be fixed in their neutral points. The servo tab cannot move when the aileron is actuated.

With everything fixed in place, hold a felt-tip pen against the aileron trailing edge with the pen point resting on the plywood, and swing the aileron up and down, letting the pen mark the arc described by the aileron trailing edge. Also mark the aileron trailing edge neutral position (even with the lower surface of the flap) onto the plywood. Use a scale to mark the travel limits (22.5° up and 17.5° down, measured in a straight line from the neutral position) on the trailing edge arc. The 4.21" and 3.17" measurements that correspond to these deflections can be found in Figure 93.2.

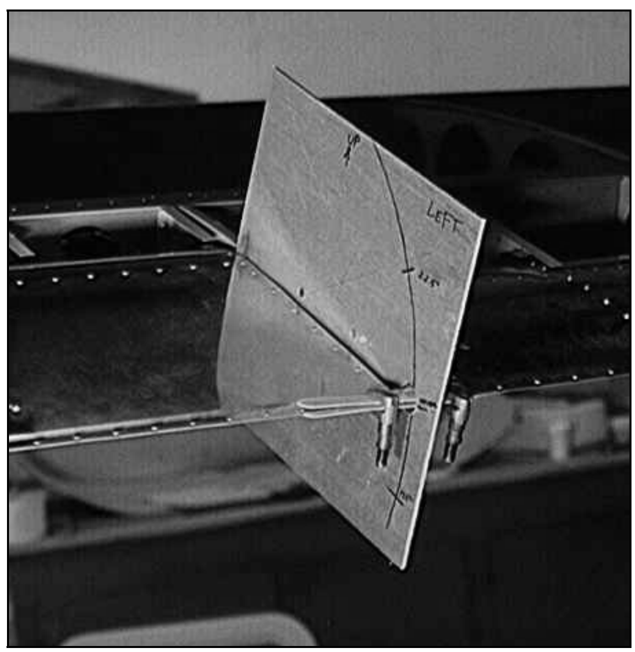

Figure 93.3: Aileron Travel Gauge

It's handy to drill a 1"-diameter hole through the gauge at the neutral position so that the aileron trailing edge can be secured to the flap trailing edge with tongue depressors and small clamps, as shown in Figure 93.3. Make the gauge for the right wing a mirror-image of the gauge for the left wing. Tape the finished aileron travel gauges to the flaps.

Move the aileron interconnect tie rod from side-to-side to check the aileron travel with the travel gauges. It's most likely that you'll have more than enough travel in both directions. If the ailerons don't have full travel, check for obstructions in the control system. (If the pushrods contact the holes in the spar, for example, enlarge the holes to permit free movement.) Keep in mind, that while under air loads, the deflections will be less than what is achieved on the ground. So error on the high side of the deflection limits if you can.

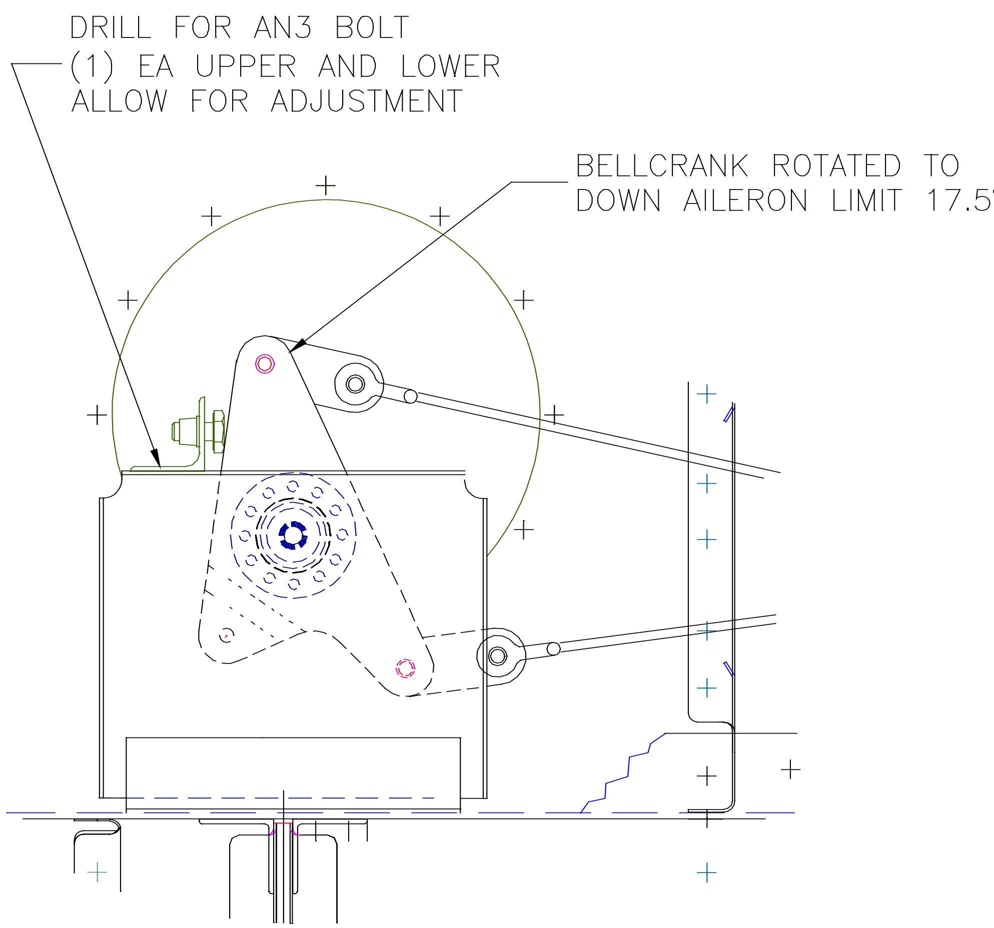

Figure 93.4: Attaching the stop angle bracket on the bellcrank brackets

Once you are satisfied that both ailerons reach the down travel limit and the up travel limit is close to it's limit (**within ± 2.5°**), the control stops can be set on the bellcrank brackets and drilled in place. Make sure the bolt is set to some mid point in the nutplate (can be threaded both in and out), which will allow for adjusting the bellcrank travel later. Using the two #10 holes in the stop angle that you drilled previously, pass drill through the angles into the brackets as shown in figure 93.4. After deburring the holes, attach both stops using AN3-4A bolts and AN364-1032A nuts.

After the control stops have been set, make a final check of the control travel in both directions and make fine adjustments as necessary. Also make a final check that the bellcranks are square to the spar and the interconnect tie rod is centered when the ailerons are neutral. When satisfied, crimp the NicoPress sleeves and trim off excess cable. Be careful not to nick or damage the control cable.

Completed: [ ]

> **Note** Since the wings will be removed to complete the rest of the procedures in "SECTION IX: SYSTEMS INSTALLATION" and the initial work in "SECTION X: FINAL ASSEMBLY," there is no point in tensioning the aileron control cables at this time. The cables will be tensioned after the wings are installed for the final time.

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166:

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Step 46: Secure the Aileron Cable Guides to the Wing Structure

Now that the aileron cables are installed and relatively tight you can finish the aileron cable guide installation that was begun in Step 43.

Determine the optimum chordwise position of each cable guide by sliding it forward and aft until the guide deflects the cables the **minimum** amount. When the optimum position of each guide has been determined, drill two **#30** holes through both the guide and the rib(s) to which it mounts, as shown in Figures 89 and 90. Trim the guides, as necessary, so that they don't protrude above the flap cove and flap track ribs and to reduce any unnecessary weight. Secure each guide with two 1/8" aluminum blind rivets. For the cable guides that mount above the flap cable guide pulleys, place the rivet heads against the cable guide.

Completed: [ ]

CONTROL CABLE RETAINERS FABRICATION AND INSTALLATION

Guards or retainers must be installed on all of the control system pulleys to keep the cables from slipping off or jamming. This is especially important if you plan to fold the wings, since the aileron and flap cables go slack when the wings are folded. Guards are essential to ensure that these cables seat properly in their pulleys when the wings experience their loading and unloading during flight and when they are re-extended after you have folded the wings.

Separate guards or retainers are not needed, however, in instances where the cables are retained in some other manner. Separate cable retainers are **not** needed for the following pulleys: the **lower outboard flap pulleys**, which are mounted in such a way that the pulley bracket itself serves as a guard, and the **crossover pulley clusters** in the fuselage cage, which have cable guards welded in place as part of the cage structure. In addition, by completing the procedures described in Step 12, you have already fabricated cable guards for the **left rudder cable guide pulley** and for the **elevator** and **flap cable reversing pulleys**; if you have not already done so, install the clevis pins and cotter pins to complete the cable guards for these pulleys, as shown in Figure 28.

Note Each cable guard must be positioned no more than **1/16"** from the edge of the pulley to effectively retain the cable.

Step 47: Install Cotter Pin Cable Retainers

The **flap cable guide pulleys** in the wings, the **lower inboard flap pulleys** in the fuselage and the **Bulkhead A pulleys** in the aft fuselage all use 1/8"-diameter, AN380-4-6 cotter pins to retain the cables. Installing these is a simple matter of inserting the cotter pin through the holes provided in the pulley mounting bracket, and spreading the legs of the pin.

Install the cotter pin cable retainers for the above-mentioned pulleys on both sides of the airplane; a total of six places. If you completed the procedures described in Step 19 Figure 37, you installed cotter pin retainers for the Bulkhead A pulleys before you bolted the pulley brackets in place.

Completed: [ ]

Step 48: Fabricate and Install the Control Cable Pulley Guard Straps

The remaining control system pulleys (the **inboard** and **outboard aileron cable guide pulleys** in the wings and the **lower forward** and **lower aft aileron pulleys** in the fuselage) all use cable retainers made from thin aluminum strips. In general, a strap is required for each 90 degrees of cable contact on a pulley.

Fabricate guard straps for the remaining pulleys from the supplied **cable retainer strap stock** [44], as shown in Figure 94. Bend the guards over a wooden or metal form block with a minimum radius of **1/16"**. For guards that fit over a single pulley, bend the legs of the strap **1/2"** apart; for guards that fit a double pulley, bend the legs **1-1/8"** apart. To drill the holes for the mounting bolt, clamp the strap over a wooden block, and use a drill press to drill through both legs of the strap and the block all at once. Deburr and corrosion-proof the finished straps.

The straps are fastened in place with the same bolts that the pulleys pivot on. Position the straps so that they are centered over the bend in the cable. To keep the strap from rotating, tighten the pivot bolt firmly and then bend the end of the strap up around either the bolt head or the nut. After installation, check the guards to verify that they retain the cables securely when the cables are slack. Adjust or re-fabricate inadequate guards.

Completed: [ ]

> **Note** The control systems are now complete except for final rigging, tensioning and safetying, which will be done after the wings are installed for the final time. You may now remove the control surfaces from the wings and the wings from the fuselage in preparation for fitting the fuel tanks and completing the remaining systems installations in both the wings and the fuselage.

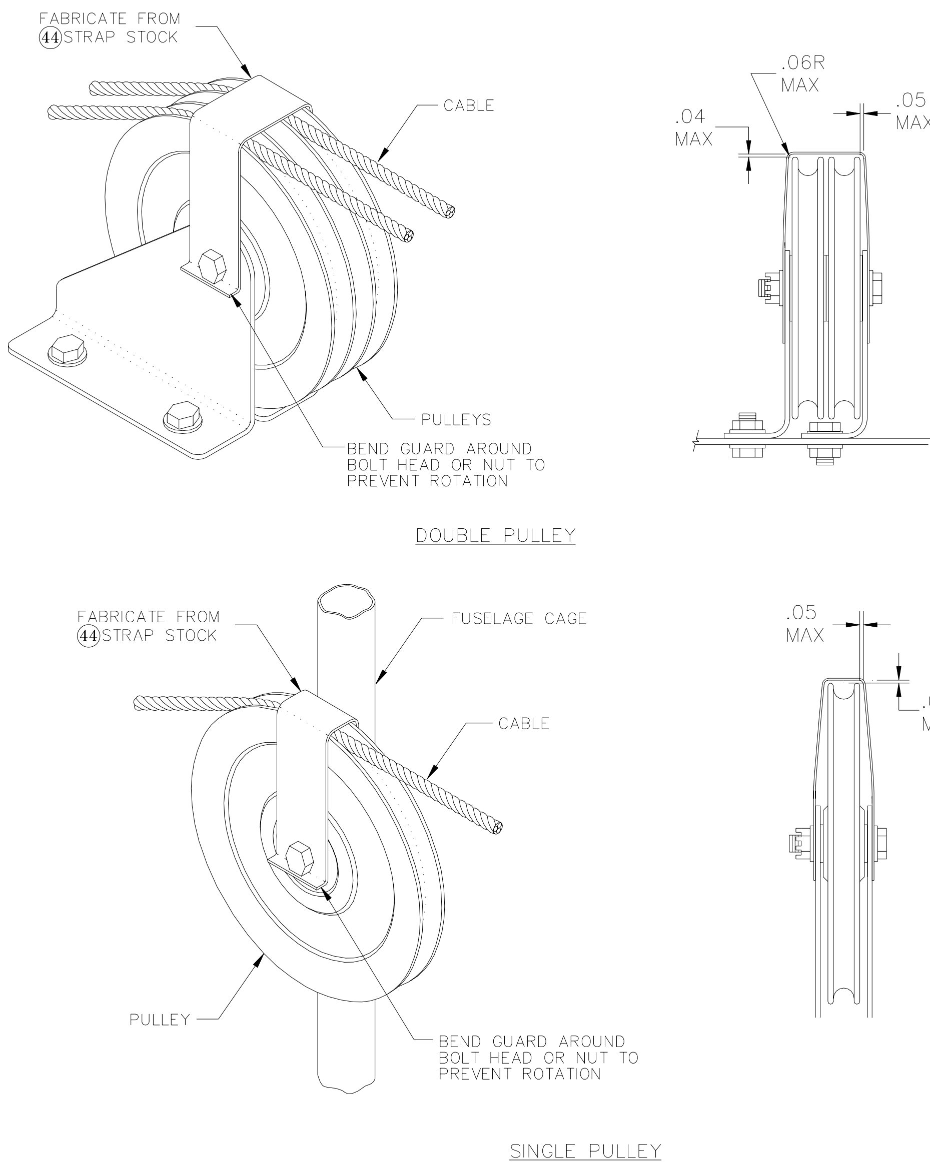

Figure 94: Pulley Guard Straps

Note The text and illustrations in the next two sub-sections of the *Assembly Manual* follow the convention established earlier of referring to and depicting the left-wing parts and procedures only, unless otherwise specified. The right-side procedures are identical.

PRELIMINARY FUEL TANK INSTALLATION

Step 49: Apply Anti-Chafe Tape to the Hat Section Stiffeners in the Fuel Tank Bays

The welded aluminum **fuel tanks** [31, 32, 359 & 360] in the Sportsman are not mounted rigidly to the wing structure. Instead, they simply nest between the root rib and the first main rib outboard of the root, supported by the lower-surface hat section stiffeners. As Figure 95 shows, the main tanks slide in from the inboard end of each wing before the root rib is riveted in place. The auxiliary tanks fit between the two most outboard ribs. There are two important advantages to this system of tank installation. First, if necessary, the tanks can be relatively easily removed from the wings for maintenance, and second, they are isolated to a degree from loads imposed by the normal in-flight flexing of the wing structure. Rigidly mounted tanks would be more subject to cracking from fatigue.

However, because the tanks are free to move relative to the wing structure, it's extremely important to provide protection at potential chafe points. The hat section stiffeners—both upper and lower—are clearly such points. The application of a durable plastic tape to all the hat section stiffeners between Main Ribs 1 and 2 as well as the outboard most two ribs is required. Cut lengths of the **anti-chafe tape** [355] so they completely cover the rounded portion of each hat section. Carefully wipe and clean each hat section with acetone prior to applying the tape to get the best possible adhesion.

Completed: Left [ ] Right [ ]

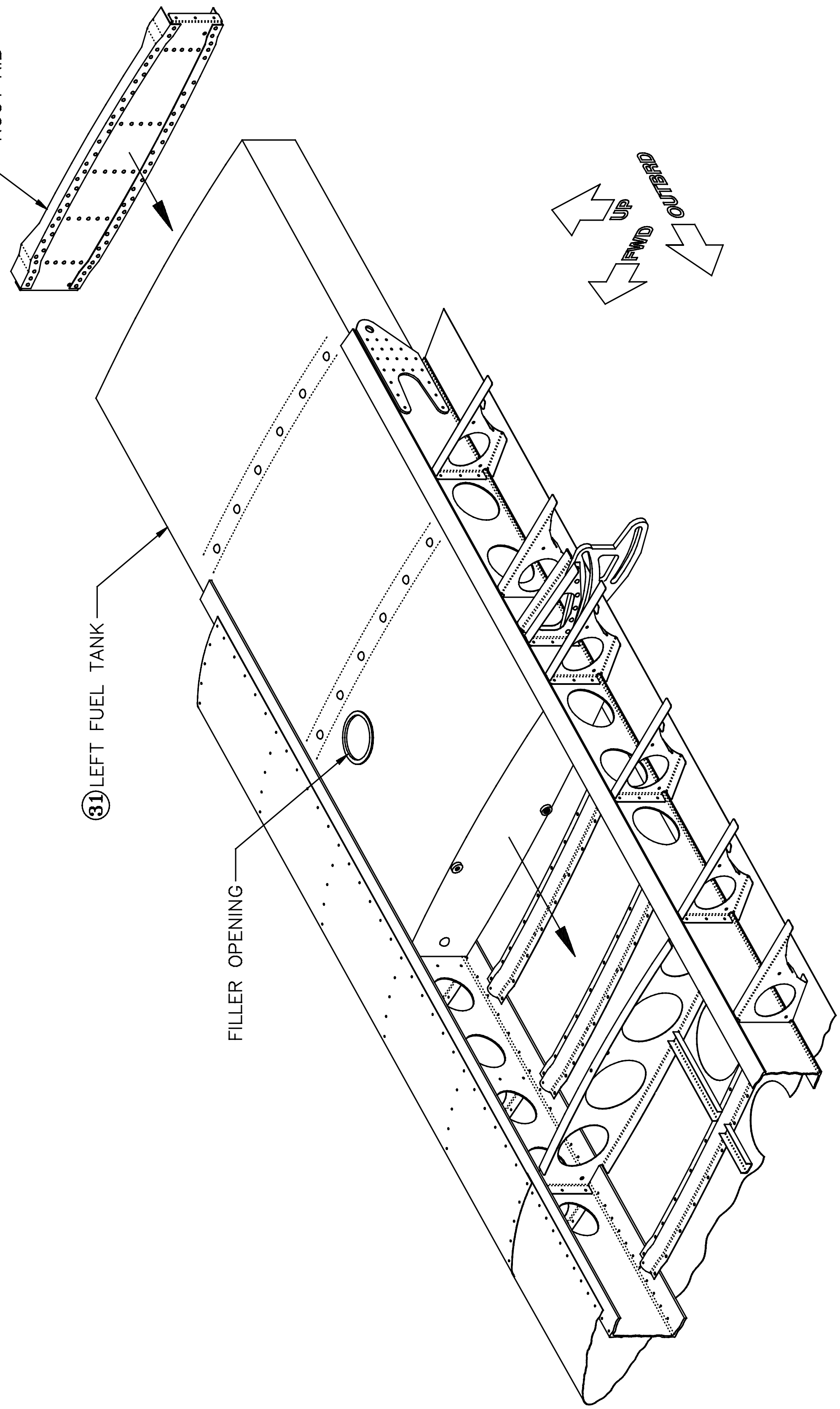

Figure 95: Standard Fuel Tank Installation

Step 50: Test Fit the Main Fuel Tank

Warning The orifices in your fuel tanks are sealed at the factory with plastic plugs and/or aluminum tape. To minimize the possibility of introducing foreign matter into the tanks, keep these seals in place until specifically instructed to remove them or until the fuel system fittings are installed.

Try sliding the fuel tank into the wing. Ideally, it will slide in between the flanges of the forward and aft spars and over the lower-surface hat sections with minimal interference. However, it's quite possible that the tank initially won't seem to fit.

Hint The left and right tanks can be distinguished by the position of the filler opening: as Figure 95 shows, the opening should be in the forward, outboard corner of the tank when the tank is properly installed.

The reason the tank may not fit is that the thin aluminum sheet from which it's fabricated tends to bulge outward between the ribs as a result of the pressure testing the tanks undergo. Because the tanks are made of soft, non-heat treated aluminum, such bulging is unavoidable, but it is easily dealt with if necessary. Place your tank flat and right-side up on a well padded workbench, with the sump area of the tank hanging over the edge. (The sump is the projection from the bottom of the tank at the inboard end.) As shown in Figure 96, place a **5" X 12"** piece of scrap wood on the upper surface of the tank and use a rubber mallet to tap the bulged areas down. It goes without saying that you don't want to whack the tank **too** hard, but with the piece of wood to distribute the force, you can apply moderately forceful blows without danger of damaging it. Start with the wood block at the forward, inboard corner of the tank and move aft. Then shift the block to the center section of the tank between the two internal ribs and again tap forward to aft. Finally, tap the outboard section. Repeat the process on the bottom side of the tank.

Figure 96: Tapping the Bulges Out of the Fuel Tank

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173:

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Note Before beginning, remove a plastic plug from any one of the orifices in the tank to relieve internal pressure during the pounding; be sure to replace it when you're done.

After tapping both the top and bottom of the tank, try once again to slide it into the wing. If it still won't fit easily, repeat the tapping process concentrating particularly on the forward and aft edges of the tank. Pounding there will tighten the bend radii of the edges a bit, providing the necessary clearance.

Completed: Left [ ] Right [ ]

Step 51: Drill a Hole in the Lower Wing Skin for the Main Tank Sump Drain Boss

As you may have noticed when you slid your tanks into the wing, the sump drain boss—that is, the threaded fitting welded into the bottom of the sump—protrudes downward almost half an inch below the bottom of the sump. In this step you will drill holes in the lower inboard wing skin and doubler to allow clearance for this boss and the sump drain valve that you will install in the boss in a later step.

As shown in Figure 97, mark a hole location **1-11/16" outboard** of the inboard edge of the lower skins and **16-1/8" aft** of the trailing edge of the forward spar's lower flange. Use a Unibit or hole saw to drill a **7/8"**-diameter hole through the skins at this location.

At 7/8", the hole will be too small to allow the sump boss to protrude through the skins, but before enlarging it, it's a good idea to slide the tank into the wings and check from underneath to see how well the boss lines up. Note any misalignment.

Finally, use a half-round file or a die grinder with a rotary file to enlarge the hole to provide approximately **1/16"** of clearance all the way around the boss and its welds, taking into account any eccentricity you observed when you checked the alignment. Leave a smooth, deburred finish.

Completed: Left [ ] Right [ ]

Step 52: Test Fit the Upper-Surface Hat Sections

Once the tank will slide easily into the wing with the sump drain boss protruding through the skins, then you need to perform one more test of fit. Take one of the upper-surface hat sections that you applied anti-chafe tape to and try to slide it in place between the forward and aft spar flanges and the fuel tank, as shown in Figure 98. You should be able to start at the inboard end and slide the hat section all the way across the top of the tank to the first main rib. The fit should be snug, but not so tight that you can't move the hat section easily by hand. If necessary, remove the tank and take up your mallet once again until the hat fits.

Completed: Left [ ] Right [ ]

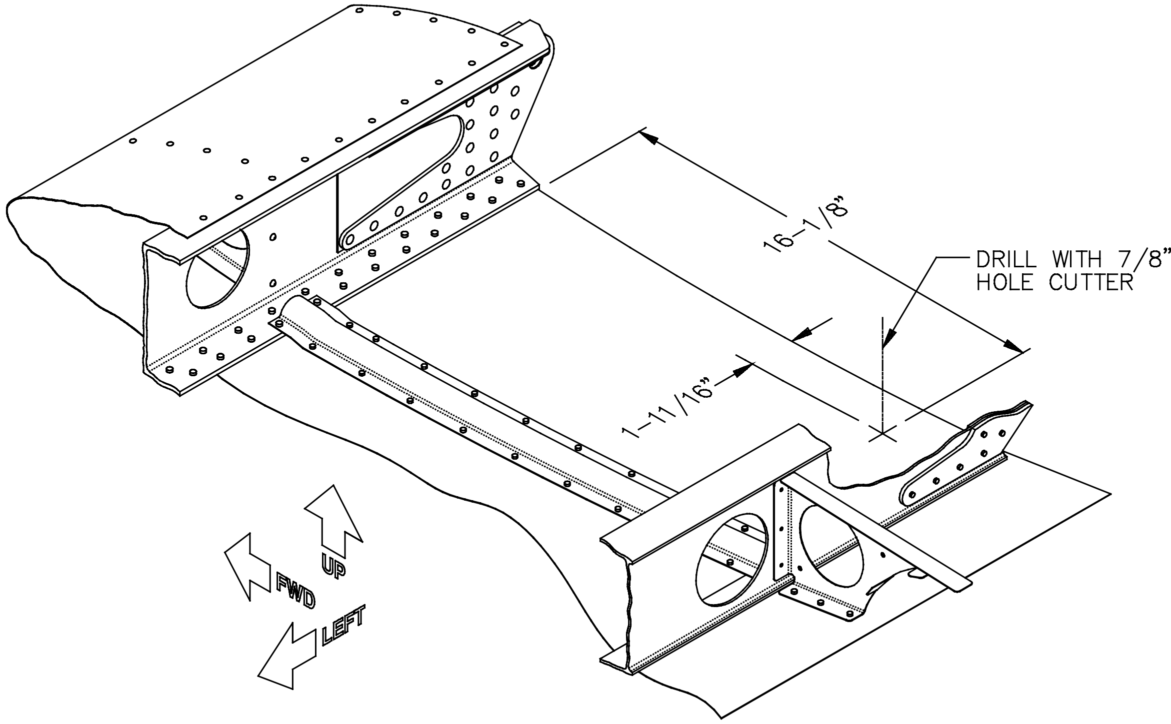

Figure 97: Marking and Drilling a Hole for the Sump Drain Boss

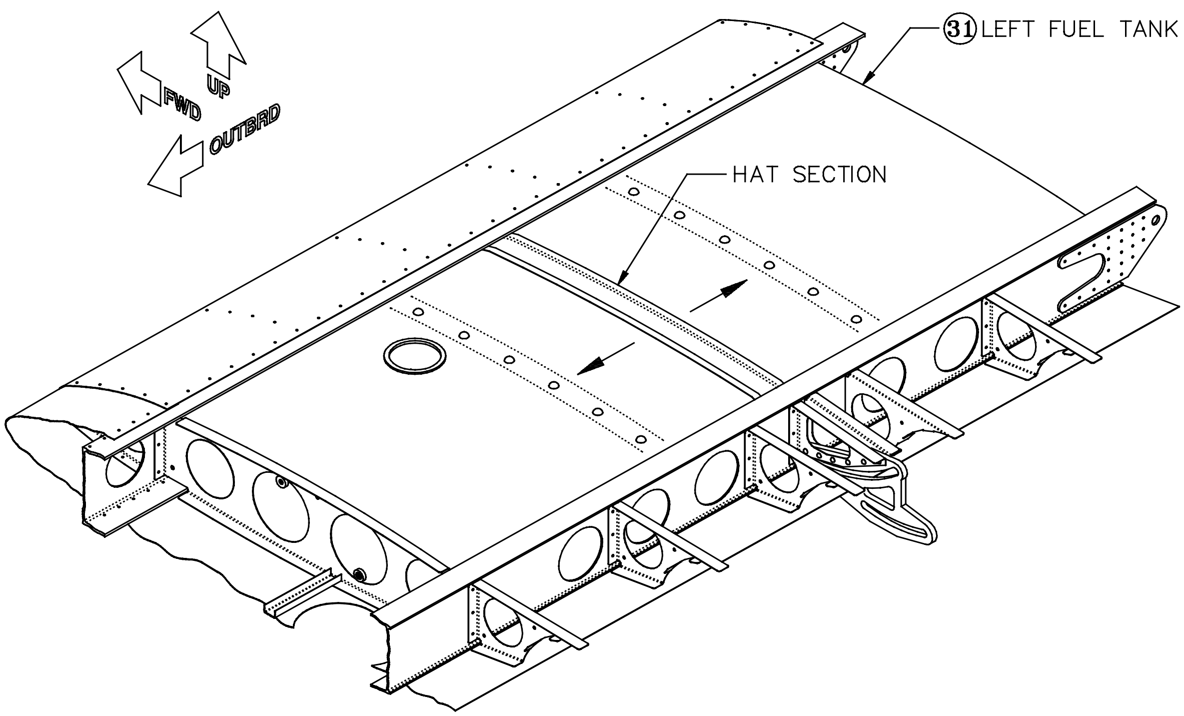

Figure 98: Test Fitting an Upper-Surface Hat Section

Step 53: Install "Bumpers" Around the Perimeter of the Tank

As you've already seen, installing the tank consists of nothing more than sliding it into the wing. However, to prevent it from rattling around, it's a good idea to provide some "bumpers" around the perimeter of the tank for cushioning. The best material from which to make these is 1/4"-thick neoprene rubber **[351]** glued to the ends of the tank with contact cement. The recommended locations and sizes of these bumpers are indicated by the shaded areas in Figure 99.

An alternative is to apply roughly 1/4"-thick layers of rubber caulking compound. We have been unable to find a caulk that is absolutely impervious to gasoline, but both RTV silicone sealer and polyurethane marine sealant appear to be reasonably resistant: when soaked in gasoline, they lose some of their adhesive qualities, but they do not break down. Since the bumpers will be held firmly in place between the tank and the ribs, the loss of adhesion is not serious, and in any case, the bumpers will never be soaked in fuel for long periods like our test samples were; at most, they will be briefly wetted with gasoline if you overfill your tanks.

If you do use rubber caulking, apply vinyl tape over it so that it doesn't adhere to the ribs when the tank is installed.

Completed: Left [ ] Right [ ]

Step 54: Make a Cutout in the Root Rib for the Fuel Gauge Mounting Flange

When the fuel tank is finally installed, three fittings will protrude inboard through the root rib: the fuel gauge mounting flange, the main fuel line boss and the fuel return line boss. (The return line boss is used only in Continental engine installations, but a clearance holes must be made for it regardless of the engine you're using.) Figure 100 shows the placement of these fittings on the inboard end of the tank. Because the fuel gauge flange sticks out furthest from the tank, the clearance cutout for it must be made first.

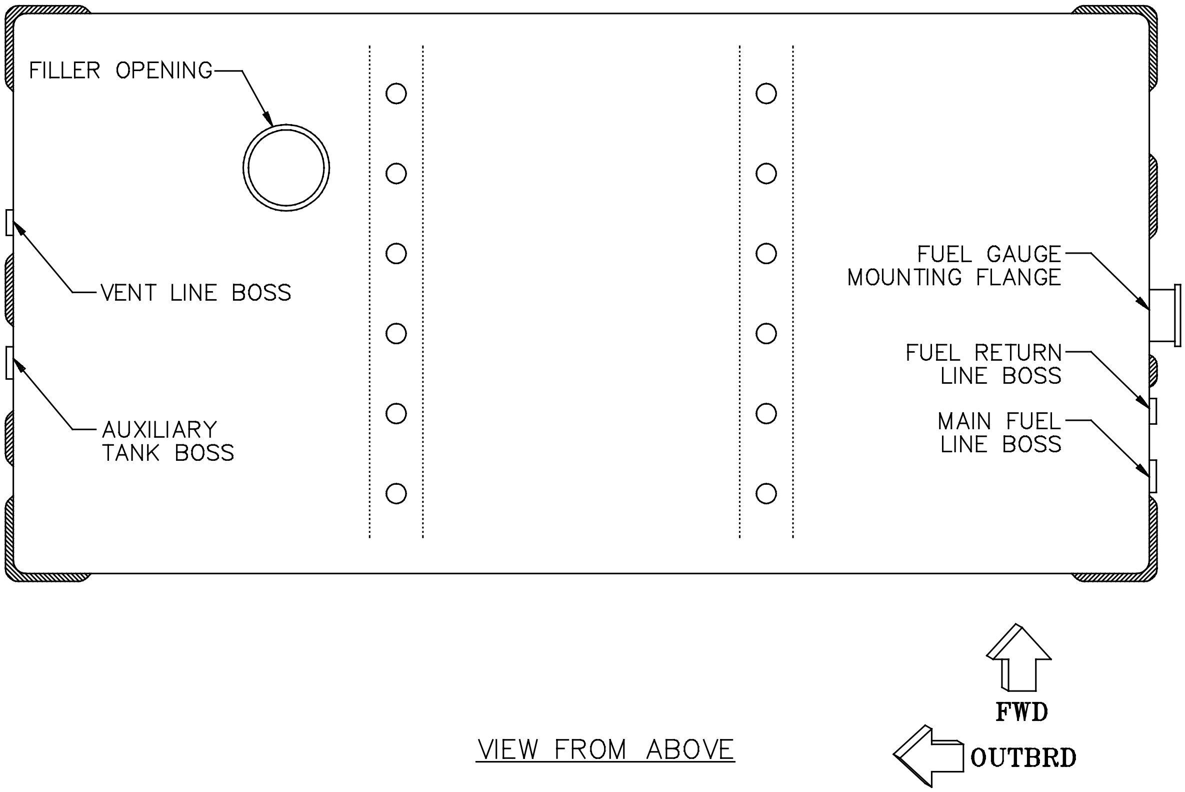

Figure 99: Bumpers Around the Fuel Tank

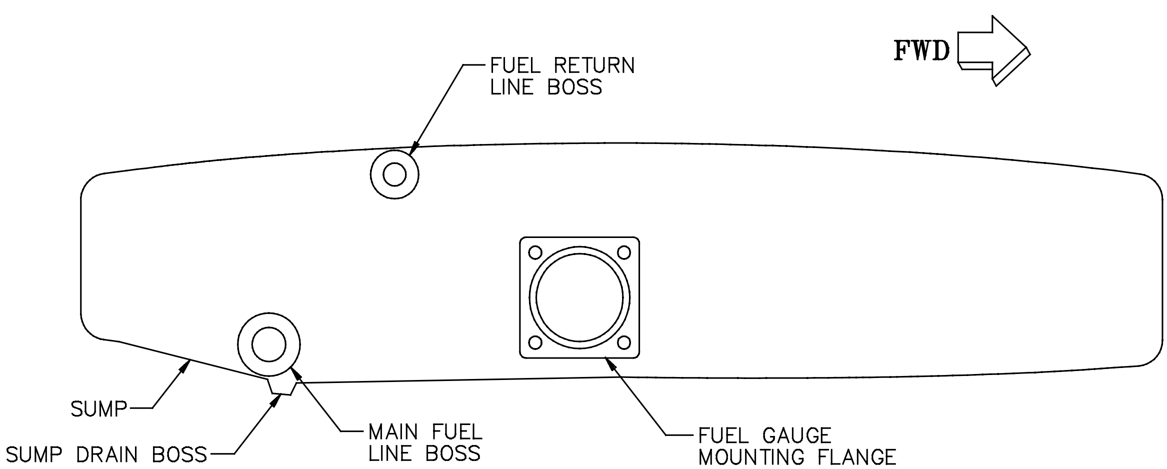

Figure 100: Inboard End of the Fuel Tank

Begin by checking the alignment of all the threaded boss fittings. A considerable amount of distortion occurs during welding and these fittings can be adjusted at this time. You may also want to check this one last time after you install the tanks in the wing just prior to final closeout.

Insert a 1/8 or 1/4 pipe nipple (approximately 4 inches long) into each boss. Use thread sealant to keep the threads from galling and gently straighten the bosses until they are perpendicular to the end ribs. Don't force them too much. Likewise, use a broom handle or piece of wood inserted into the fuel filler opening to bend it perpendicular to the upper surface.

Now slide the tank into the wing all the way to the outboard rib, making sure that the sump drain boss falls into its hole in the lower skins. To mark where the fuel gauge flange falls on the root rib, apply a thin (about 1/16"-thick) layer of modeling clay to the outboard face of the root rib web. As shown in Figure 101, the flange falls between the third and fourth root rib doubler angles (counting fore-to-aft), so you only need to apply the clay to that portion of the rib.

The clay will allow you to take an impression of the flange when the rib is moved into position. Slide the rib in between the forward and aft spars until it contacts the gauge mounting flange. Press the rib against the flange to make a good, solid imprint in the clay, and then remove the rib.

Note You don't want the clay to actually contact the surface of the mounting flange, as it's residue can be difficult to remove. If your tanks came to you with aluminum tape over the mounting flange, then just leave that in place while performing this operation. If your flange is exposed, apply a light coating of grease to it before pressing it into the clay.

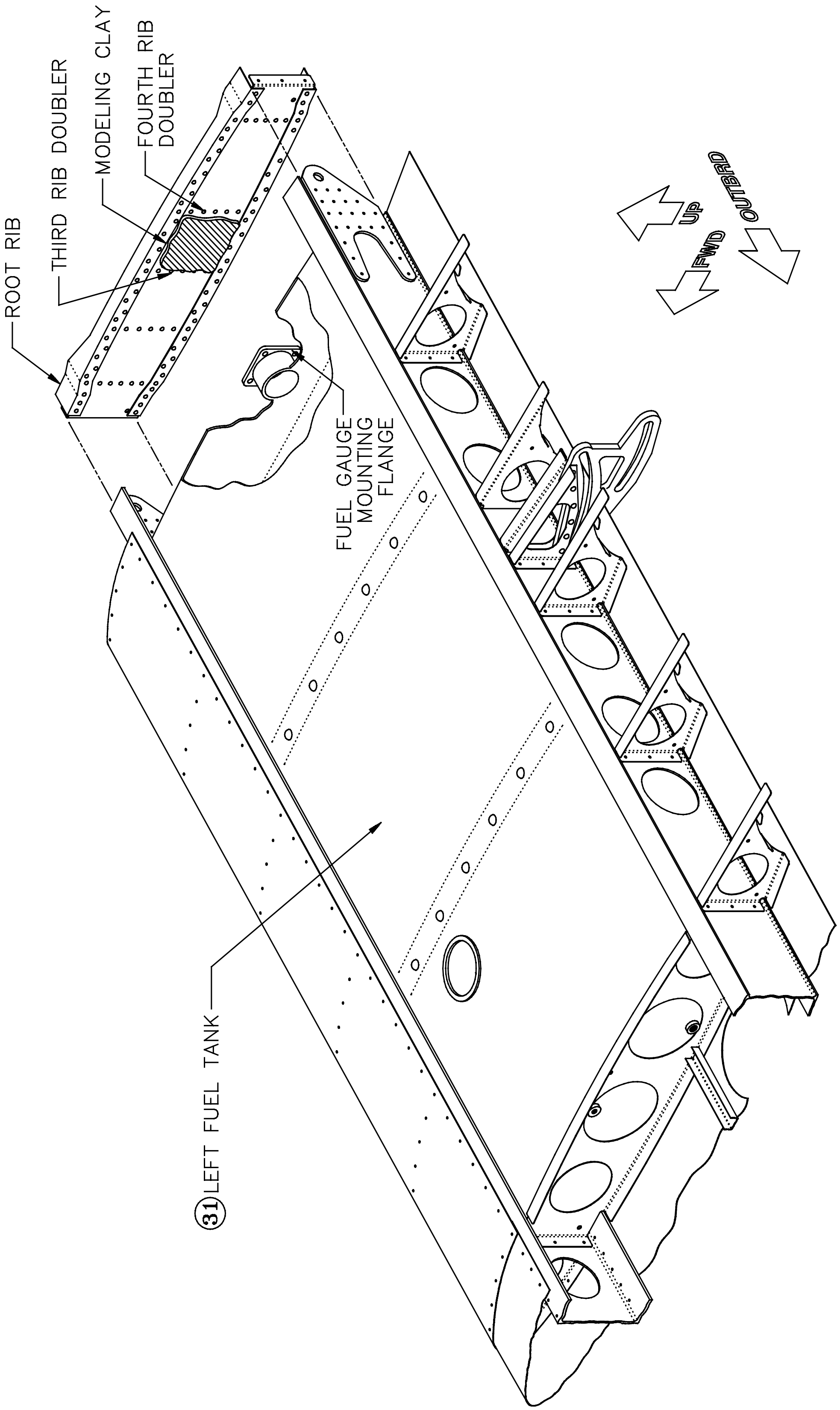

Figure 101: Taking an Impression of the Fuel Gauge Mounting Flange on the Root Rib

Next, as shown in Figure 102a, use a sharp scriber or awl through the clay to make a mark on the rib web at the **outermost** point on each rounded corner of the flange imprint. Remove the clay and mark lines connecting the opposite corner points (Figure 102b), and then mark hole locations on these lines **1/4"** in from each corner point (Figure 102c). Use a Unibit or hole cutter to drill a **1/2"**-diameter hole at each of these locations.

Mark tangent lines connecting the four holes and use a single-bladed hacksaw or a rotary cutting tool to remove the material between them. The resulting cutout will be exactly the same size as the gauge flange. Use fine-toothed files to enlarge the cutout just enough to allow the flange to pass cleanly through the rib web. Leave a smooth, deburred finish, and avoid sharpening the corner radii of the cutout.

Completed: Left [ ] Right [ ]

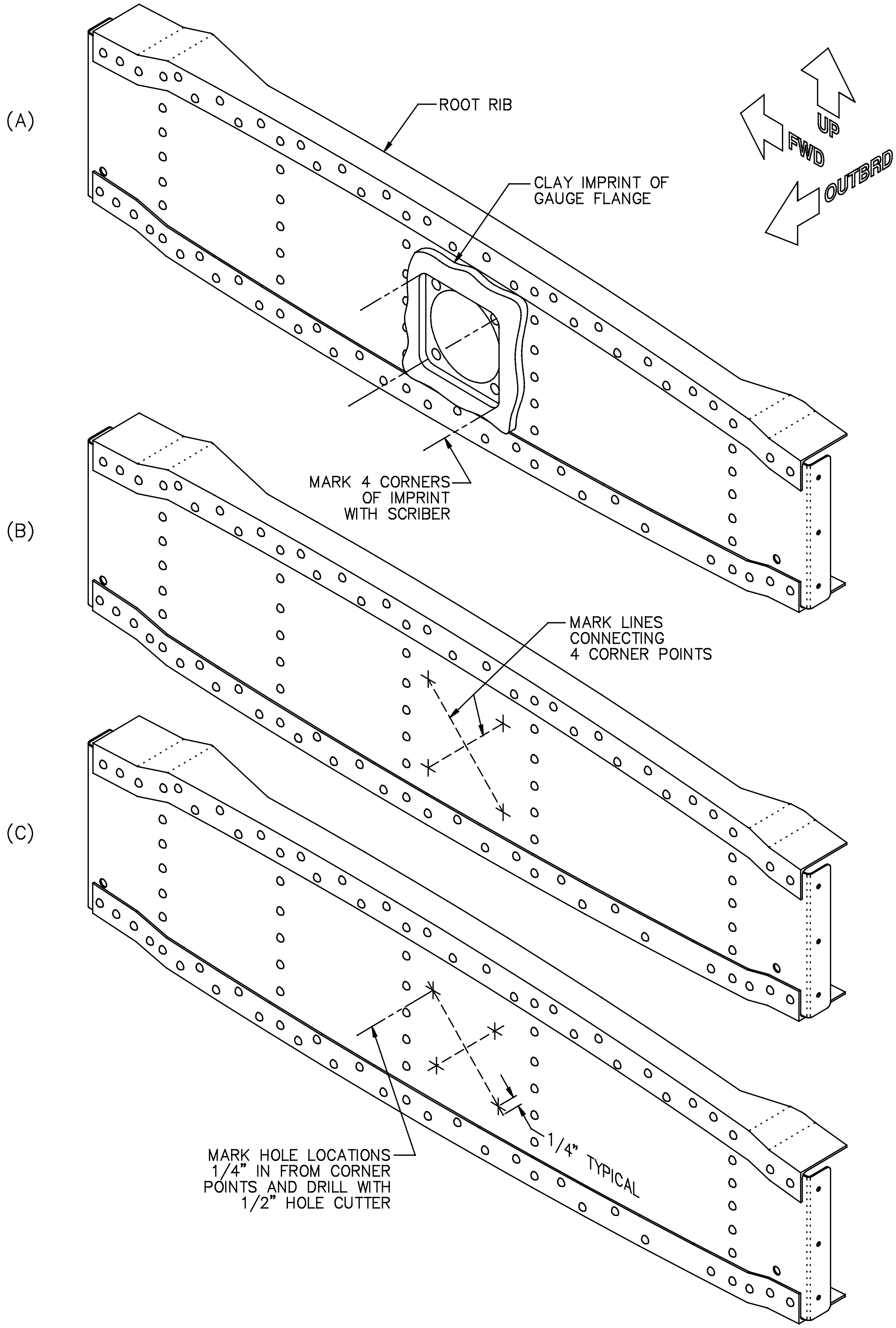

Figure 102: Marking and Drilling the Corner Holes for the Fuel Gauge Mounting Flange Cutout

Step 55: Drill Holes in the Root Rib for the Main and Return Fuel Line Bosses

With a cutout made for the fuel gauge mounting flange, you can now move the root rib closer to its final position. However, holes must still be provided for the bosses for the main fuel line and the fuel return line (see Figure 100).

Use the modeling clay method once again: apply a thin layer of clay to the areas of the rib web where the bosses will make contact, slide the rib into position between the spars (and over the gauge mounting flange), and take imprints of the two bosses. Mark the center of each hole through the clay with a scriber or awl, and then remove the clay.

As shown in Figure 103, drill the hole for the fuel return line boss with a **7/8"** unibit or hole cutter and the hole for the main fuel line boss with a **1"** hole cutter. Then use a half-round or rotary file to enlarge the holes as necessary until you can Cleco the root rib to the forward and aft spars through the appropriate holes. Ultimately, there should be about **1/16"** of clearance between the rib web and each tank boss.

Note Both of these holes will overlap from the root rib web onto the upper or lower root rib doublers, especially the lower main fuel port line. This is **not** a problem; simply drill the holes where the bosses fall.

Leave the root rib Clecoed between the spars after you have it fit to your satisfaction.

Completed: Left [ ] Right [ ]

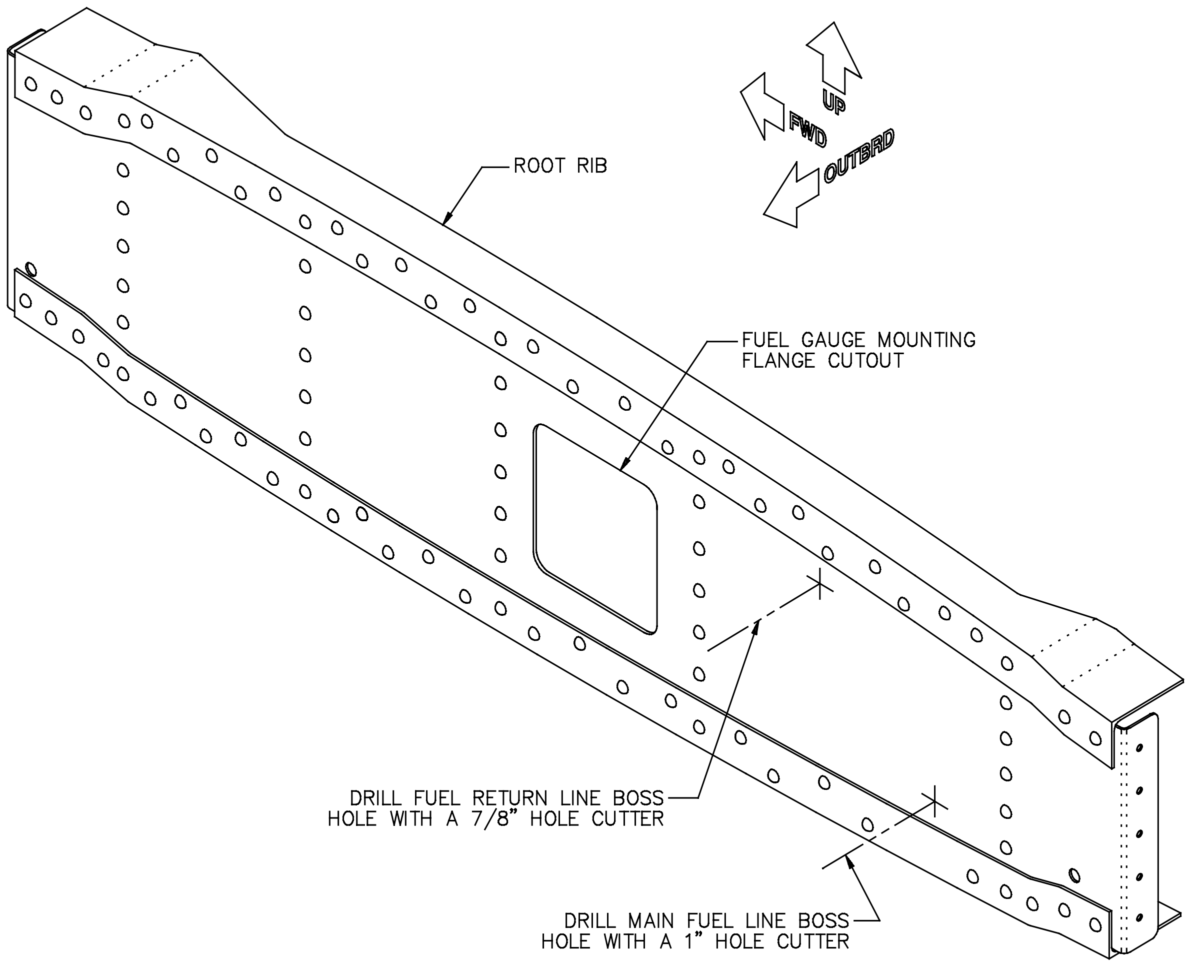

Figure 103: Drilling Holes for the Main and Return Fuel Line Bosses

Step 56: Cut Hole in the Upper Wing Skin for the Filler Neck

When the upper inboard wing skin is riveted in place in "SECTION X: FINAL ASSEMBLY," the **fuel tank filler neck** [33] will protrude through it, and this will go easier if you provide a hole in advance!

First you have to figure out where the hole belongs. With the tank in place and the root rib Clecoed between the spars, thread the filler neck into the filler opening in the tank. Don't tighten it down; just get it started. Then measure and record the two dimensions labeled "X" and "Y" in Figure 104; "X" is the chordwise distance from the trailing edge of the inboard leading edge skin to the filler neck, and "Y" is the spanwise distance from the inboard edge of the inboard leading edge skin to the filler neck.

> **Note** To be certain the filler neck hole ends up properly positioned, it's necessary to use the actual dimensions from your Sportsman.

With that fairly important gas tank sitting in the wing under the skin, we recommend cutting the hole with the skin **off the wing**! Lay the skin **right-side up** on a bench and mark an initial hole location according to the dimensions given in Figure 105: **"X" + 1-1/8" aft of the leading edge** and **"Y" + 1-1/8" outboard of the inboard edge**. (The additional 1-1/8" increments place the hole location in the center of the 2-1/4"-diameter filler neck.) Drill a **2-1/4"** hole at this location with a hole cutter.

> **Note** Hole size for optional flush fuel cap p/n 201-40003-01 is 3". For the flush locking fuel cap p/n 201-40004-01 is 2 1/2".

Check the size of the hole by trying to slide the skin over the neck. You'll probably have to enlarge the hole a bit with a round, fine-toothed file. Enlarge the hole until you can Cleco the skin in place on the wing structure with about **1/16"** of clearance around the neck. Be sure to leave a smoothly filed finish on the edges of the hole. When you're done, remove the filler neck and tape over the filler opening. You will install the filler neck permanently later.

Completed: Left [ ] Right [ ]

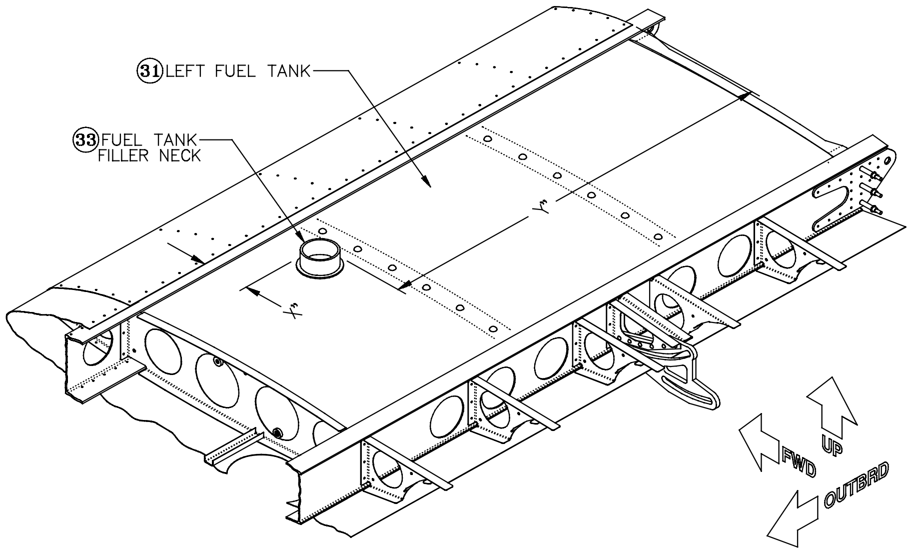

Figure 104: Measuring the Location of the Filler Neck

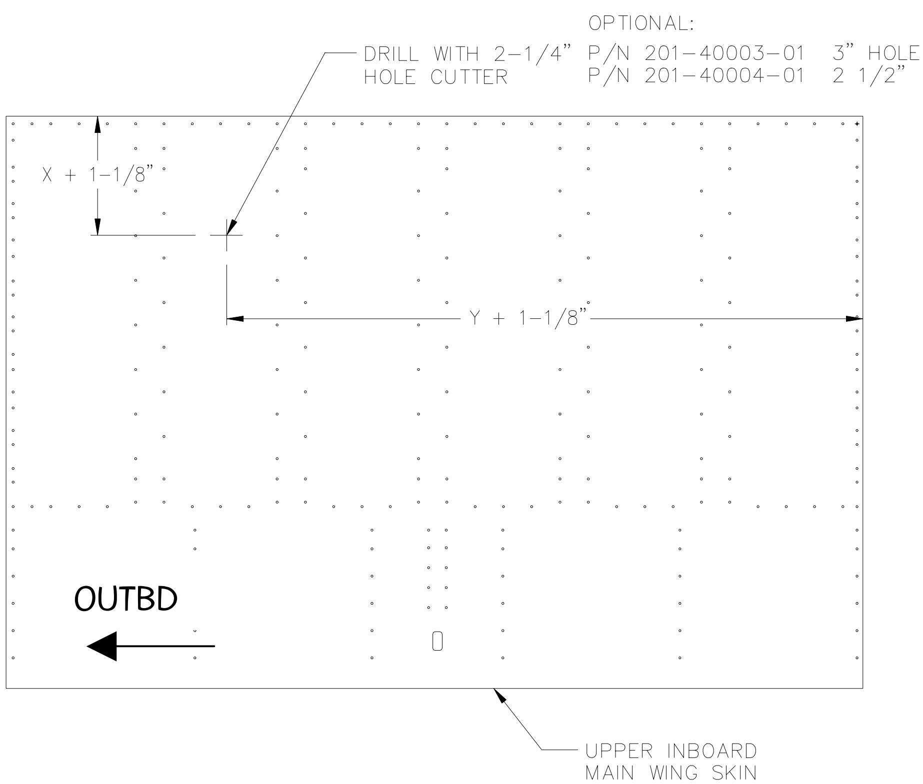

Figure 105: Marking and drilling the filler neck location

Step 57: Position and Drill the Aux Tank Mounting Channels

The aux tanks must be installed a bit differently than the main tanks. In the aux tank bay (between the outboard two main ribs), there are only two hats, and resting the aux tank directly on these would concentrate the load on the bottom of the tank to an unacceptable degree.

For this reason, the aux tanks are supported by a pair of sheet-metal **mounting channels** [361 (**forward)** and 362 (**aft)**]. These channels are riveted to the forward and aft spar webs, providing support for the tank along its entire length.

Begin with the forward channel, which is the wider of the pair. Identify the inboard end of the channel by measuring from the end to the first pair of dimples in the web of the channel; as shown in Figure 106, Detail A, the dimples are **1-1/2"** from the **inboard** end of the channel.

The main view in Figure 106 shows the general placement of the mounting channel against the forward spar web. The pairs of dimples align with areas of the spar web between lightening holes. The purpose of the dimples is to offset the channel from the spar web to clear the heads of the nose rib rivets.

> **Note** It is important that the nose and cove rib rivet heads do not bear on the mounting channels. The dimples in the channels should be deep enough to prevent this, but check to be sure. If one or more rivet heads do impinge on the channel, thin aluminum shims should be used between the channels and the spar webs as necessary to produce sufficient clearance.

The precise positioning of the mounting channel is illustrated in the two detail views of Figure 106. In a spanwise direction, the inboard end of the channel should be about **1/4"** outboard of the flange of the main rib at station 171.75 , as shown in Detail A. In a vertical direction, the upper flange of the channel should contact the upper hat sections, as shown in Detail B. Temporarily Cleco a couple upper hat sections in place to gauge this spacing.)

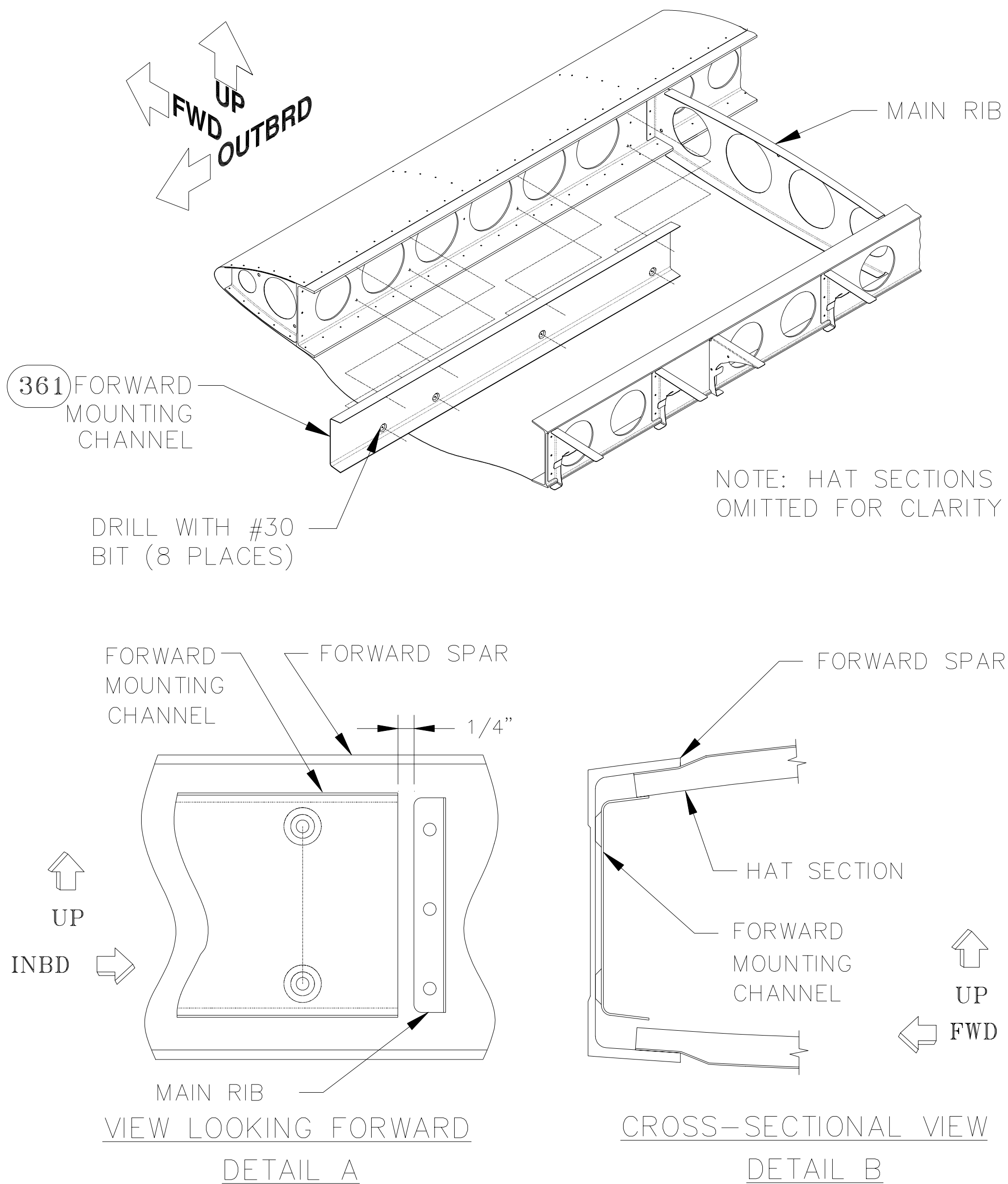

Figure 106: Positioning the Forward Tank Mounting Channel

With the channel held in position, use the pilot hole in each dimple as a guide to drill a #30 hole through the channel and the spar web. Cleco as you go. After all eight holes have been drilled in the mounting channel, remove it from the wing and thoroughly deburr all the holes in the channel and the wing spar. Corrosion-proof the channel as you see fit.

When riveted in place, the upper flange of the tank mounting channel lies just below and parallel to the upper flange of the forward spar—a placement that would make it extremely difficult, if not impossible, to rivet the upper hat sections and upper wing skin to the forward spar flange with the channel in place. The channel cannot be finally riveted to the spar, therefore, until after the upper hats and skin are riveted in place. However, in order to size and bend the fuel lines and to prepare the aux tanks for installation, the channel needs to be in position.

The solution to this problem is to temporarily rivet the channel in place with only two rivets—one through the upper dimple at each end of the channel—and then to drill these rivets out later. Use a couple of AAPQ-43 blind rivets for this purpose, but you may prefer to use a pair of cheap aluminum pop rivets from the local hardware store. With their hollow shanks, these will be a bit easier to drill out later without enlarging the holes.

The aft tank mounting channel is positioned and drilled using the same procedures you used for the forward one. Once again (as shown in Figure 106, Detail A) the inboard end of the channel should be about **1/4"** outboard of the flange of Main Rib 5, and (as shown in Figure 106, Detail B) the upper flange of the channel should contact the upper hat sections. The only real difference lies in identifying the inboard end of the aft channel. In this case, the inboard pair of dimples is **4"** from the **inboard** end of the channel.

Position the aft channel and drill all eight holes with a **#30** bit. Then follow the same procedures for riveting the channel to the aft spar web as you followed for the forward channel, depending on the type of installation. Test fit your aux tank to see that all fits well.

Completed: Left [ ] Right [ ]

Step 58: Install Bumpers on the Tank Perimeter

Depending on installation variables, the mounting channels may hold the tank either loosely or tightly in a fore-and-aft direction. In the spanwise direction, the tank is captured between the two outboard ribs, but as with the main tanks, it's necessary to provide some padding to the ends of the aux tank where it meets these ribs.

6" X 8" **neoprene sheets** [351] with self-adhesive backing are provided for this purpose. Cut these sheets into quarters to make sixteen **3" X 4"** pads. Peel off the backing paper and apply a pad to the end of each tank where it will contact the web of the two main ribs between the lightening holes. Add more pads, as necessary, to achieve a tight fit between the ribs. Next, using the remaining neoprene, install pads on the forward and aft surfaces of the tank at the corners to make the tank fit tightly in both of the mounting channels. Male sure to trim these pads so that they do not extend above or below the tank. Finally, install **anti-chafe tape** [355] on all areas of real or potential metal-to-metal contact between the tank and the wing structure. This includes both the mounting channels and the hats.

Completed: Left [ ] Right [ ]

Step 59: Position, Drill and Rivet the Transfer Pump Mounting Doubler

The transfer pump is mounted to the lower inboard wing skin just aft of the first inspection hole outboard of the wing strut. An aluminum doubler sheet will reinforce the lower skin.

Use one of the **.032" X 3" X 6-1/8" aluminum sheets** [356] for the doubler. As seen in Figure 107, the long dimension of the doubler should span inboard/outboard, and placed parallel to and about **1/4" aft** of the skin stiffener channel. Location is not critical, the doubler merely reinforces the skin.

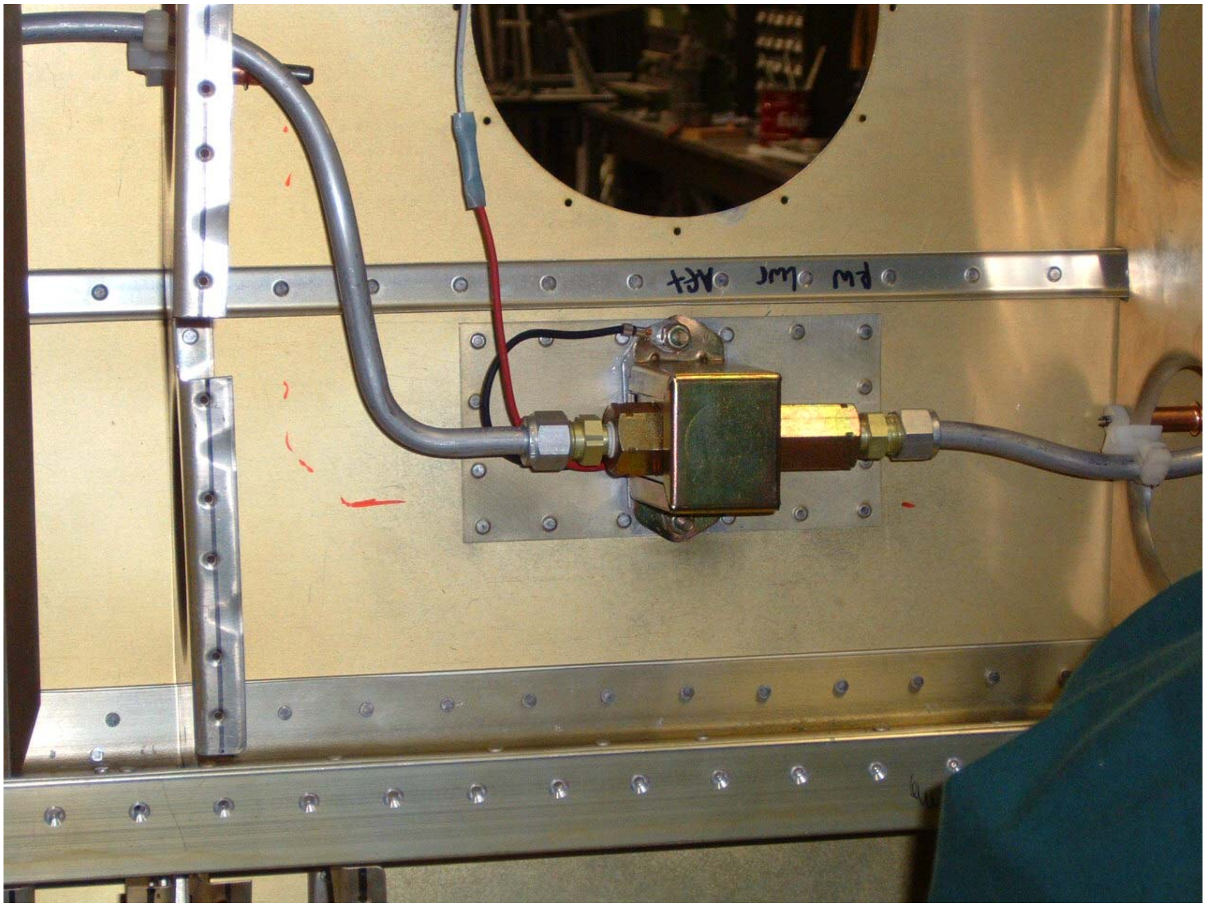

Figure 107: Positioning the fuel transfer pump and doubler plate. (RH shown)

Position the doubler as shown and use a #40 bit to drill approximately sixteen rivet holes around the perimeter of the doubler. Locate the holes 3/16" in from the edge of the doubler. Use the pump to ensure the positioning of the rivets will not interfere with the mounting flange on the pump. Once the doubler is drilled and clecoed, Use the pump to mark the hole locations for the mounting screws. Drill these holes through the doubler and skin using a #10 drill bit.

Thoroughly deburr all the holes and radius any sharp corners. Apply the anti-corrosion protection of your choice. Using AN470AD3 universal-head rivets of the appropriate length, rivet the tank mounting doubler inside the wing.

Completed: Left [ ] Right [ ]

Step 60: Install Vent and Fuel Line Fittings in the Tanks and Transfer Pumps, Route Vent Lines

Thread an aluminum **1/4" NPT to 3/8" tubing male connector** [353] into the auxiliary fuel tank feed line boss at the lower outboard end of the **main tank**. To prevent galling, use a thread lubricant/sealant on this and all other metal-to-metal threaded connections in the fuel system. We recommend Permatex High Tack Adhesive Sealant. Do **not** use Teflon tape, as small particles of the tape can break off and contaminate the fuel stream.

Both the inlet and outlet of the transfer pump also require fittings, in this case **1/8" NPT to 3/8" tubing male connectors** [352].

Each **auxiliary fuel tank** [359 (**left)** and 360 (**right)**] gets three fittings (not including the sump drain fittings; these will be installed in a subsequent step). Before installing them, however, inspect each tank carefully for any debris left over from the welding process. Thoroughly vacuum the tank through the filler opening if any foreign matter is found. In installing the tank fittings, take great care not to overtighten them; to do so risks damaging the threads in the tank bosses.

First, thread one of the remaining 1/4" NPT to 3/8" tubing male connector into a **finger screen** [372]. Then, thread the finger screen into the fuel outflow boss on the inboard end of the tank. Finally, thread the body of a **nylon male tubing connector** [370] into the vent line boss on the outboard end of the aux tank. Set the nut portion of the connector aside for the moment. Remember, no thread sealant should be used on the nylon vent line fittings.

> **Warning** If your tanks and pumps will be sitting for any length of time before final installation, we strongly recommend putting a small piece of tape over each open fitting to prevent foreign object contamination.

The fuel tanks must be vented to the outside air to ensure proper fuel flow. Each vent line runs from the vent line boss near the top of each tank to the wingtip. Begin, therefore, by cutting the supplied 25' length of **1/4" nylon tubing** [83] in **half**. Make the cut with a utility knife, taking care to keep it perpendicular to the The tubing is secured to the vent line boss, as shown in Figure 108, with a **nylon**

male connector [35] and **nylon connector insert** [36]. The connector has three parts—the body, nut and sleeve. Unscrew the nut from the body; the sleeve will come off with the nut. Thread the body into the vent line boss, as shown in Figure 108. The end of the body with the **finer** threads goes into the boss.

Note The use of thread sealant is **not** recommended with nylon fittings.

Slide the nut and sleeve over the square-cut end of the tubing and push the tapered end of the tubing connector insert into the end of the tubing. Then insert the end of the tubing and the insert into the coarse-threaded end of the body and tighten the nut and sleeve down over it.

Next, route the main tank vent line. Keep the line high in the wing avoiding low spots. It is easiest to work from the wingtip inboard rather than the other way around. Insert an end of the vent line through the small gap at the upper aft corner of Nose Ribs 15, 16 and 17, and then aft through the first forward-spar lightening hole just inboard of the aux tank. Reference Figure 110 and 111 for additional information. Holes drilled through the main ribs between the first and second lightning hole as shown in Figure 111 should be drilled with a 7/16" diameter bit sized for the MS35489-6 **7/16" rubber grommets** [161]. Secure the line where it passes through Nose Ribs 15, 16 and 17 by applying a fillet of RTV sealer around the line, filling the small gap between the rib web, the spar and the leading edge skin. Leave 12" sticking out at the wing tip for later use when completing the plumbing.

Completed: Left [ ] Right [ ]

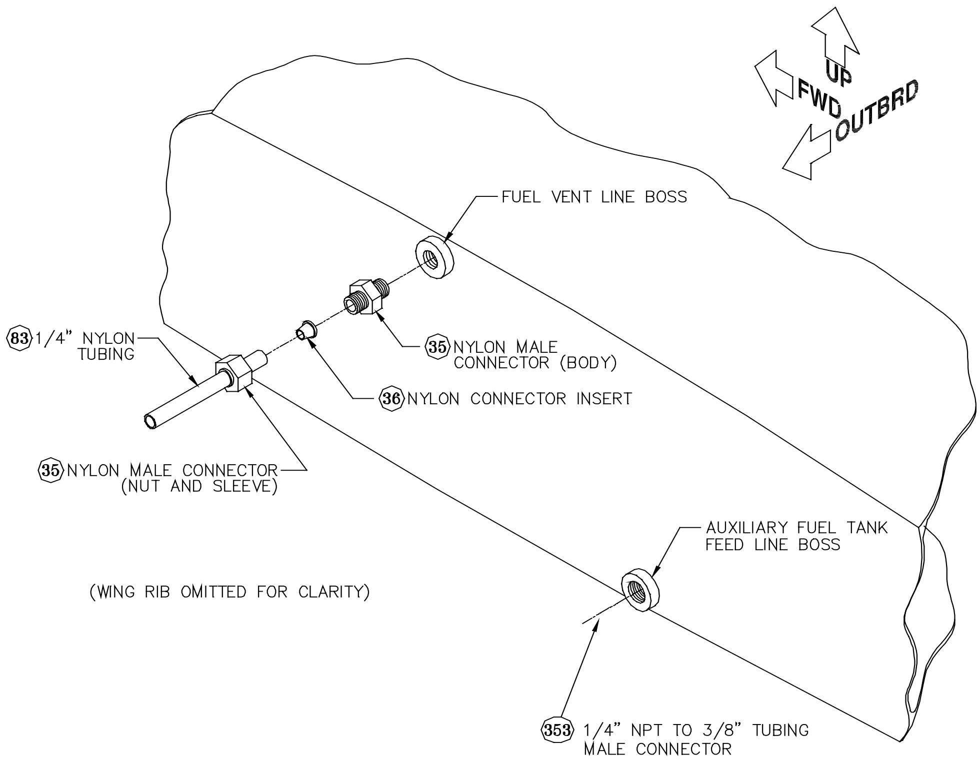

Figure 108: Installing the Main Tank Outboard-End Tank Fittings

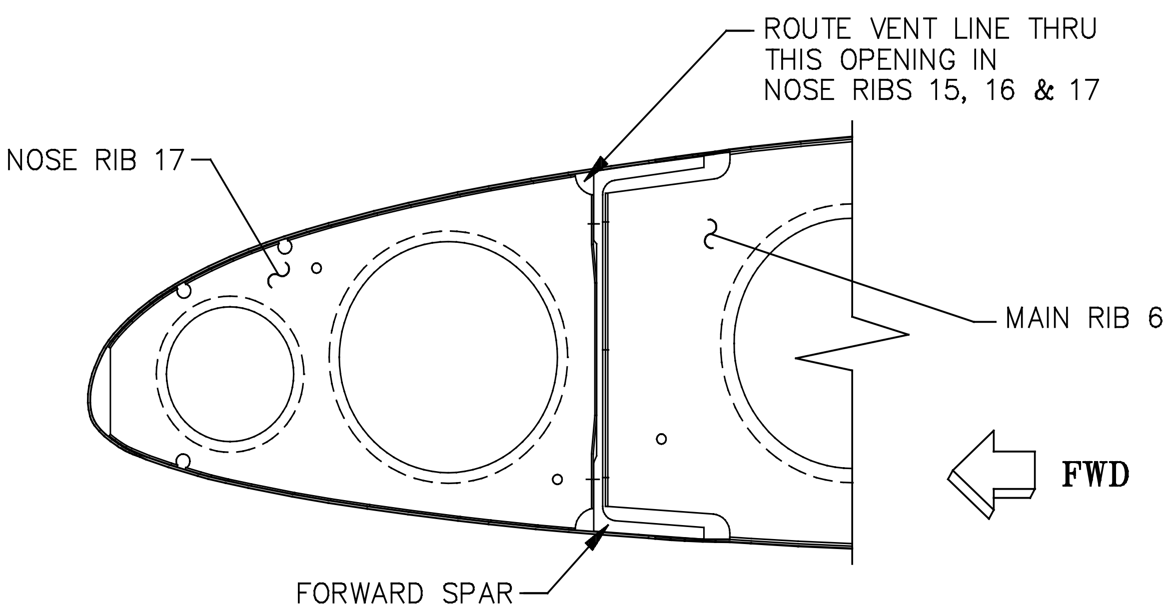

Figure 109: Routing the main tank vent lines thru the outboard nose ribs

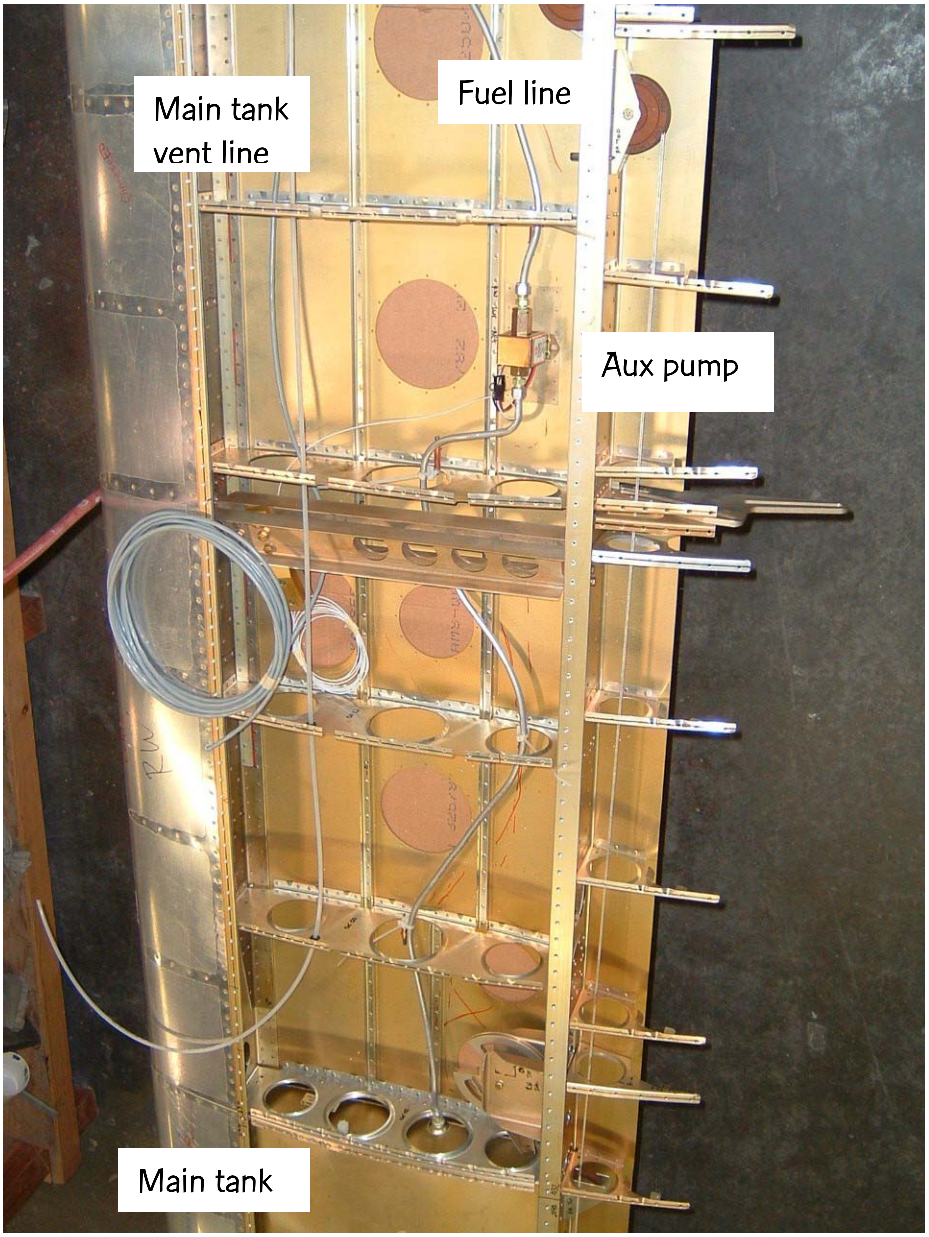

Figure 110: Plumbing of fuel and vent lines

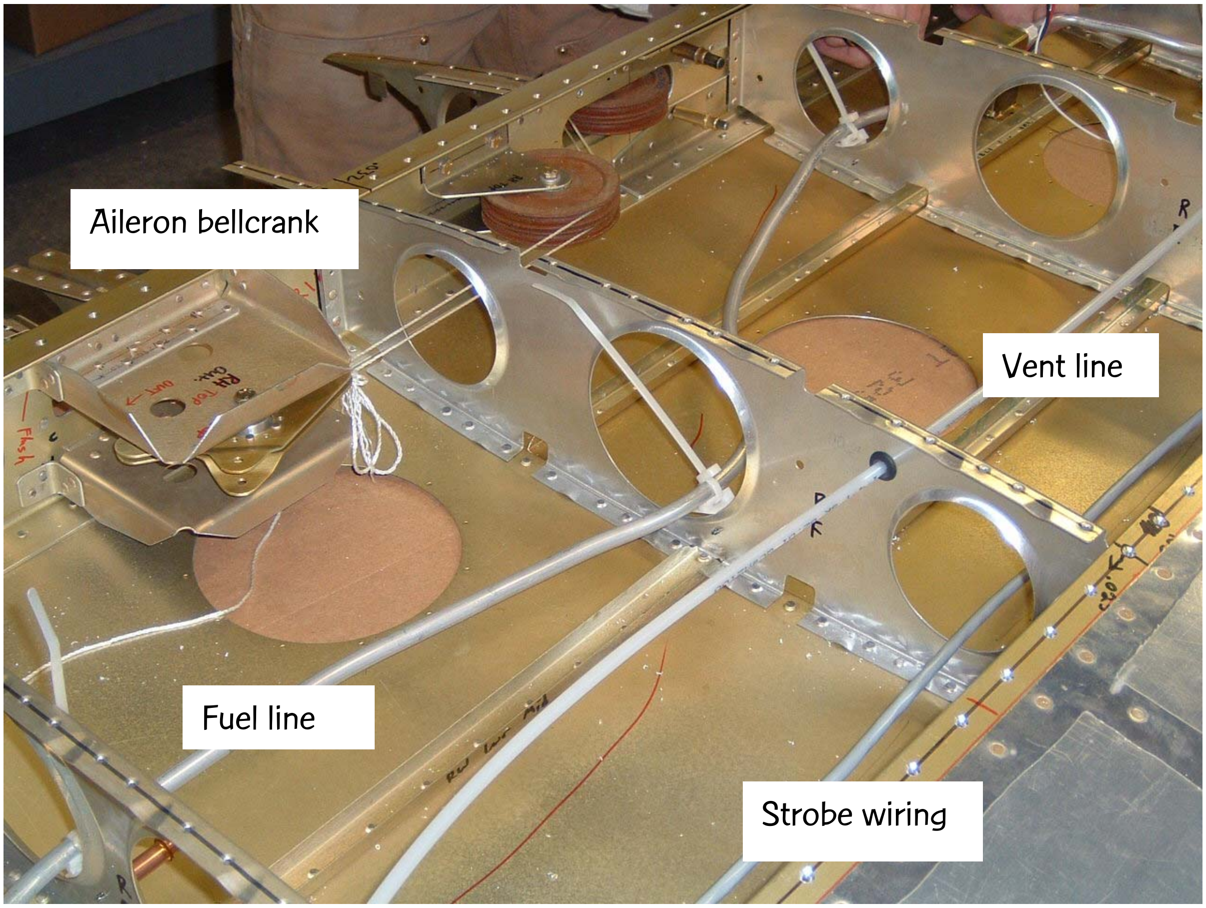

Figure 111: Plumbing of fuel and vent lines.

Step 61: Fit the Fuel Lines

The **3/8" O.D. X .035" wall aluminum tubing** [376, 79] may be coiled for shipment. In order to bend and fit the fuel lines, however, you need to straighten it out. Fortunately, the tubing is very soft and easily straightened by hand without much danger of kinking or cracking. Nevertheless, work it slowly. We recommend unrolling the coil slowly against a flat table for best results.

Begin with the run between the outlet of the transfer pump and the main fuel tank as seen in Figure 110. Rout your path so the line misses access panels and avoids any really low spots in the run. It is not necessary to loop the tubing forward under the strut beam as shown in figure 110, a straighter more direct line here is acceptable.

Initially, cut a straight length of tubing about **60"** long or whatever **your** chosen run will require. Then loosen the nut on the tank fitting and slide one end of the tubing into the fitting until it bottoms out. Rotate the tubing until the outboard end is aligned fore-and-aft with the pump outlet and then finger tighten the tank fitting.

Warning In positioning the transfer pump, be sure to note that it is a **one-way** unit; there is a distinct inlet and outlet. The **inlet** is the **longer** of the two bosses, and it is oriented **outboard**.

Now you can determine how much additional length must be trimmed off the outboard end of the tubing in order for the pump to be positioned over its mounting screw holes when the tubing is bottomed out in the pump fitting. Trim the line to fit, and when you're satisfied, go ahead and mount the pump, using NAS603-8P **round-head machine screws** [387], AN960D10L **thin aluminum washers** [386], AN960-10L **thin washers** [385] and AN365-1032A **nylon self-locking nuts** [380]. Insert the screws from **outside** the wing, using aluminum washers under the screw heads and steel washers under the nuts.

Once the pump is secured, you can tighten the fittings on the pump outlet and the main tank inlet. If necessary, refer to *Assembly Manual* "SECTION II: TOOLS AND TECHNIQUES" to refresh your memory on the proper techniques for tightening Swagelock fittings.

Next up is the run from the pump inlet to the aux tank. This requires an initial tubing length of about **55"**. Follow essentially the same procedures you just used for bending and sizing the other fuel line run. One again, avoid impinging the access thru the inspection holes.

The aux tank and transfer pump inlet fittings **cannot** be tightened just yet, but leave the tank and the line in place for the moment.

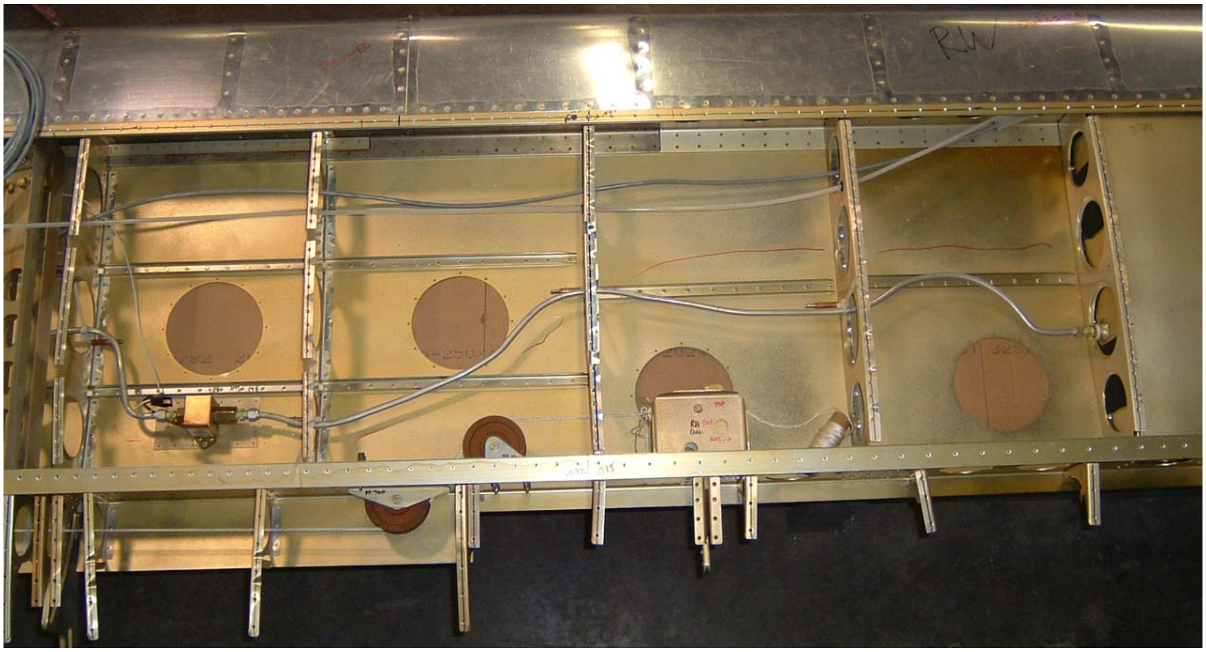

Figure 112: Fuel line routing from the pump to the aux tank. (RH shown)

Completed: Left [ ] Right [ ]

Step 62: Install the Fuel Line Brackets

Where the fuel line crosses any main rib, it's desirable to secure it so that it won't chafe against the rib webs. Special nylon **fuel line brackets** [354] are provided for this purpose. The brackets are blind riveted to the rib webs at the bottom of the lightening holes, where they provide a cradle for the tubing. Slots in the brackets accommodate nylon cable ties that secure the tubing in place.

Figure 113 illustrates the installation of the brackets. Note that the curved portion of the bracket is designed to fit over the flared rim of the lightening hole. Use a **#30** drill bit to drill through the brackets and rib webs, and then use **1/8" X 5/16" blind rivets** [375] to install the brackets. Do not install the cable ties at this point, however.

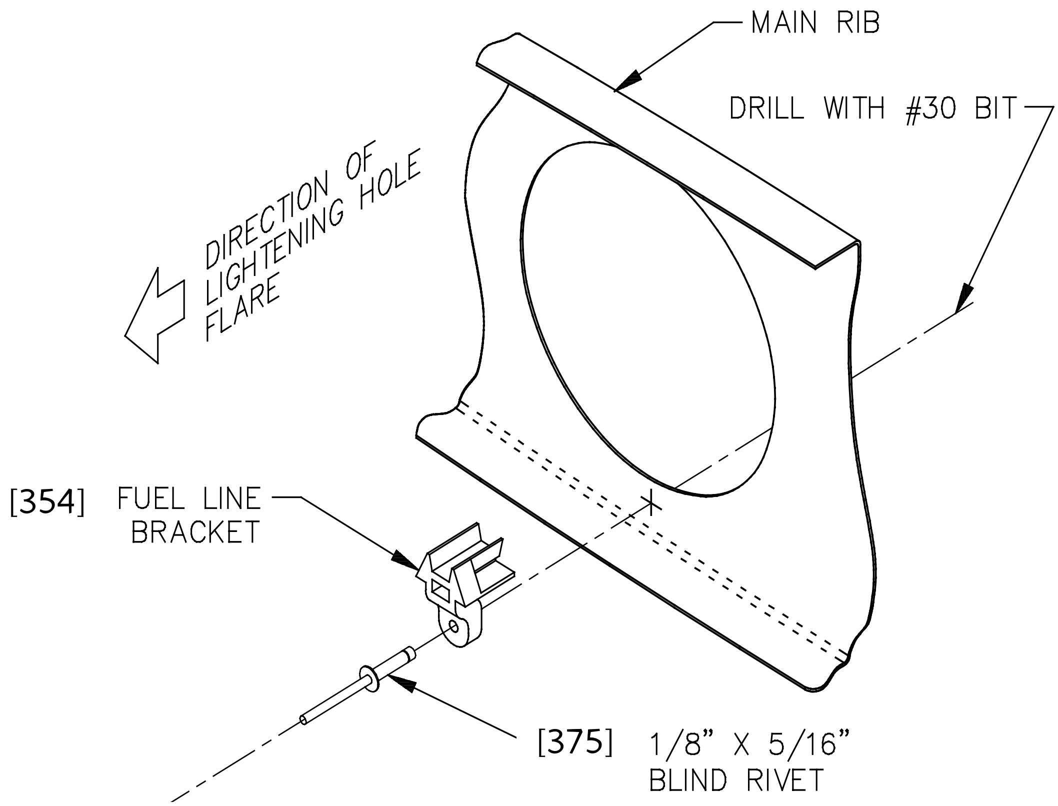

Figure 113: Installing a Fuel Line Bracket

Completed: Left [ ] Right [ ]

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: [redacted]

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Step 63: Cut the Filler Neck Opening in the Upper Outboard Wing Skin

With the aux tank and the main rib still in position (upper skin removed), thread a **fuel tank filler neck** [358] into the aux tank filler opening. The procedure for cutting the filler neck opening in the upper outboard wing skin is almost identical to that you used for cutting the main tank filler neck openings.

Lay out the reference dimensions on the skin and cut a 2-1/4" diameter hole. (Hole size for optional flush fuel cap p/n 201-40003-01 is 3". For the flush locking fuel cap p/n 201-40004-01 is 2 1/2".) Then check the fit with the tanks and filler neck in place and enlarge the hole as necessary to achieve a clearance of about 1/16" all the way around the neck.

Completed: Left [ ] Right [ ]

Step 64: Route the Transfer Pump Wiring

The transfer pump naturally requires a power lead to the positive bus in the fuselage, but it can be grounded directly to the wing. The pump comes with a ring terminal on the ground lead, and when the pump is finally mounted, this can simply be inserted between the pump mounting flange and the washer on whichever mounting screw is handiest.

Note If you primed your mounting doubler, be sure to scrape away a little primer under the pump flange to insure good metal-to-metal contact.

Note If you prefer, there's certainly no reason you can't run a ground lead from the pump all the way back to a ground bus in the fuselage, but in our prototype installation, we found that the wing structure itself provided a very effective ground with less cost and weight.

Thirty feet of **16-gauge single-conductor wire** [378] is provided for the positive leads. Begin by cutting the wire into two **15'** lengths.

Next, clip off the plastic connector on the positive pump lead and install a **16–14 gauge butt connector** [365]. Crimp the other end of the connector onto the positive lead from the wing root. The Sportsman prototype wiring is routed thru the wing strut. If you chose to do so, secure the wiring against chafing and coil the excess near the lift strut as shown in figure 110 for routing down the strut later.

Completed: Left [ ] Right [ ]

Step 65: Drill Preliminary Sump Drain Holes in the Lower Wing Skin

Low-point drains are provided for each of the aux tanks. The **fuel drain valve** [371] for each tank is threaded into a 1/8-npt, threaded **sump drain opening**. This valve is installed through the bottom of the tank in one of two threaded openings provided in the bottom of each tank at the inboard end. The reason there are two openings is that the low point of the tank changes depending on whether the Sportsman is on tricycle or conventional landing gear. The **forwardmost** drain opening in each tank is for the **tricycle** drain and the **aftmost** opening is for the **taildragger** drain.

Note Builders who intend to switch their Sportsman back and forth between landing gear configurations have two choices. They can install the drains in the taildragger (aft) opening and simply lower the tail of the aircraft to fully drain the aux tanks, or they can install two drains in each aux tank. To accommodate the second choice, we offer the **Auxiliary Fuel Tank Drain Valve Installation** (P/N 933-01010-01), which includes an extra pair of drain valves.

Because of slight variations in the position of each tank within the wing, it is difficult to prescribe dimensions on the wing skin that correspond to drain opening locations on the tanks. The safest course is therefore to drill somewhat undersized holes through the lower wing skins first, and then to adjust these hole locations as necessary after the tanks are in final position.

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201:

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

ADV[illegible]

Sec[illegible]VI: Wing Assembly

Page 130: The Text under figure 67 was revised as follows: ~~Provide .75 clearance between rib & center of track.~~ Provide .30 minimum clearance from edge of track. Figure 67 was updated accordingly with 2 arrows and text .30 indicating this change.

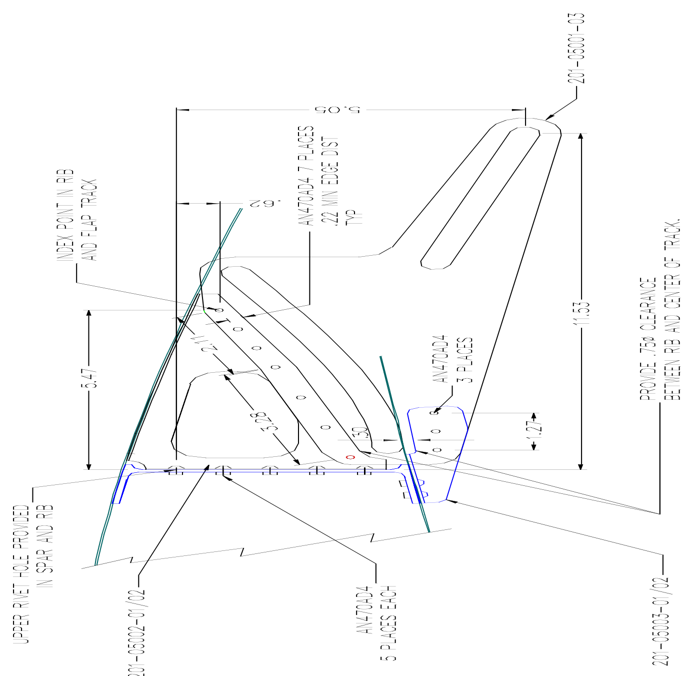

Figure 67: Flap Track Assembly

Page 155: Figure 83 was updated, the overall length of the flap track reinforcement was added 3.25.

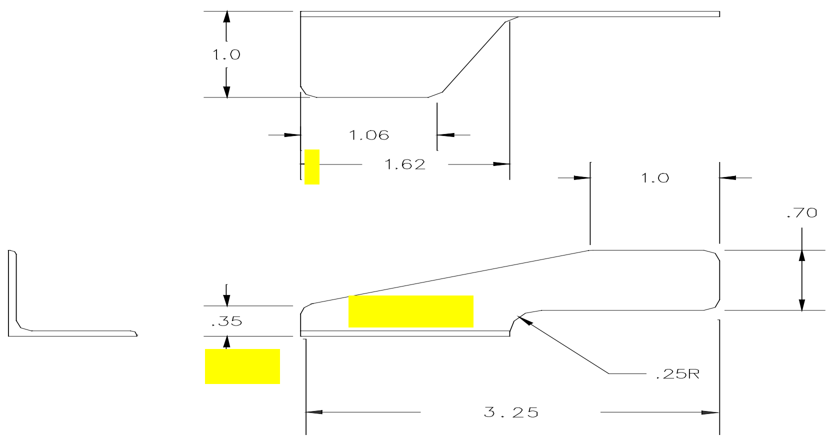

Figure 83: Flap Track Reinforcement Angles

Section IX Systems Installation

Main Parts List: Part number 450-[42]

Page 48: Press the ~~3/16" X ½" roll pin [42]~~ **pan-head screw** #10 X 7/16 [167.1] and **the self-locking nut**, 10-32 [108] into the hole at the upper end of the flap handle ratchet plate; this pin serves as a limit stop for the flap handle.

Page 49: Figure 20, Flap Handle Assembly, the text changed on figure to reflect the new parts listed above. (42 was modified)

First, carefully measure the locations of the preferred opening on the tank relative to the outboard and aft tank edges (called dimensions "A" and "B", respectively).

Next, insert the tank into the wing and cleco the tip rib in place. Measure the distance from the outboard edge of the skin to the outboard face of the tank, and from the lower aft skin edge to the aft face of the tank (called dimensions "C" and "D" respectively). Add "A" and "C" together to establish the drain opening relative to the outboard edge of the lower skin; add "B" and "D" together to establish the drain opening location relative to the aft edge of the lower skin. After these dimensions are carefully established, remove the tip rib and the tank from the wing.

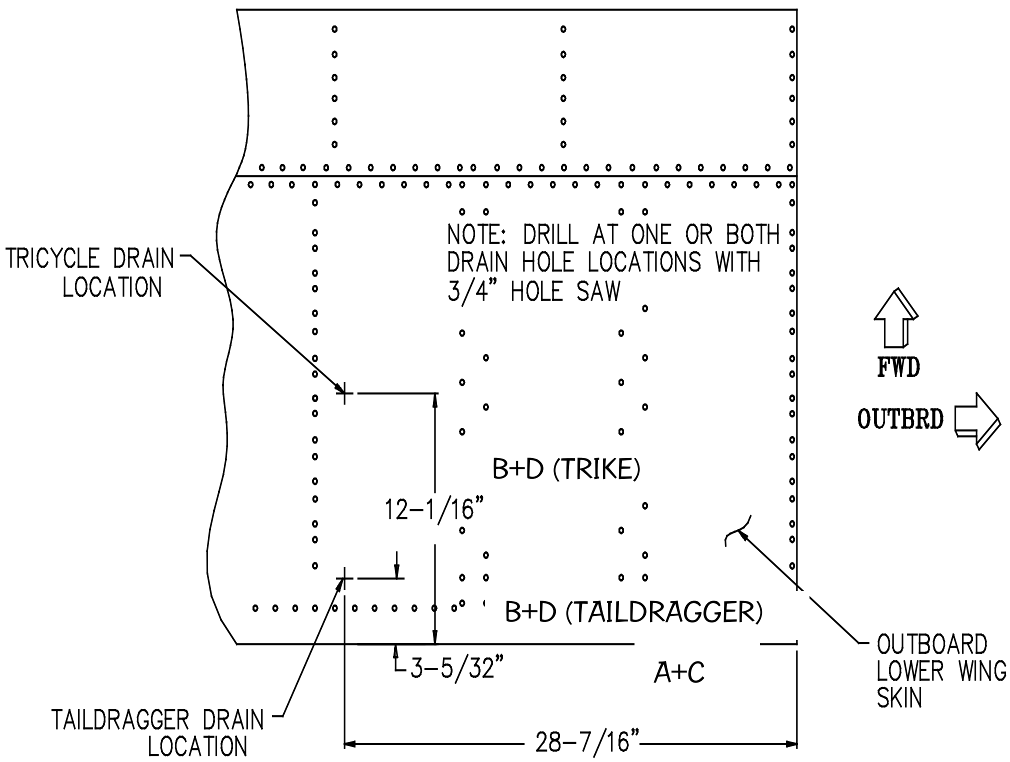

Figure 114: Preliminary Sump Drain Hole Locations

Figure 114 shows the approximate locations of the sump drain holes relative to the trailing edge and the outboard edge of the outboard lower wing skin. Mark one or both of the hole locations and drill a **3/4"** hole using either a piloted hole saw or a Unibit. (This hole will be enlarged to a diameter of approximately 1-1/4" in a subsequent step.)

Completed: Left [ ] Right [ ]

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

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618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202:

Wing Plumbing, Wiring and Other Miscellaneous Stuff

Step 66: Install the Nutplate for the Wing Support Strut Eyebolt (Optional)

Wing Brace Option If you are sure that you **never** intend to fold your wings, **skip this step**, however, keep in mind that installing these eyebolts may enhance resale.

The folding-wing feature of the Sportsman relies on a temporary steel support strut running from the bottom of the wing strut to the forward wing spar. This rod takes the torsional load imposed by the wing's weight when the forward spar is disconnected from the fuselage cage and keeps the forward spar attach point in proper alignment while the wing is folded. To secure the rod to the wing, you must install a small eyebolt through the lower flange of the forward spar. The eyebolt itself can be installed at any time, but because the fuel tank will restrict access to the lower flange of the spar, it's necessary to install the nutplate for the eyebolt at this time.

Wing Brace Option The nutplates and rivets for this step are included in the standard Sportsman kit. However, the eyebolts themselves, as well as the steel support struts and other necessary parts, are included in the Wing Brace Option Kit. Order P/N 902-01000-01. These nutplates and rivets are the **only** parts of the wing-fold system that are not easily retrofittable to a Sportsman at any stage of completion, so there's no need to turn to the option instructions or even to purchase the option kit at this time, although you certainly can do so if you wish.

As shown in Figure 115a, drill the central, **#10** hole for the nutplate between the first and second rivets **outboard of the root rib** in the forward most row through the lower spar flange. This location need not be measured too precisely; simply locate the hole on the rivet line and roughly midway between the two rivets.

Next, using standard procedures, drill two **#40** mounting holes for a K1000-3 **nutplate** [156]. Deburr all three holes, both inside and outside the wing. Finally, as shown in Figure 115b, use 3/32" AN470AD3 universal-head rivets to rivet the nutplate to the spar flange. The rivet heads should be on the outside of the wing.

Completed: Left [ ] Right [ ]

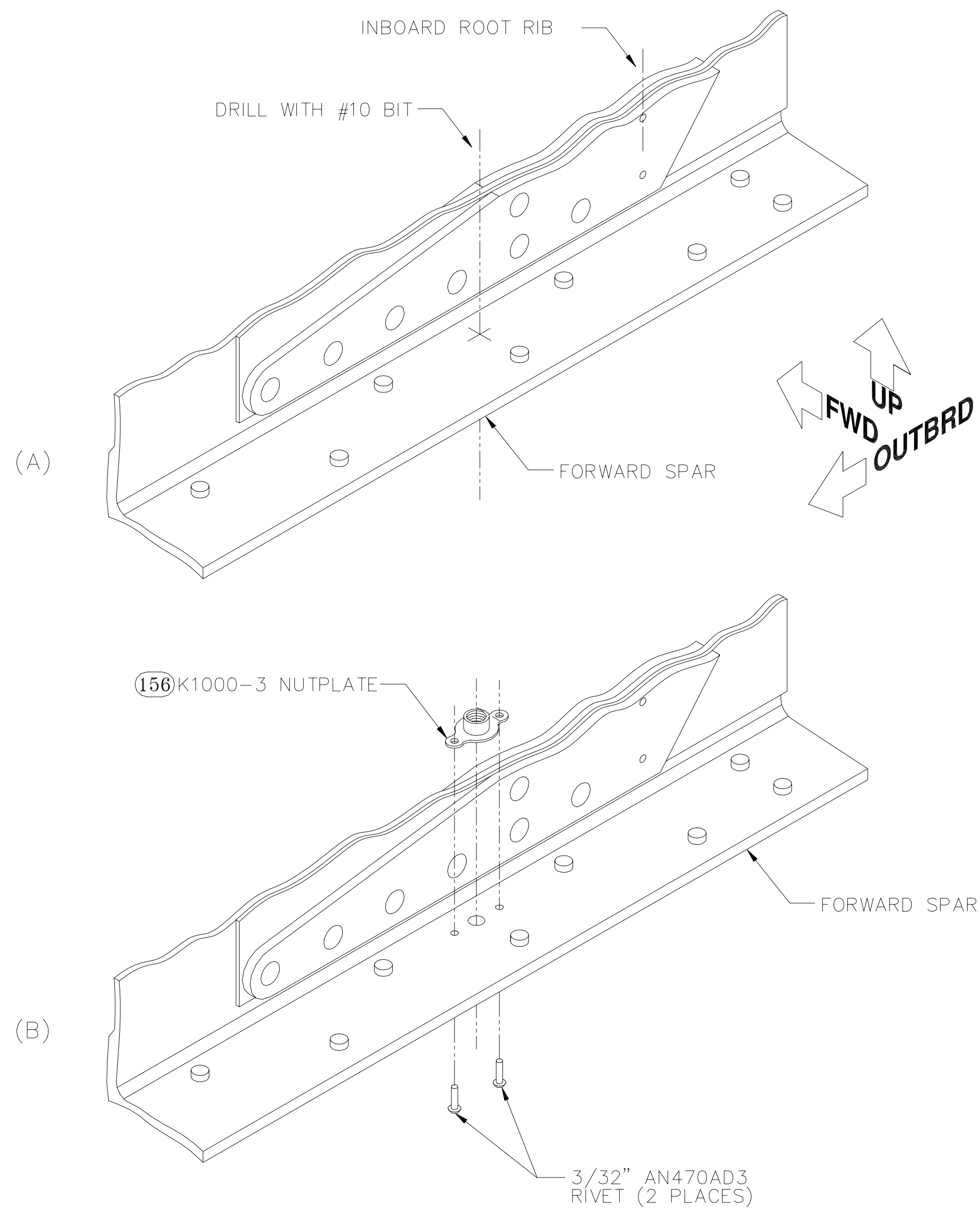

Figure 115: Installing the Nutplate for the Forward-Spar Wing-Fold Eyebolt

Step 67: Drill the Inspection Hole Doublers

There are eight inspection holes in the lower wing skins, which provide access for inspection of the flight control, furl and electrical systems of your completed Sportsman. These openings also provide access for riveting on the upper skins, and so it's desirable to leave the holes as open as possible for as long as possible in the construction process. Therefore, you won't rivet the inspection hole doublers inside the holes until late in "SECTION X: FINAL ASSEMBLY," but you can drill the rivet holes in the doublers now before you string lots of wires and tubing in the way!

There are three different sizes and shapes of hole, with a corresponding doubler and cover for each. Figure 116 gives the locations of each of the holes, and Table 1 specifies the appropriate doubler and cover for each.

HOLE	SIZE	COVER KEY NO.	COVER PART NO.	DOUBLER KEY NO.	DOUBLER PART NO.
A	6.2" X 4.7"	271	201-34001-01	29	201-34002-01
B	4.45"	270	201-33001-01	28	201-33002-01
C	5.75"	272	201-35001-01	30	201-35002-01

Table 1: Inspection Hole Covers and Doublers

Future runs of the lower inboard main skins 201-00017-03/04 will have an additional access hole provision in them for ease of riveting the fuel bay. If you wish, you may add this access hole yourself and order the (2) additional covers and backup rings form NGA.(part No. 201-33001-01 and 201-33002-01). The access hole is located at Station 58.0 and roughly 9.6" aft of the forward spar rivet line. You will also need eight of the K1000-08 nutplates and the AN526-8R6 screws to finish this installation.

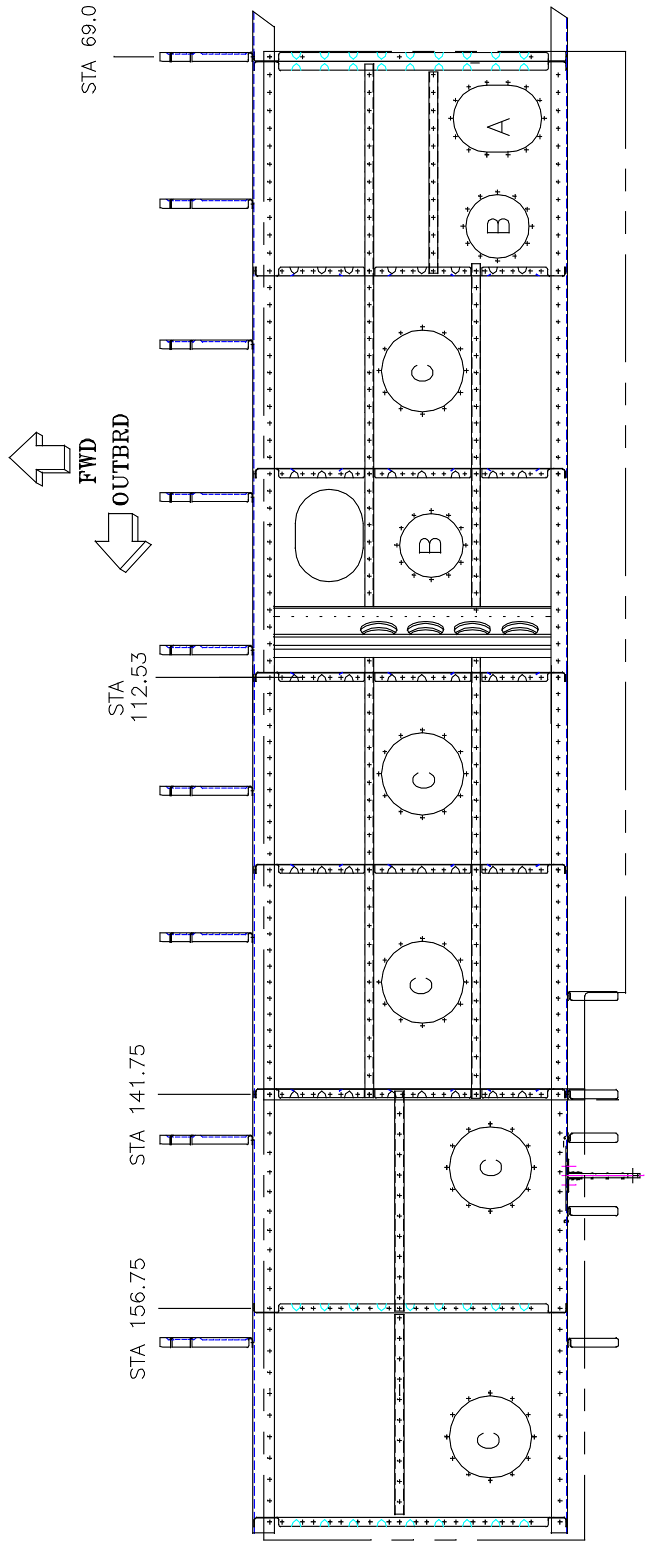

Figure 116: Inspection Hole Locations

The procedure for positioning and drilling the doublers is identical in all cases. As shown in Figure 117a, Cleco an appropriate cover to the doubler with 5/32" Clecos, and then seat the cover in the inspection hole so that the doubler rests on the **inside** surface of the skin. When the cover and doubler are properly positioned, tape the doubler to the inside surface of the skin with several generous strips of duct tape or wide masking tape. As shown in Figure 117b, the tape can lap right over the cover, which should remain Clecoed in place.

Now, working from **outside** the wing skin, you can drill through the skin and the doubler at each of the pre-punched pilot holes in the skin, as shown in Figure 117c. Use a **#40** bit. If possible, have an assistant hold a block of scrap wood tightly against the doubler from inside the wing to back up the drilling. It will also be helpful to Cleco the drilled holes as you go.

After all the skin/doubler rivet holes are drilled, mark all the doublers with their specific locations **and orientations** so that you can match them up again later hole-for-hole. (We used an engraving tool to permanently etch the locations and orientation of each cover on its inside surface.) Un-Cleco the doublers from the skin and the covers from the doublers. Position K1000-08 **nutplates** [282] on the doublers at the cover screw holes and drill **#40** rivet holes. After deburring, dimple the nutplate rivet holes in the doublers to accommodate 3/32" AN426AD3 flush-head rivets.

Completed: Left [ ] Right [ ]

Step 68: Corrosion-Proof the Doublers and Rivet the Nutplates to Them

Apply the corrosion-protection of your choice to the doublers (transferring the location and orientation marks as necessary). Then flush-rivet a K1000-08 nutplate at each screw hole, with the rivet heads on the undersides of the doublers. When you're finished, use masking tape to secure the doublers on the **inside** of the lower wing skins immediately beside their final locations. This will allow you to reach inside the wing easily to buck the upper-skin rivets, but then you'll be able to release the tape to final-position the doublers.

Completed: Left [ ] Right [ ]

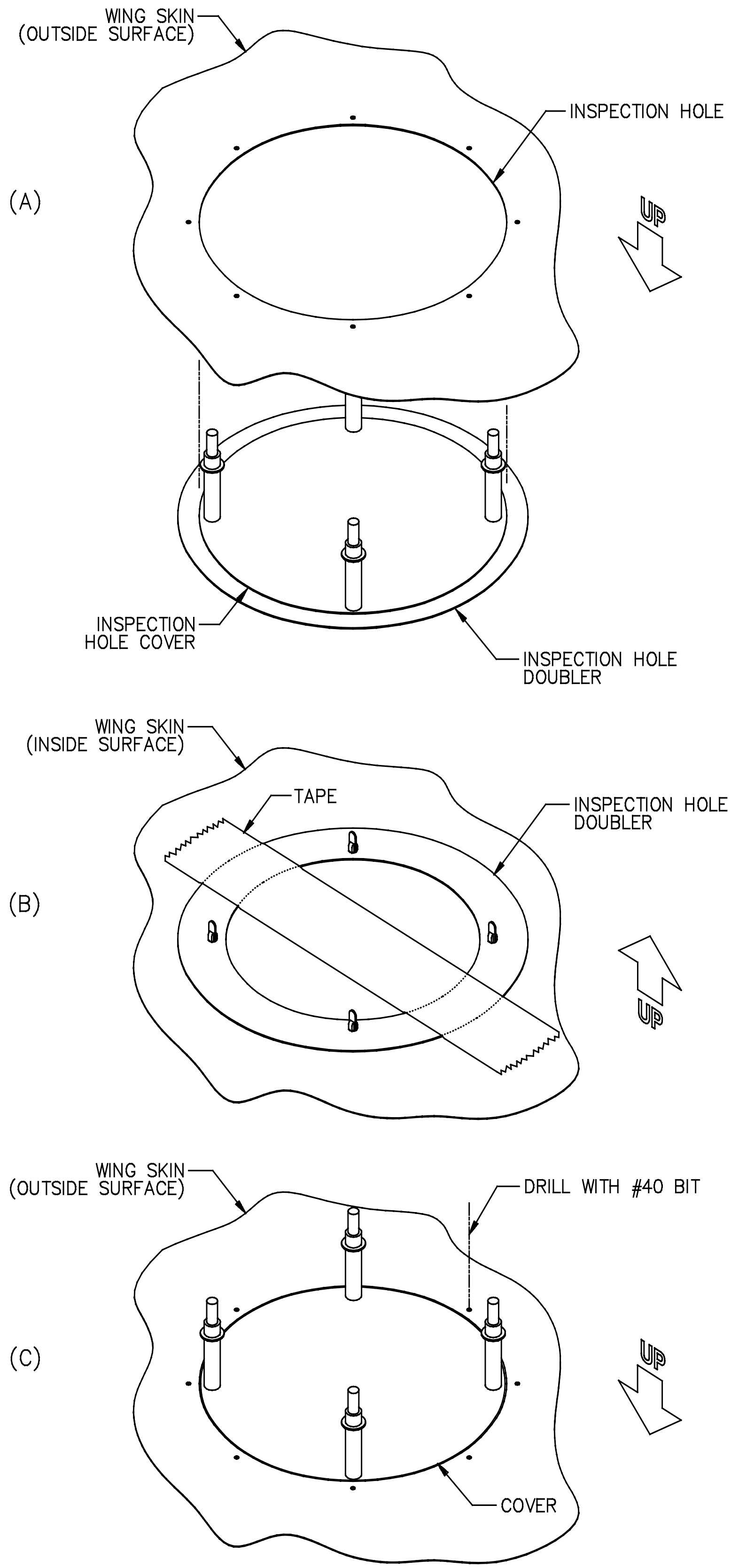

Figure 117: Drilling an Inspection Hole Doubler

Step 69: Install the Pitot Tube and Line

Since an airspeed indicator is required for even the most basic VFR operations, you'll need to install a pitot system. However, because of the variety of possible installations, the standard kit does not contain the components of such a system.

Pitot/Static System Options Glasair Aviation offers two pitot/static system option kits for the Sportsman. The Non-Heated Kit (P/N 912-01000-01), which is suitable for VFR flight only, includes a simple, non-heated pitot tube, two custom-designed static ports, all tubing and fittings, all installation hardware and detailed instructions. The Heated Kit (P/N 912-02000-01), which is intended for IFR operations, does **not** include the pitot tube itself. The reason for this is that we have been unable to secure a reliable supply of standard, AN5812 heated tubes at competitive prices. Since they are readily available at retail prices through a variety of aircraft parts suppliers, we leave it to the individual builder to purchase the tube, but we do supply the static ports, all tubing and fittings, all electrical wiring and connectors, all installation hardware and detailed instructions.

If you are installing one of these kits, **turn to the *Option Instructions* now**. Return to Step 70 of this *Assembly Manual* when the specified option steps have been completed.

☞

The pitot tube can be located on either wing, although the left wing seems to be the conventional choice of just about everyone, perhaps simply because the airspeed indicator is typically on the left side of the panel, thus shortening the tubing run by a foot or two. Figure 118 shows the recommended location for the pitot tube on the left wing—centered between the two longitudinal stringers and outboard of the rib at station 69.0. We have found this location to provide accurate pressure readings and to minimize the potential for poking unwary pedestrians in the eye.

In the Sportsman prototype, we have routed all plumbing and electrical down the wing strut. You may want to allow for a disconnect in all lines in the unlikely event that you should ever need to remove the wings from the aircraft.

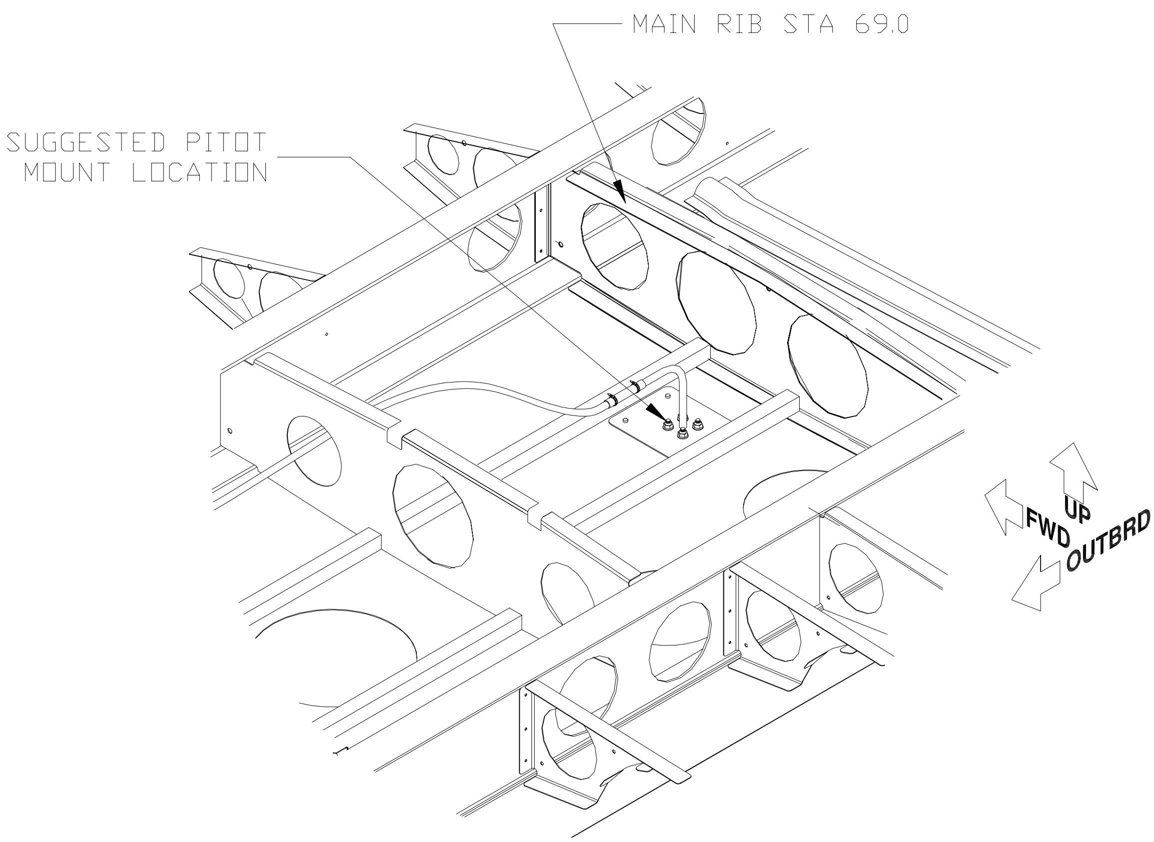

Figure 118: Pitot tube mounting location.

Although the pitot tube could be installed through the inspection holes in a finished wing, we strongly recommend installing the tube now, when it's much, much easier! Be aware that the center skin is relatively thin aluminum; it should be reinforced on the inside for the pitot tube mounting. A small reinforcing bracket (bathtub fitting) made from .032 aluminum sheet that ties into the forward and aft stringers and has formed flanges between those stringers will provide adequate stiffness for the mount. Also, be sure to properly deburr all mounting holes and corrosion-proof exposed aluminum surfaces as you deem necessary.

Figure 119 shows the routing of the pitot line and wiring, the fuel vent line and the fuel line running between the main and auxiliary tanks. The cutout for the pitot mast can be seen just forward of the flap bellcrank access hole.

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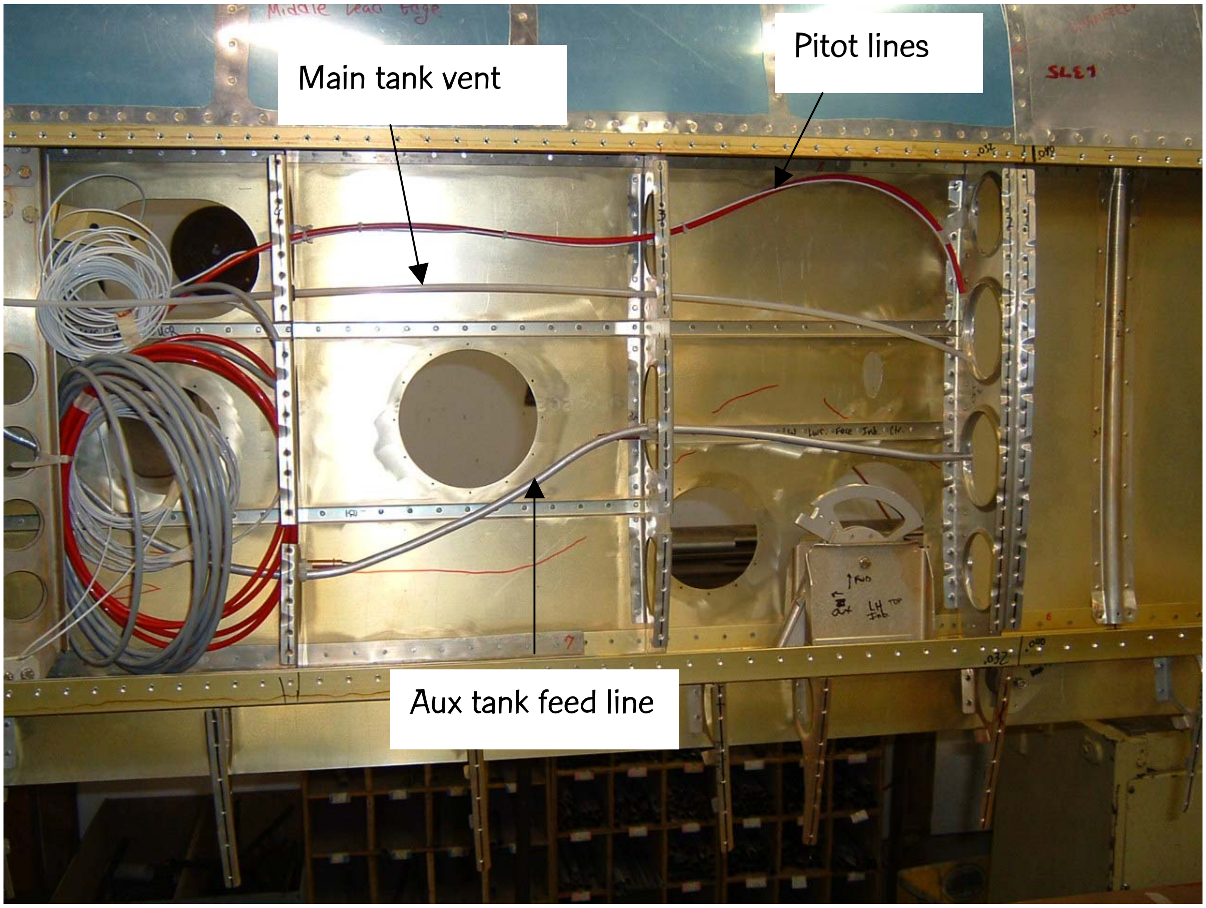


Figure 119: Wing plumbing and wiring shown ready to be routed down the wing strut

Step 70: Install the Wing Light Wiring (Optional)

Lighting isn't required for daytime VFR operation, but even if that's the only kind of flying you plan to do, an anti-collision strobe or rotating beacon is **strongly recommended**. Night flying requires white, red and green position lights as well as a strobe or beacon. Refer to FAR Part 91.33 for precise lighting requirements.

Nav/Strobe Light Option Glasair Aviation, LLC's Nav/Strobe Light Option Kit (P/N 921-02000-02) provides everything necessary to bring your Sportsman into conformity with all FAR Part 91 standards for aircraft position and anti-collision lighting. The system consists of two wingtip-mounted light units, each of which contains an appropriately colored position light, a white strobe and an aft-shining white position light. These light heads are manufactured by Whelen Engineering, a world leader in aircraft lighting systems. The kit also includes a Whelen 14-volt power supply for the strobe system; complete wiring harnesses for both the strobe and navigation lights; all electrical connectors and supplies; and all installation hardware, as well as complete installation instructions. The kit does not include switches or circuit breakers, although these items are available separately.

If you are installing the Nav/Strobe Light Option Kit, **turn to the *Option Instructions* now**. Return to Step 71 of this *Assembly Manual* when the specified option steps have been completed.

Route the wiring harness(es) for any wingtip lighting systems you're installing approximately as shown in Figure 112, passing the wiring thru the leading edge to miss the aux fuel bay. If you run more than one wire, bundle the individual strands with 4" nylon **cable ties** [34]. Secure the wiring every 8" or to main rib. You can drill holes in the rib webs to accommodate rubber grommets or simply run the wiring through the forward-most lightening hole in each rib. If you elect the latter option, however, wrap the wiring in short lengths of **3/8" spiral wrap** [82] to provide anti-chafe protection where it passes over the sharp edge of the rib web.

Pass the wire thru the strut beam and coil it inboard of the strut beam near the strut hole in the lower wing skin. You will route it down the strut later.

Hint If you don't plan to install a lighting system right away but contemplate doing so at some point in the future, you can save a tremendous amount of trouble by installing a conduit for future wiring at this stage. Select a flexible nylon tubing with an inner diameter of about **5/8"** and route it exactly as you would the wiring. Then, when you add lighting later, you can simply snake the wiring through the tubing without having to perform all kinds of gymnastics through the inspection holes.

Completed: Left [ ] Right [ ]

Main Gear Leg Installation

It's finally time to put your Sportsman on its landing gear! You'll begin by installing the main gear legs. The parts and procedures for doing this are virtually identical regardless of whether you're building a tricycle- or a conventional-geared Sportsman. The main thing is to remember to use the **aft** gear sockets for a Tricycle configuration and the **forward** ones for a taildragger. You'll have a lot of flying fun in either case—just don't use one of each! Other differences in procedure will be noted in the text.

Step 71: Support and Level the Fuselage

The first step is to support the fuselage high enough off the floor to allow you to insert the legs into the sockets. The best method is to rest the fuselage on a sturdy, narrow table about 32" high. Does your wing jig table come to mind? Pad the surface with an old blanket and set the fuselage on it, with the long axis of the airplane parallel with the long axis of the table. Put a padded support under the aft fuselage to bring the waterline level. Use a level clamped between the waterline marks on the inside edges of the door cutout to check this, just as you did in "SECTION VIII: FUSELAGE ASSEMBLY."

Next, level the fuselage laterally. Be as precise as you can, and once you've leveled the fuselage, wedge sand or shot bags under it on both sides to keep it that way.

Note You should be using the same lateral leveling method throughout your construction project. You are trying to end up with an airplane with flying surfaces set to some angle relative to a datum so it performs well in the air and looks level on the ground.

Completed: [ ]

Step 72: Insert and Position the Gear Legs

The **main gear legs** [39] are interchangeable, both from left to right and between tricycle and conventional gear configurations. Installation of the legs is very similar for both types of gear. Begin by **liberally** coating the bearing surfaces at the upper ends of the legs with bearing grease or anti-seize compound. This will make it much easier for you get the legs in and possible to get them out again. Insert each leg into one of the gear sockets in the fuselage cage until the upper end of the leg is flush with the top of the socket. The fit will be snug, but if you rotate the leg as you push it in you should be able to insert it without too much trouble. You may need to purchase a brush hone (1-5/8" diameter available through most automotive supply stores) in order to clean up the two holes. **See bottom note on page 216.**

The only difference between the main gear leg installation in the tricycle- and conventional-geared configurations is the degree of "toe-in" or "toe-out." The main axles and wheels on a **tricycle**-geared Sportsman should be slightly toed-**in**, which means that they angle slightly **inboard** at their forward ends rather than being perpendicular to the aircraft centerline. By contrast, **taildragger** mains must have a slight amount of toe-**out**—that is, a slight angle **outboard** at the axles. Proper toe-in and toe-out is essential for good ground handling and straight, easily controllable take-off and landing rolls.

At the same time that you're setting the proper toe-in or toe-out, you must also ensure that the axle portions of the gear legs are level relative to the fuselage so that your Sportsman will sit level on its gear. The procedure for leveling the legs and setting the toe-in or toe-out is illustrated in Figure 120. As the figure shows, an 8' length of angle stock is clamped between the gear legs to provide a means of leveling the axle ends of the legs. This angle also allows the toe-in or toe-out to be established by means of a shim between the outboard end of the axle and the vertical flange of the angle. The location of the vertical flange of the angle and the shim either forward of or aft of the axles determines whether toe-in or toe-out is established. This will be further clarified below.

The 8' length of angle stock should ideally be at least **2" X 2"** and heavy enough to be rigid and straight—i.e., not to sag in the middle when supported at the ends. It can be made of any metal, although aluminum is preferable simply for ease of handling.

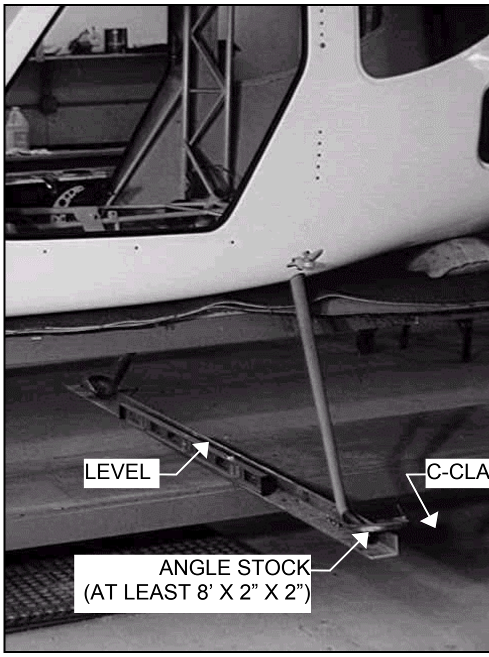
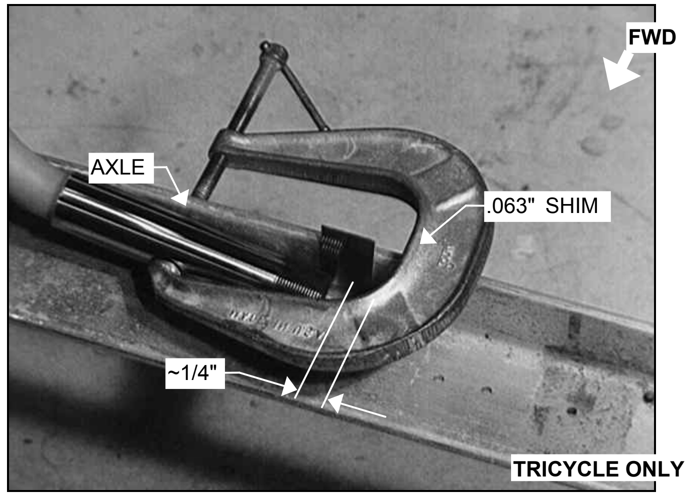
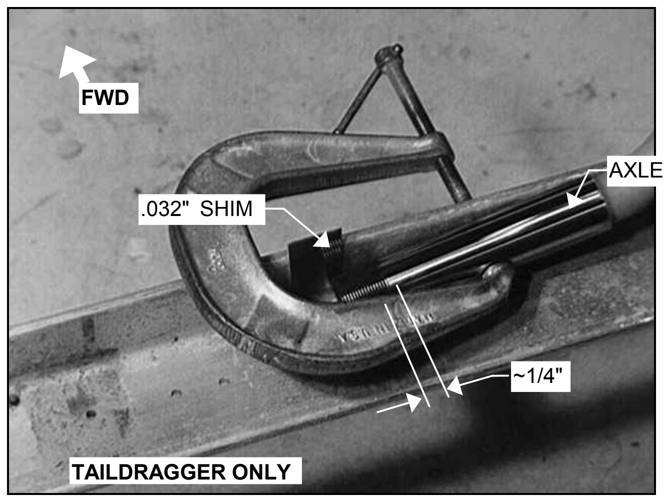


Figure 120: Leveling the Gear Legs (a)



(b)



(c)

Hint This angle stock is used only for this procedure, so you don't want to spend an arm and a leg on it. At the same time, however, this is a vital procedure that will have an important impact on how easily your Sportsman handles on the ground. We recommend scouting out local salvage yards for a suitable piece of angle. It doesn't have to be pretty—just straight!

With the Sportsman fuselage leveled laterally and the gear legs inserted into the sockets, position the angle under the axle portions of the legs. As shown in Figure

120, the **vertical** flange of the angle should be **aft** of the axles for a **tricycle**-geared Sportsman and **forward** of the axles for a **taildragger**. Not shown in the photos but a real help in managing this procedure is to support the ends of the angle from below with any convenient props—boxes, paint cans, whatever.

Hint You can clamp with lighter pressure if you shim the angle to precisely the proper height from below. That way, the clamps don't need to do the work of holding the angle up.

With the angle held in its approximate position, insert a scrap-aluminum shim between the **outermost 1/4"** of the axle and the vertical flange of the angle, as shown in Figure 120. The shims should be **.063"** thick for **tricycle** gear and **.032"** thick for **taildragger** gear. With the shims in place, draw the axles in tight against the vertical angle flange with large C-clamps, located as shown. Rotate the gear legs in their sockets by hand as necessary to allow the clamps to hold the axles tightly against the angle and shims. When tightening the clamps, be sure the axles are firmly in contact with the **horizontal** flange of the angle as well.

Hint To avoid damaging the axles, it would be a good idea to use scrap wood blocks between the jaws of the clamp and the axles, especially if your axles are polished as nicely as the ones in the photos!

The clamps need to be tightened only until the axles are firmly in contact with the vertical angle flange at the inboard ends and with the shims at the outboard ends. As long as you don't overtighten the clamps, the aluminum shims will not damage the axle threads.

With the clamps in place, the proper degree of toe-in or toe-out has been established; all that remains is to make sure the axles are level relative to the fuselage. To check this, set a level on the horizontal flange of the angle, as shown in Figure 120. Adjust the gear legs as necessary by inserting them further into or withdrawing them from the sockets. This is a tricky procedure, since sliding the legs in and out will tend to upset the clamped axles. Just keep adjusting until the level reads level with the axles clamped as described.

Note When the gear legs are leveled, they won't necessarily be even with the tops of the gear sockets. However, neither **tricycle** leg can stick out more than **3/16" above** the top of its socket, or else the bolt hole may fall below the hollow portion at the top of the leg, which is unacceptable. By contrast, neither **taildragger** leg can be more than **1/8" below** the top of its socket, or else there won't be enough edge margin between the bolt hole and the end of the leg. When adjusting the legs in or out, try to divide the necessary adjustment between the left and right legs, but be sure to honor these conditions.

If you are unable to bring the axles level within these constraints, try switching the gear legs from left to right. In some cases, slight variations in the bend angle of the axles will make it impossible to achieve level axles without making such a switch.

Hint A common difficulty is that one or both gear legs will try to slip out of the sockets, making it tough to level the angle. A very large C-clamp tightened on the gear socket itself will hold the legs in place temporarily.

Note In Figure 120, it may appear that the angle is resting on the shelf under the bench, but this is only an optical illusion. It is in fact hanging above the shelf from the clamps.

Note The gear sockets should be a very tight slip fit. If you are having trouble inserting the gear into the socket, check for obstructions such as paint or dents in the socket. If your gear will pass the lower portion of the socket but not into the upper portion of the socket, concentrate the brush hone on the upper portion of the socket, not the lower end. Sometimes the upper and lower portion of the socket are slightly out of alignment and a small amount of honing or sanding on the upper end will allow the gear to be fully inserted. Do not sand the inside of the lower socket, otherwise a sloppy fit may result which will get worse over time.

Completed: [ ]

Step 73: Drill and Bolt the Main Gear Legs

A single bolt holds each gear leg in place in the sockets. This might not sound like much, but bear in mind that all the bolt is really responsible for is supporting the weight of the legs against gravity—that is, keeping them from falling out in flight! In take-off, landing and taxiing operations, it's the gear sockets that are taking most of the load, not these bolts.

The gear leg **AN5-22A** bolts [134] require a **5/16"**-diameter hole. However, this is too large a hole to drill easily in one pass. Instead, you'll drill all the way through each socket and gear leg with either a **#10** or a **3/16"** bit first; then step up to an "**L**," "**M**" or **19/64"** bit; and finally ream the holes to final size with either a **5/16"** bit or a **.3125"** straight reamer.

Hint These holes **can** be drilled with ordinary, high-speed steel drill bits. However, because the gear legs are made of hardened steel, you will probably destroy many bits of each size in the process, and the job will take a lot of time and effort. Considering this, you may wish to use special cobalt bits, which are designed especially for drilling through hardened steel. These bits cost a little more than standard bits, but they'll cut considerably faster and last longer. Even cobalt bits may have to be sharpened several times to complete this step, so you may want to have several bits on hand or know how to sharpen them.

Regardless of which bits you use, drill both sets of holes with a heavy-duty, variable speed electric drill turning at **low RPM (400-800)**. Do **not** use a pneumatic drill. Also, use the shortest bit long enough to go all the way through the socket, and make **liberal** use of a **good-quality cutting oil** to lubricate the bit while drilling. Apply cutting pressure for short intervals (3-5 seconds) and clean the chips out after every release of pressure.

After drilling so many holes in thin aluminum, these holes will seem to take a long time and a lot of effort! You will have to apply considerable pressure on the drill to keep it cutting. In fact, we recommend making this a two-person operation: one person can bear down on the drill while the second keeps an eye on the perpendicular alignment of the bit with the socket.

As Figure 121 shows, the aft, tricycle-gear sockets are drilled at different angles and different distances from the top of the socket than the forward, taildragger sockets. The angles are dictated by the geometry of the tubing junctions in the cage, and the distances by the internal shape of the sockets, but these differences also allow you to use the same gear legs for either landing gear configuration if you ever want to switch.

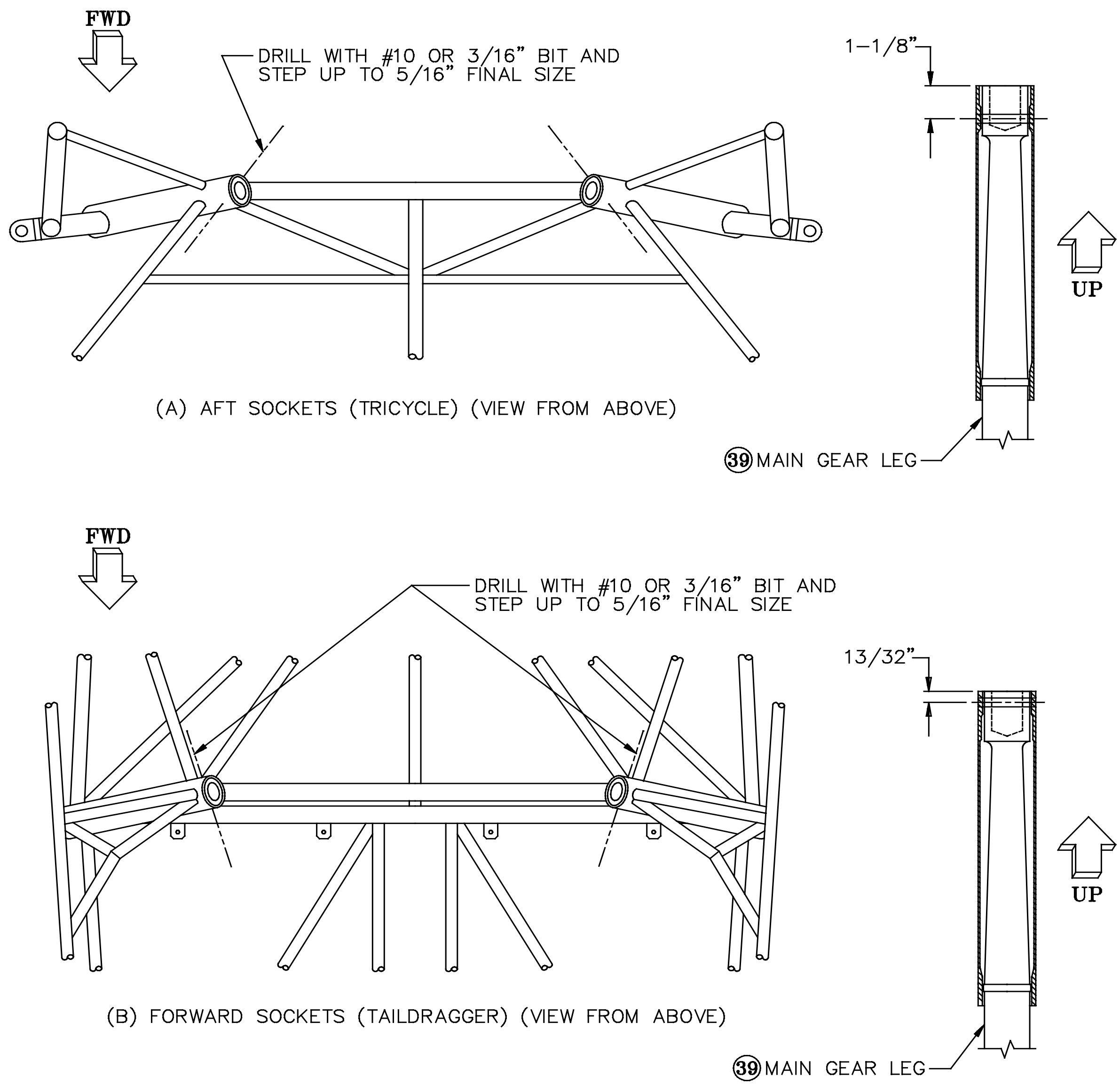


Figure 121: Drilling Angles for the Main Gear Leg Bolts

Note If one of your tricycle gear legs sticks out beyond the top of its socket (remember, no more than **3/16"** is acceptable!), then measure the **1-1/8"** distance shown in Figure 121 **from the top of the leg**. All other distances should be measured from the top of the socket.
If you do not intend to use the same gear for both the tricycle and taildragger installation, then the dimensions from the top of the sockets are not as critical. Later cages will have the same socket design on the upper end, which will give you better degree of adjustment for leveling the gear and a wider range of where you can position the 5/16" diameter hole.
Not shown in the figure below is a recommended vise grip plier to firmly clamp the socket to the gear leg to keep the gear from moving during drilling.

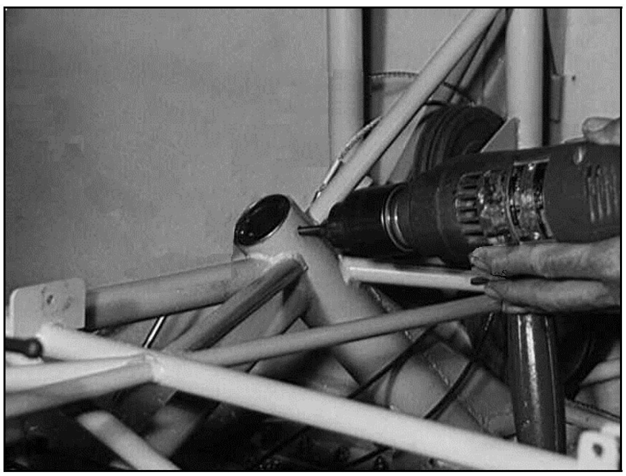


Figure 122: Drilling the Main Gear Leg Bolt Hole

Refer to Figure 121 and mark the locations of the holes appropriate to your gear configuration on the sockets. Mark holes for tricycle legs **1-1/8"** below the tops of the sockets and holes for taildragger legs **13/32"** below the tops. Before proceeding, hold an AN5-22A bolt across the top of each socket over your proposed drilling location just to check to see that the bolt head and the washer and nut will clear all the welds on the tubes, and adjust the location and angle as necessary. Center punch each location. Position the drill against the punched location and have an observer help you ensure that the bit is as perpendicular to the socket as possible in all dimensions, as shown in Figure 122. Drill the holes and then remove the legs from the sockets. Use a small rat-tail file to deburr the holes in both the legs and the sockets. Re-install the legs (applying more anti-seize if necessary) and insert AN5-22A bolts with the heads forward. Secure these bolts with AN960-516 **washers** [144] and AN365-524A **nylon self-locking nuts** [112].

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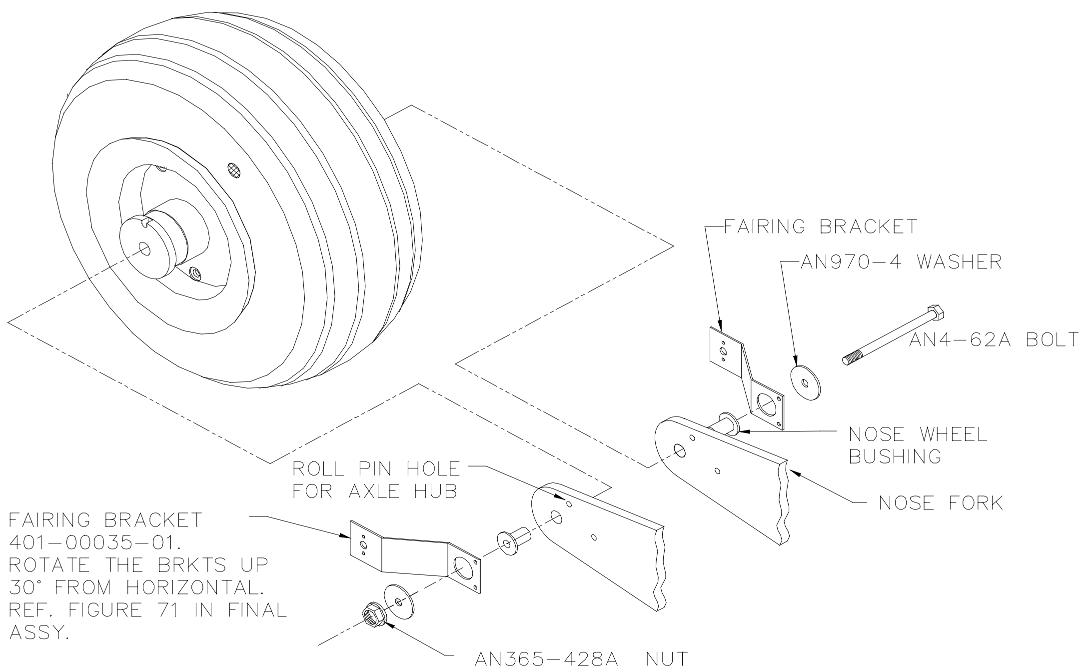
Page 221-222: [redacted]

Page 272-277: In the Brake System Plumbing section, (10) 032-00310-01 Brake Line Inserts will be included in future kits. These inserts help prevent the ferrule from getting crooked and causing leaks. The small metal sleeve stiffens and supports the brake line internally and keeps the ferrule straight because it has a flat, flared end. It also keeps the brake line from collapsing. An additional (6) are required for dual brake installations.

Page 244-246: A new method will be used to install the nose wheel pant to the nose wheel fork, which has made the installation easier. This will require a longer axle bolt AN4-62A, two brackets 401-00035-01 and two AN970-4 washers. These will be included in later kits. Step 85 will be reworded to install the two brackets and larger washer. The bracket is oriented on the nose fork with the aft end up 30 degrees to horizontal per Figure 71 in Final Assembly. Drill one 1/8

diameter hole through each bracket and into the nose fork arms. Install (1) 1/8"diameter x 1/2" roll pin 450-0070-002 in each bracket. Figure 138 will be revised as follows:



Page 247: The last sentence should refer to AN960-416 steel washers, not AN960PD416.

MAIN GEAR WHEEL AND BRAKE INSTALLATION

Note The instructions in this sub-section apply equally to standard (i.e., 6.00 X 6 wheels) tricycle **and** taildragger installations. With the large-tired **8.00 X 6 or 8.50 X 6 Taildragger Option**, you merely need to omit the information regarding the mounting of the wheel pant mounting brackets.

Step 74: Install the Brake Mounting Flanges

The 6.00/8.00/8.50 x 6 brake mounting flanges requires two bolts through the axles clocked ninety degrees to each other. Begin by positioning the **Brake Mounting Flange** [177] assembly over the axle as shown in Figure 123, with the outboard end of the sleeve **4-11/32**" from the outboard end of the axle. The orientation of the flange (relative to waterline) will determine how straight the brake caliper will be positioned. It doesn't change the effectiveness of the brakes, but merely keeps the calipers back behind the axles at a good height off the ground. Mark the two hole locations as shown in Figure 123. Notice the 7 degree clocking. There is very little clearance between the aft upper nuts and the gear legs (one o-clock position). Mark a position or clocking indicator for both the axle and the brake flange so if disassembled, they can reoriented without confusion. Clamp the brake flange securely to the axle.

Remove the gear leg if you are using a drill press and vise (recommended) or leave the gear installed and use a heavy duty electric hand drill. Using a slow speed and plenty of cutting oil, drill first with a sharp **#10 or 3/16"** bit. Then step up to a **19/64**" bit and finally **ream** using a straight reamer to a **5/16" (.3125")** diameter hole. After the first hole is drilled, insert an **AN5-20A** [185.1] bolt to pin the sleeve to the axle. Then drill the second hole clocked 90 degrees to the first as shown in Figure 123.

Deburr and clean all the holes and apply corrosion proofing (anti-seize or grease) to the newly drilled holes, flanges and hardware. Install the flanges on the axles using the two AN5-20A bolts (bolt heads installed up and forward) and **AN363-524** [182] high temperature self locking nuts as shown in Figure 124A. Use AN960-516 washers if necessary.

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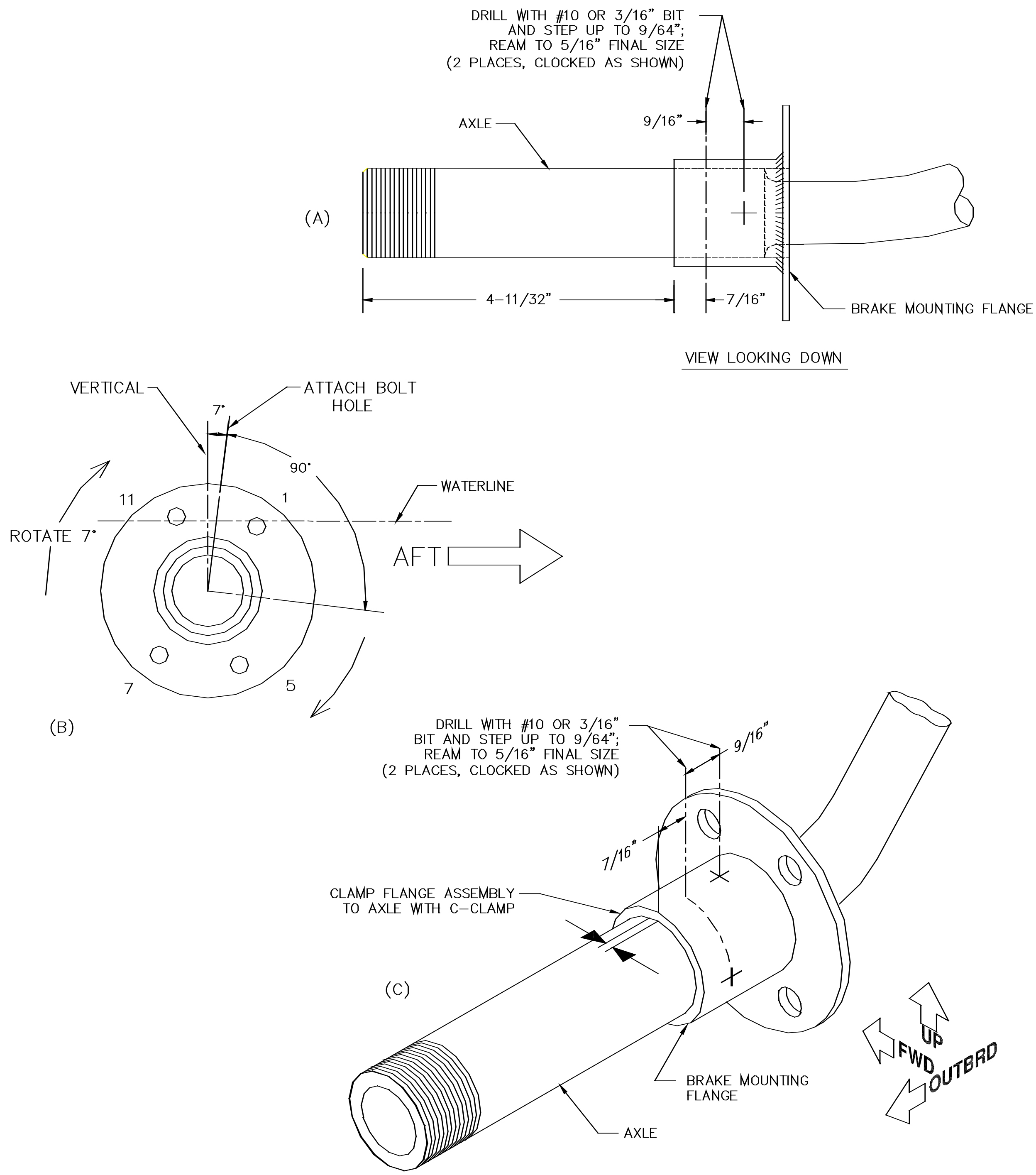

Figure 123: Drilling the Brake Mounting Flange/Axle Bolt Holes

Step 75: Install the Brake Torque Plate and the Wheel Pant Mounting Brackets

Remove the two brake caliper assemblies from the **main wheel and brake kit** [181] and set the rest of the kit aside. Disassemble the calipers into their five major components by removing the two 1/4" bolts as shown in Figure 125. You may remove any 5/16" bushings in the torque plates at this time.

If you are not installing the wheel pants, then assemble and install the torque plate as shown in Figure 124A. If you plan on installing the wheel pants, then reference Figure 124B. In both cases orient the torque plate with the wide end aft and the alignment pin bushing extending further outboard. You may find it necessary to reverse the orientation of the two upper AN6-7A or AN6-13A bolts if clearance with the gear leg requires it.

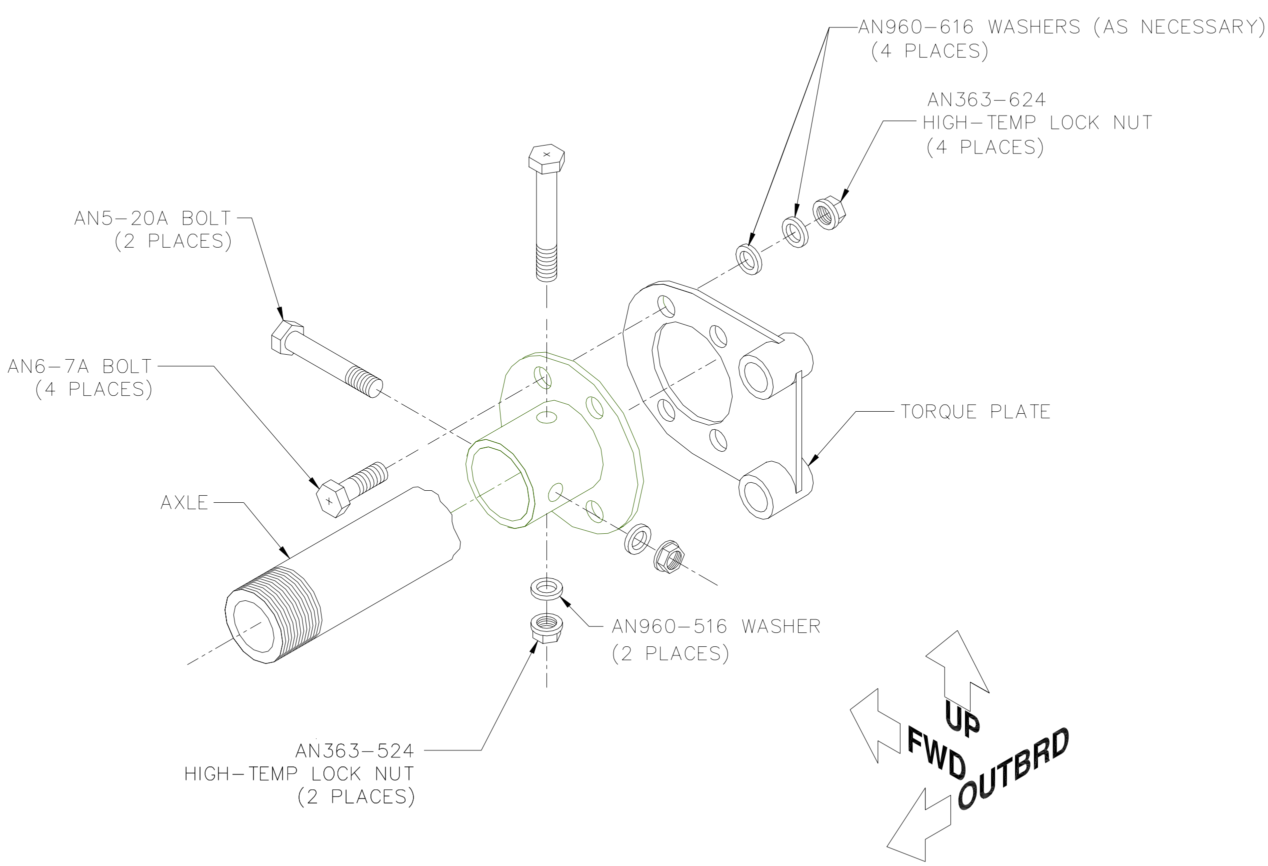

Figure 124a: Installing the Brake Torque Plate Without Wheel Pants

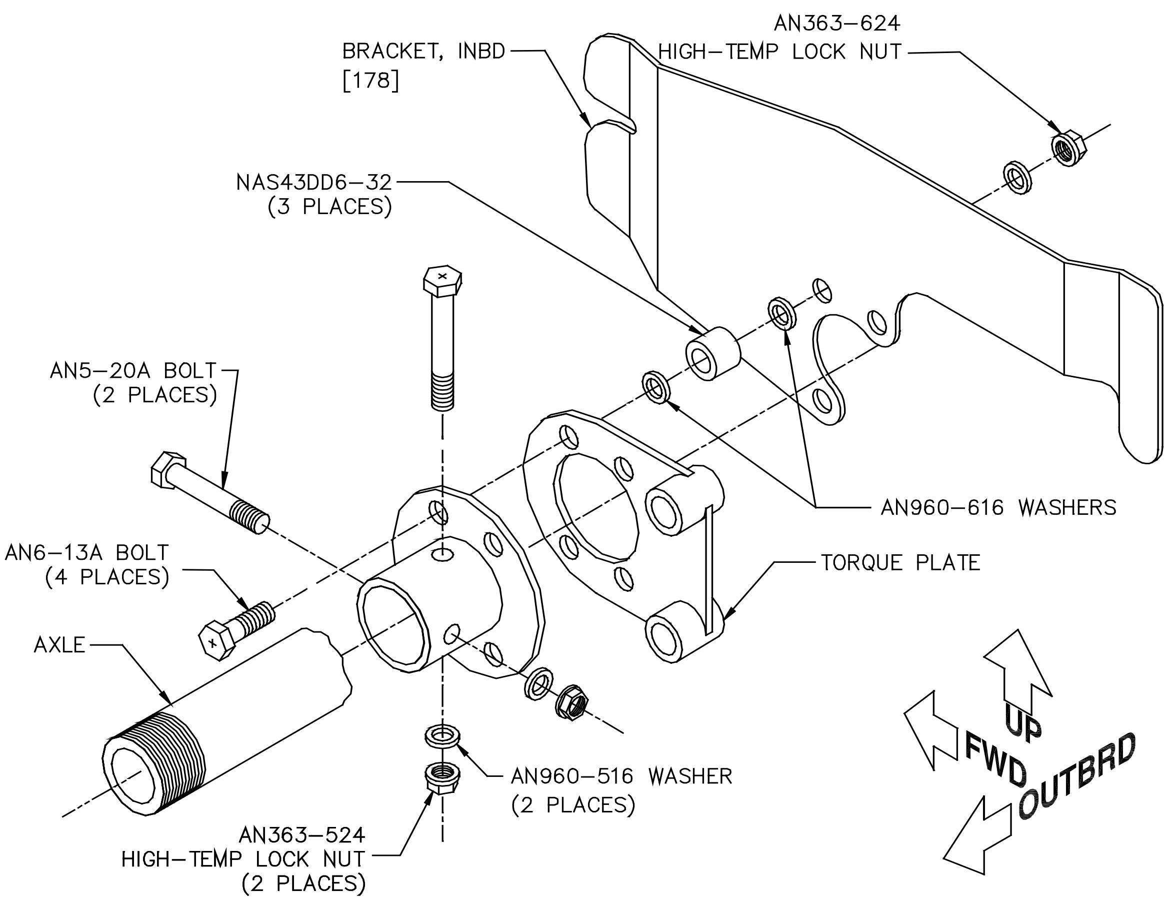

Figure 124b: Installing the Brake Torque Plate With Wheel Pants

Install the appropriate **AN6-7A** [190] or **AN6-13A** [191] hardware as shown in the two figures. For wheel pant installations, install three **NAS43DD6-32** aluminum spacers [189] between the two **AN960-616** [192] washers to space out the inboard **wheel pant bracket** [178]. Secure them with **AN363-624** [194] high temperature self-locking nuts. An MS21042-624 may be required for the top aft nut. If you have to reverse the orientation of the upper AN6-7A or –13A bolts, the torque plate can be mounted to the brake mounting flange before the flange is bolted to the axle.

Slide the brake cylinder assembly into the torque plate and make sure it clears the inboard bracket. Trim any material away that interferes with the brake cylinders. Set the cylinder and pressure plate aside for the time being.

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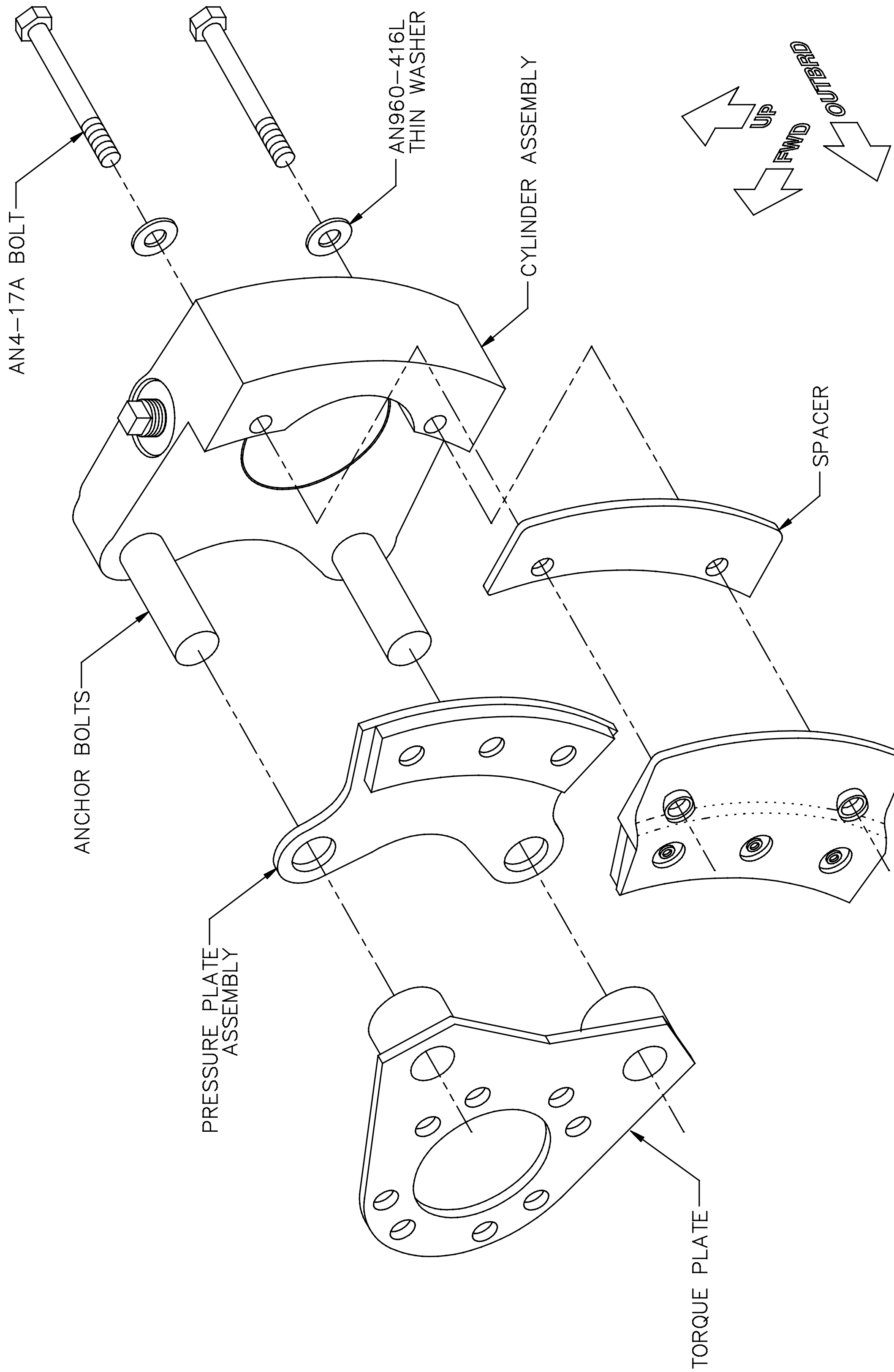

Figure 125: Components of the Brake Caliper Assembly

Step 76: Mount the Tubes and Tires on the Main Wheel Assemblies

Using a 7/16" socket on the nuts and a 7/16" open-end wrench inserted endwise on the bolt heads, remove the three bolts to separate the two halves and the brake rotor of each main wheel, as shown in Figure 126.

> **Hint** The use of the open-end wrench is necessary because the thick walls of the brake rotor prevent the use of a standard socket. However, an alternative is to grind down a 7/16" socket on one side so that it clears the rotor wall. If you do this, you'll have a handy tool that will be useful every time you need to change a tire or tube.

Insert a **6.00 X 6 tube** [180] into one of the **6.00 X 6 tires** [179] with the valve stem aligned with the painted reference mark on the tire. This mark is used to confirm that the tire doesn't move in relation to the wheels when in service. (If your tire doesn't have such a mark, make one yourself and align the valve stem with it.) Inflate the tube with just enough pressure to give it shape inside the tire, and then insert the two wheel halves into the tire, taking care to avoid pinching the tube between them. Guide the valve stem through the rubber-grommeted hole in the outboard wheel half as you bring the halves together.

When the halves are joined, use an inspection mirror and a flashlight to double check that you haven't pinched the tube, and then reassemble the wheel unit, including the brake rotor, with the original bolts, washers and nuts. Inflate the tire to **35 - 40 psi**.

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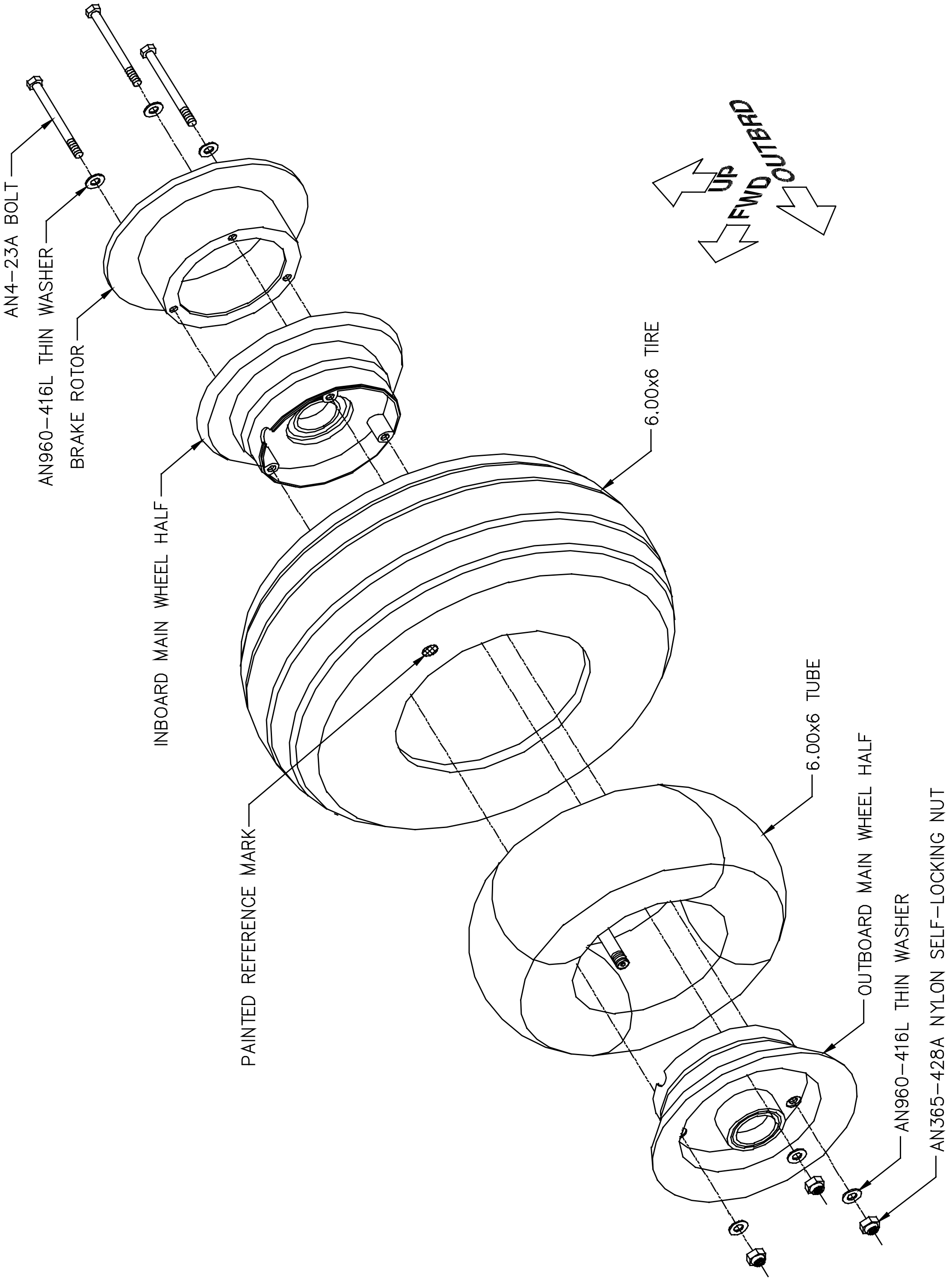

Figure 126: Mounting the Tube and Tire on the Wheel Assembly

Step 77: Install the Outboard Wheel Pant Nutplates on the Axle Nuts

In “Section X: Final Assembly,” you will secure the inboard portion of the wheel pants to the mounting bracket by means of four machine screws and nutplates. The outboard attachment uses a nutplate that is riveted to a welded strap on the castellated **axle nut** [175]. Since you will secure this nut to the axle in the next step, it's necessary to rivet that nutplate in place now.

Figure 127 shows where the MF5000-4 **floating nutplate** [188] is mounted on the nut. Center the nutplate on the 9/32" hole in the nut strap and drill **#40** rivet holes using standard procedures. Countersink the rivet holes on the **outside** of the strap to accommodate AN426AD3 flush-head rivets, and then rivet the nutplate in place.

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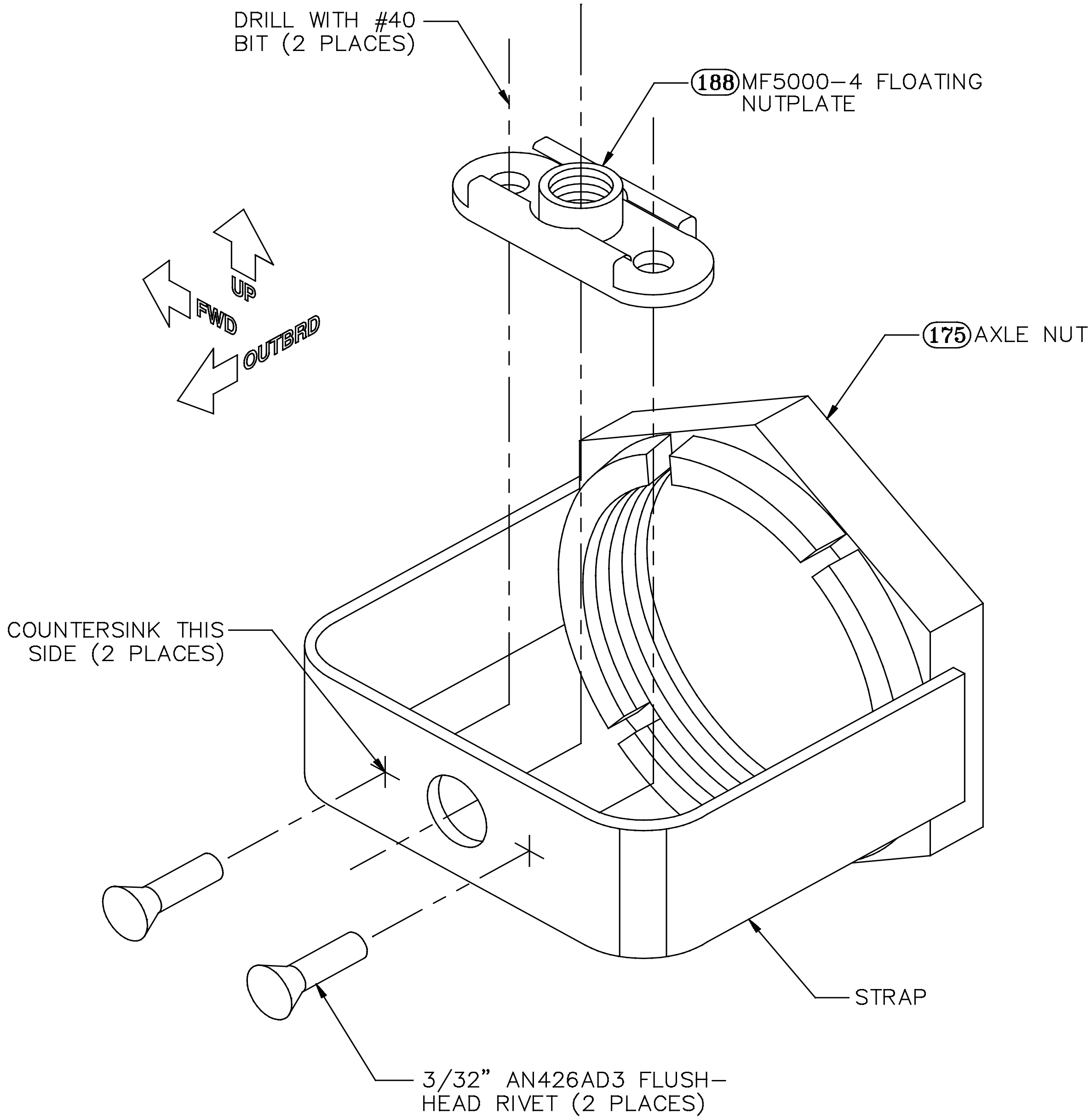

Figure 127: Installing the Outboard Wheel Pant Nutplate on the Axle Nut

Step 78: Mount the Wheels on the Axles

Before you can mount the wheels, you must pack the wheel bearings with grease. There are two sets of roller bearings in each wheel, one on the inboard side and one on the outboard side. To access the bearings for packing, use the tip of a screwdriver to remove the snap ring from its groove near the axle hole on each side of the wheel (pry the snap ring inward, toward the axle hole, to remove it). Remove the seal rings and the felt grease seal, noting their positions and orientations, and then the roller bearings themselves. The traditional way to pack wheel bearings is to put a gob of grease in the palm of one hand and use your other hand to force the bearing into the grease with a scraping motion as if you were trying to clean the grease off your palm with the bearing. (Have a mechanic show you how if you don't understand.) Continue all around until all the rollers are coated with grease and the grease thoroughly fills all the spaces between the rollers. Alternatively, use a bearing packing tool; this consists of a pair of cones, between which the bearing is clamped, and a grease fitting, into which grease is pumped with a grease gun. When finished, reinstall the bearings (with their seals, seal rings and snap rings) into the wheel.

Figure 128 shows how the wheel assembly is mounted on the axle. First, slide the **axle washer** [40] and the **chamfered axle spacer** [38] onto the axle and tight up against the sleeve of the brake mounting flange. The chamfer must face outboard. Next, slide the **axle sleeve** [193] over the axle and tight against the spacer. Follow this with the wheel assembly, with the brake rotor inboard and the valve stem outboard. Finally, slide the plain **axle spacer** [176] onto the axle and nest it tightly inside the wheel bearing, followed by the axle nut.

Note The two axle spacers are **not** identical. The **inboard** spacer (Key No. 38) is **thicker** than the **outboard** spacer (Key No. 176).

Finger-tighten the axle nut against the outboard spacer. Then, while continuing to tighten the nut with a wrench, simultaneously rotate the wheel assembly by hand. Tighten the nut until you begin to feel resistance in the wheel bearings, and then back the nut off until the resistance disappears. This will probably entail backing off between 1/8 and 1/4 of a turn. When the nut is set in its final position, there should be no resistance to rotation and no side-to-side play in the wheel bearings.

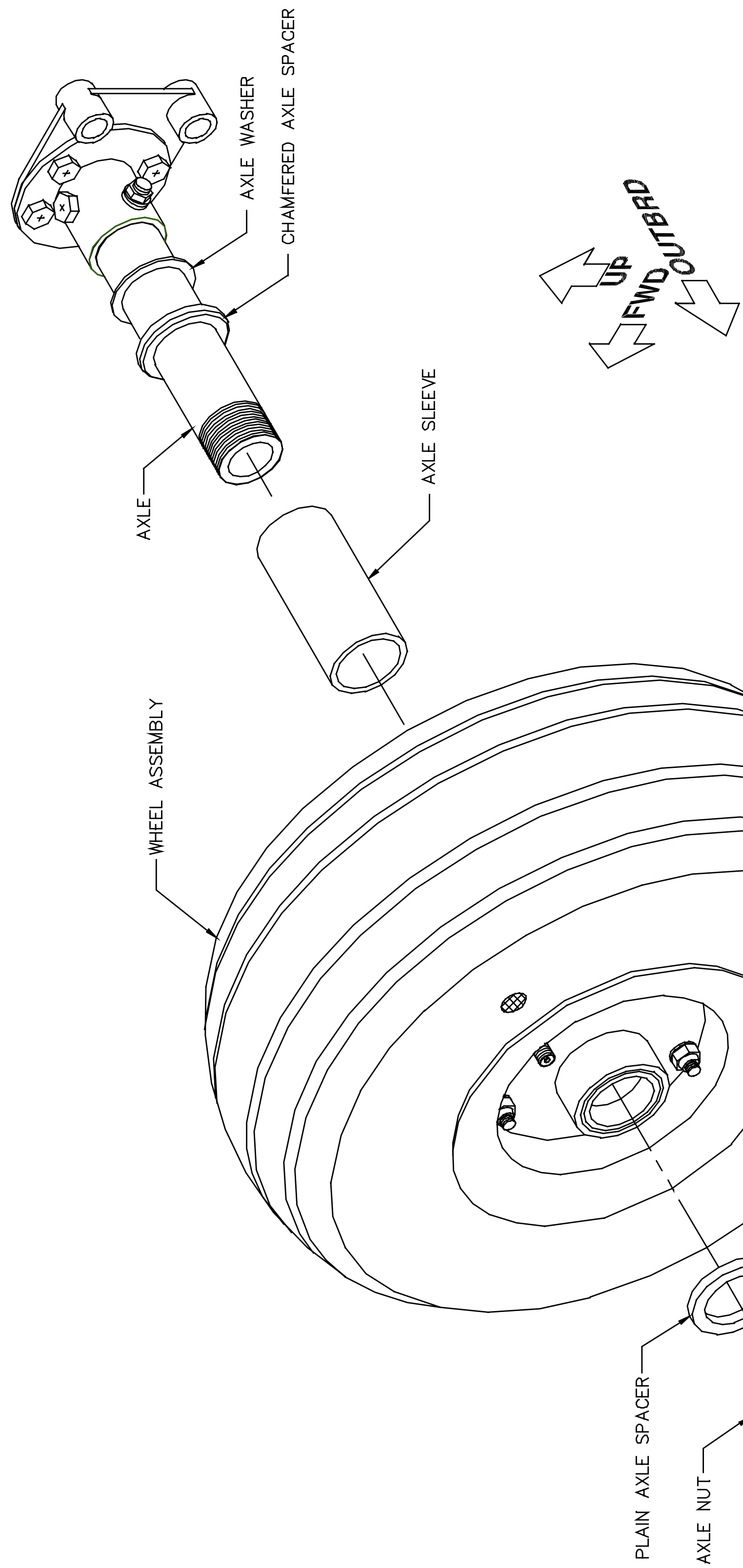

Figure 128: Mounting the Wheel Assembly to the Axle

The nut will be secured with an AN380-4-8 **cotter pin** [117] through the **castellated axle nut** [175], and you must drill a hole through the end of the axle to accommodate this. Select the notch in the crown of the nut that is nearest the 12 o'clock position and use either a **1/8"** or a **#30** bit to drill through the axle near the base of the notch, as shown in Figure 129. Have an assistant monitor the drilling from outboard to make sure that you keep the bit aligned with the opposite notch on the other side of the castle nut crown.

> **Hint** With the tire and wheel in place, you'll probably need to use a 90° drill motor and a short bit to drill this hole. You may find it easier to mark the axle through the castle nut notch with a felt-tip pen, remove the wheel assembly temporarily, and replace the nut on the axle, aligning it with the mark before drilling.

After both holes are drilled, insert the AN380-4-8 cotter pin from above and secure the ends.

Completed: Left [ ] Right [ ]

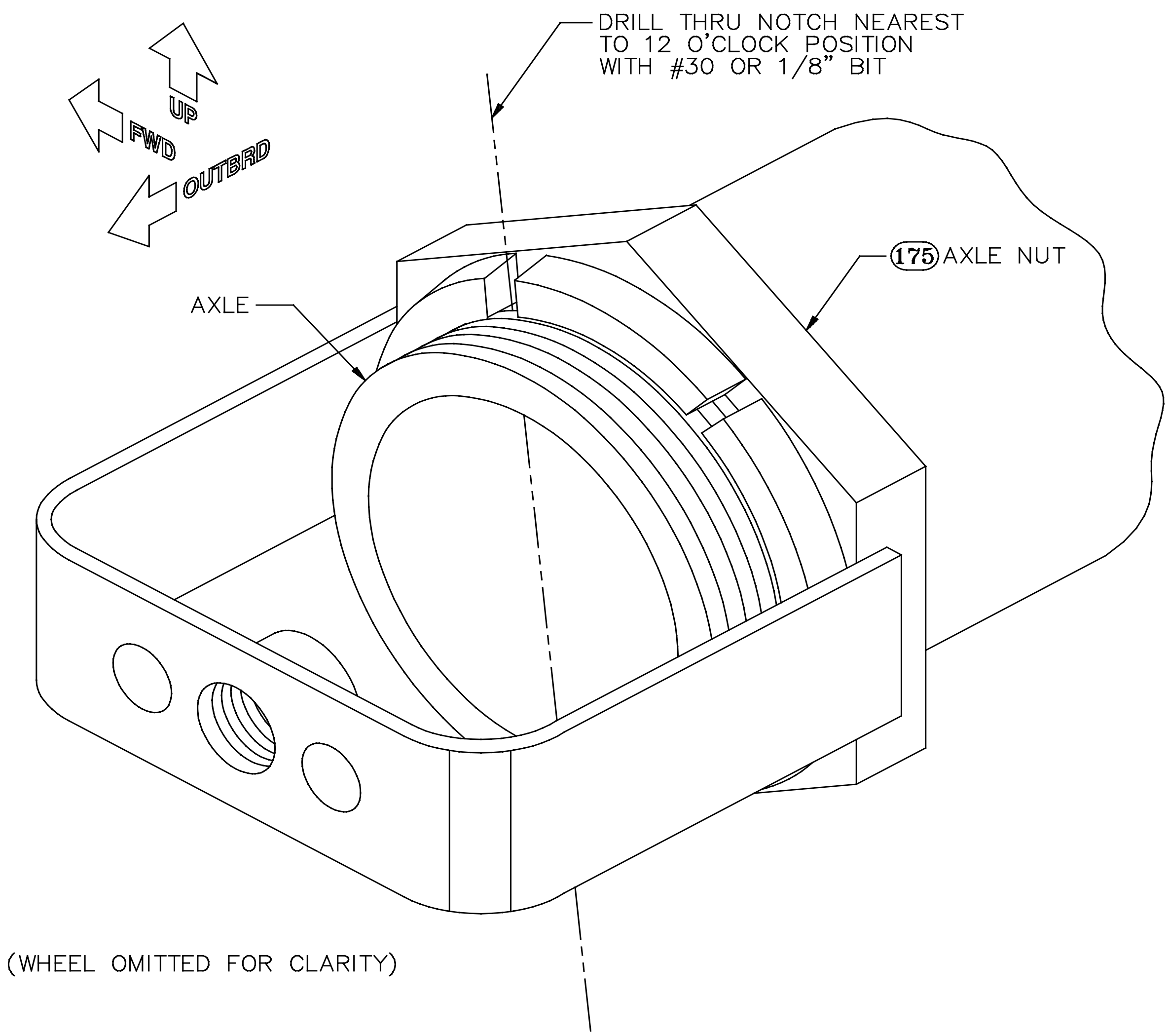

Figure 129: Drilling the Cotter Pin Hole in the Axle

Step 79: Mount the Brake Calipers

Figure 130 illustrates the mounting procedure for the brake caliper assembly. First apply a thin film of bearing grease to the slide pins. From inboard side of the wheel, slide the cylinder assembly into the torque plate, which is now bolted inside the hub of the wheel. The pressure plate assembly and the spacer should be in place on the cylinder assembly when you do this. Then, with the cylinder assembly held tightly against the inboard face of the brake rotor, slide the backplate assembly in between the brake rotor and the inboard wheel hub flange. Align the backplate assembly with the spacer and the cylinder assembly, and re-attach all the components with the pair of AN960-416L thin washers and the AN4 drilled head bolts. Tighten these bolts with a 7/16" socket wrench and safety the heads together to prevent rotation.

Caution To avoid foreign object contamination, be sure to leave the plugs in the upper and lower ports in the cylinder assembly until you attach the brake line fittings in a subsequent step.

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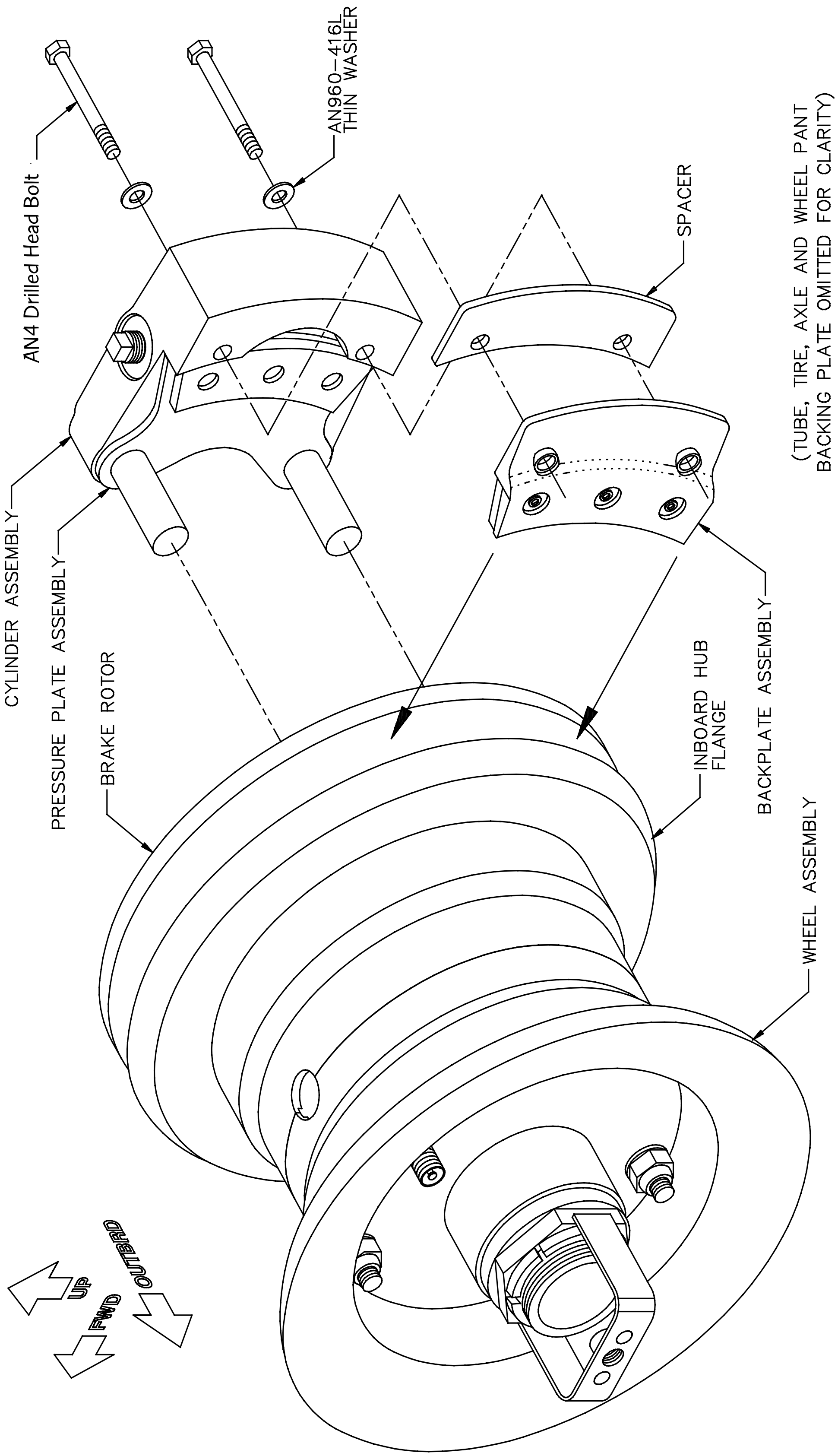

Figure 130: Mounting the Brake Caliper Assembly

NOSE GEAR INSTALLATION (OPTIONAL)

Taildragger Options If you are installing the taildragger gear, **skip to Step 87**.

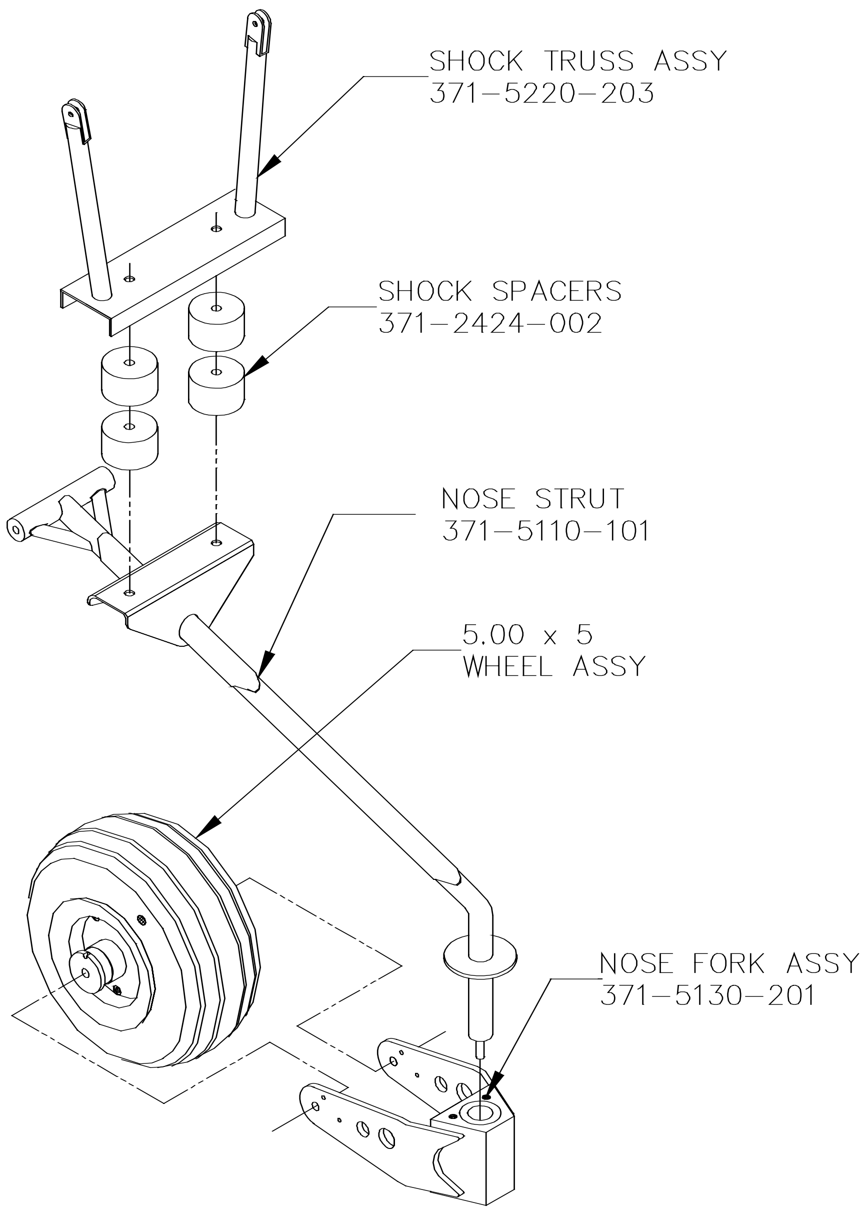

Figure 131: Nose Gear Installation

The nose gear installation consists of five main parts as shown in Figure 131. The gear installation is pretty much an assembly process with very little drilling or fabricating required. You will find it easiest to work with the tail on the ground and the nose up for access.

Note The Sportsman nose gear installation is designed only to mount to the bottom of the Lycoming O-360 engine mount available through Glasair Aviation. If you chose an alternative engine, **careful** consideration must be made as to how to attach the shock damper to the engine mount on your airplane.

The engine mount will have to be installed for the installation of the nose gear. Turn to the instructions on the mount and install it at this time.

Additionally, the SS firewall will be installed later, but the removal of the nose gear installation for this step is a very quick and easy process, so do not make any permanent connections until after the firewall has been installed.

Step 80: Mount the Tube and Tire on the Nose Wheel

Note The nose wheel assembly is shipped with bearings in place. However, these bearings are packed with shipping grease and need to be repacked with waterproof wheel bearing grease.

The **5.00 X 5 tire** [201] and **tube** [202] are installed on the **nose wheel assembly** [203] just as the main tires and tubes were installed, except that the nose wheel lacks a brake rotor. Figure 132 illustrates the relationships among the parts.

Remove the bearings from the wheel assembly and repack with waterproof bearing grease. Make sure the valve stem is aligned with the painted reference mark on the tire. Inflate the tube just enough to give it shape inside the tire, and then insert the two wheel halves into the tire, taking care not to pinch the tube between the wheel halves.

Inflate the nose wheel to **45-50 psi** after it's mounted.

Completed: [ ]

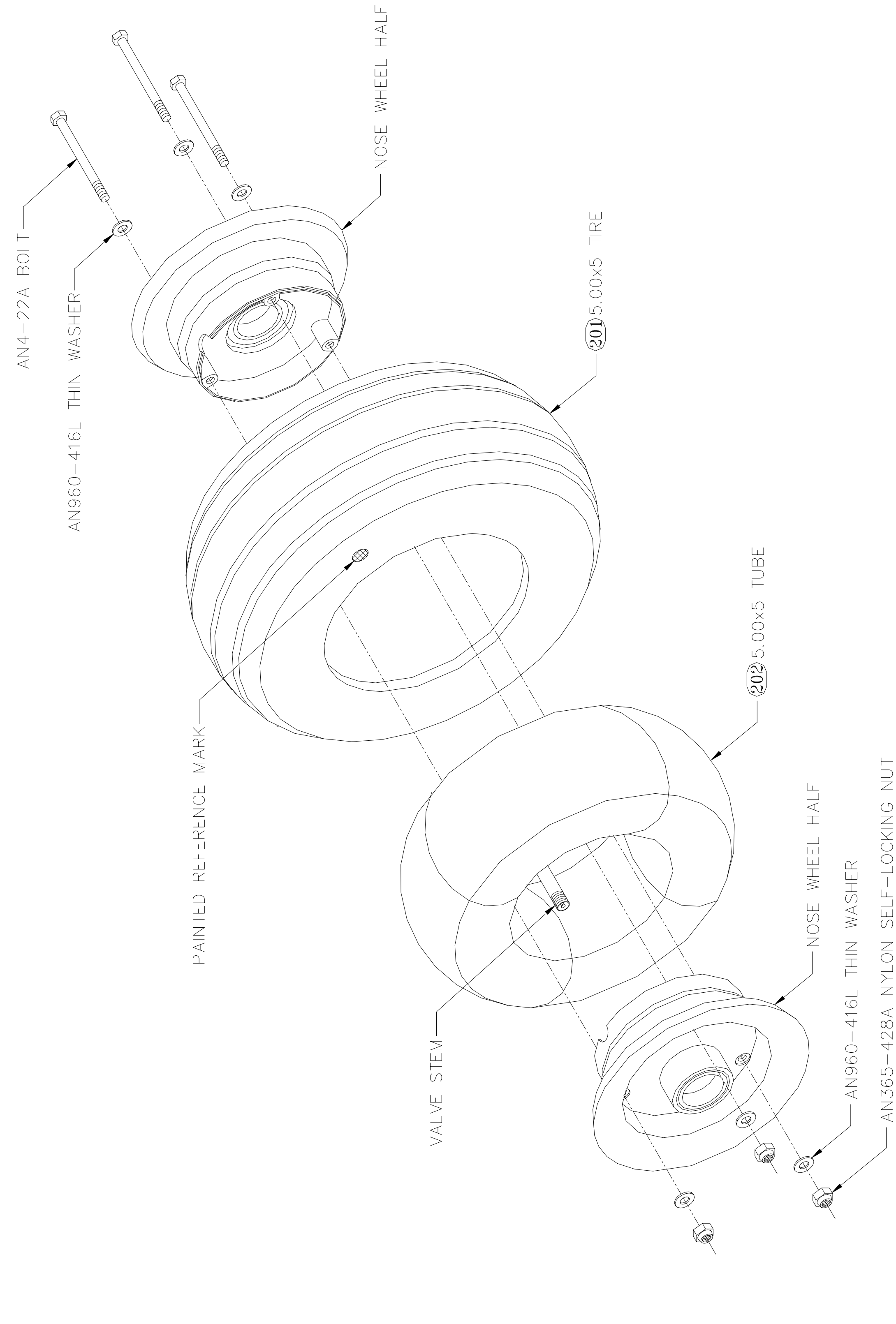

Figure 132: Mounting the Tube and Tire on the Nose Wheel

Step 81: Mount the Shock Truss to the Engine Mount

The lower engine mount rings have predrilled tabs which serve as the mounting points for the upper arms on the **shock truss** [206]. The truss should be orientated so the support link tabs on the channel face aft toward the firewall as shown in Figure 133. You may have to force the arms apart to fit over the engine mount tabs. When aligned and in position, insert two **AN4-10A** bolts [184], **AN960-416** washers [186] and **AN363-428** high temp self locking nuts [183]. Do not tighten the hardware at this time, since further adjustment will be needed later.

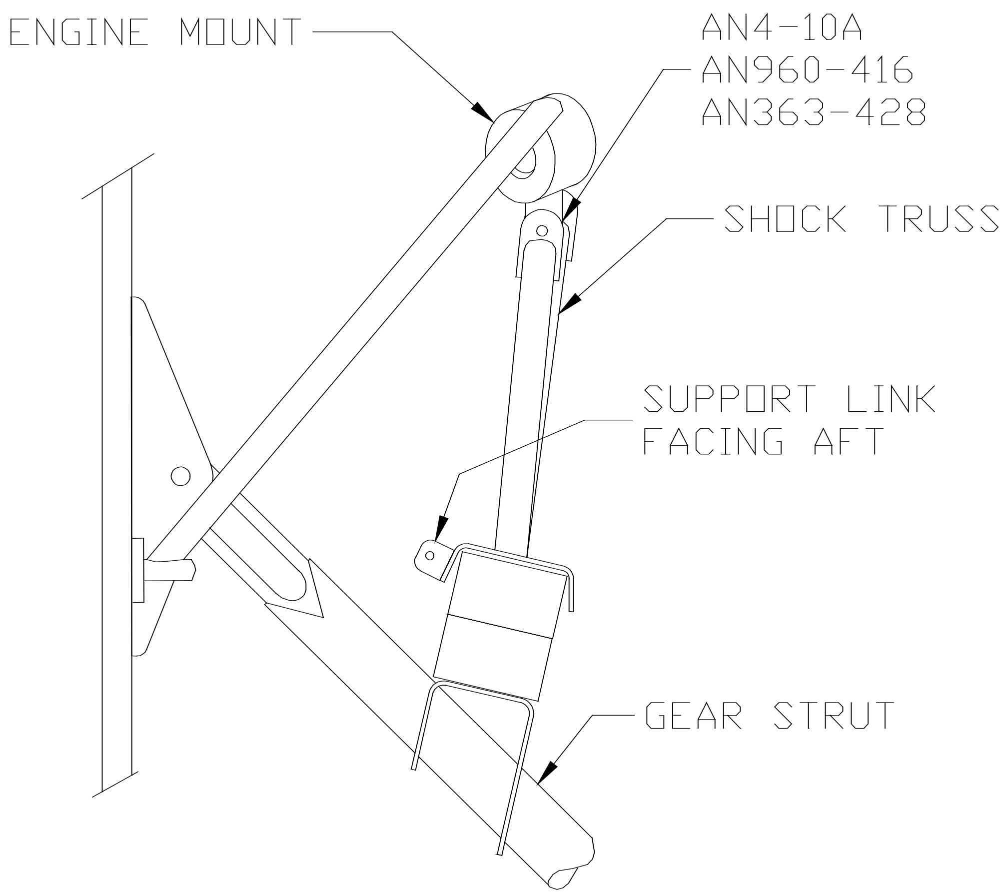

Figure 133: Mounting the Shock Truss to the Engine Mount

Step 82: Mount the Nose Strut to the Firewall

The **nose gear strut** [204] attaches to the two large triangular arms on the center of the firewall frame. Before it can be installed, some bushings need to be inserted in the attach arms and the nose gear strut itself. The use of Loctite is recommended on the bushings**. It is also recommended that you grease these bolts and bushings as well.**

Begin by inserting one **flanged bushing** [195] into each of the arms with the head of the bushing against the outboard face of the arm and then insert two more flanged bushings into the trunnion end of the nose gear strut as shown in Figure 134.

Insert the long **AN5-70** bolt [185] through one of the two **support links** [208], then into the firewall attach lug, one **AN960-516** washer [187], through the trunnion of the nose gear strut and then mirror that on the other side of the gear strut as shown in Figure 134. Adjust the thickness of the washers as required to minimize any lateral play between the trunnion and the firewall lugs. Secure the bolt with an AN960-516 washer, **AN310-5** castle nut [196] and an **AN381-2-10** cotter pin [197].

Note Notice that the support link assembly is only drilled on one end and is long. The other end will be cut to length and drilled to match the two aft facing tabs on the shock truss after the shock bushings have been installed.

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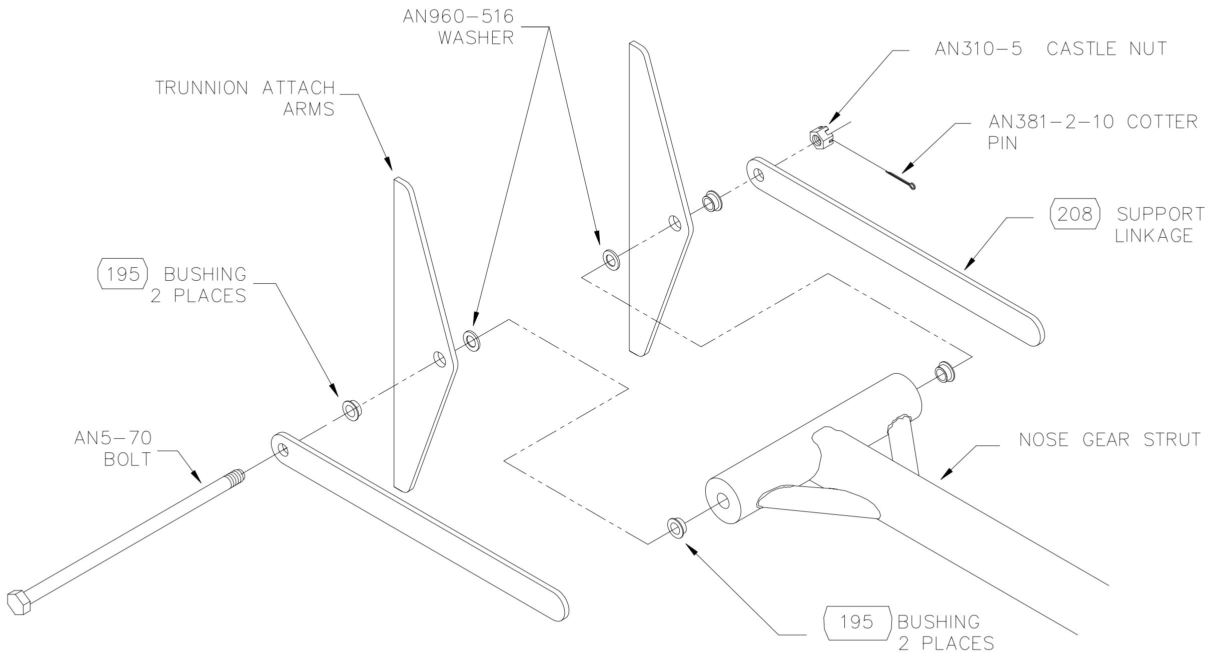

Figure 134: Mounting the Nose Gear Strut to the Firewall

Step 83: Install the Shock Bushings on the Truss

Four rubber **shock bushings** [207] absorb the gear loads and transfer them through to shock truss up into the lower engine mount. Because large welded assemblies such as the fuselage cage and the engine mount can have variations due to weld shrinkage, some additional spacers may be required to adjust the static height of the gear. You will make these spacers if you need them later when your engine is installed.

Begin by inserting an **AN7-36** bolt [198] thru an **AN970-7** washer [199] and down into the top of the shock truss as shown in Figure 135. Insert two shock bushings between the truss and the channel frame on the nose gear and pass the bolt through all of that. Install a second AN970-7 washer and an **AN365-720A** self-locking tension nut [200]. You can install a temporary 7/16 castle nut for now if you wish, as you will be making adjustments later to the shock spacers. Draw the nut just tight enough to remove any play. Once again final adjustment will be done later.

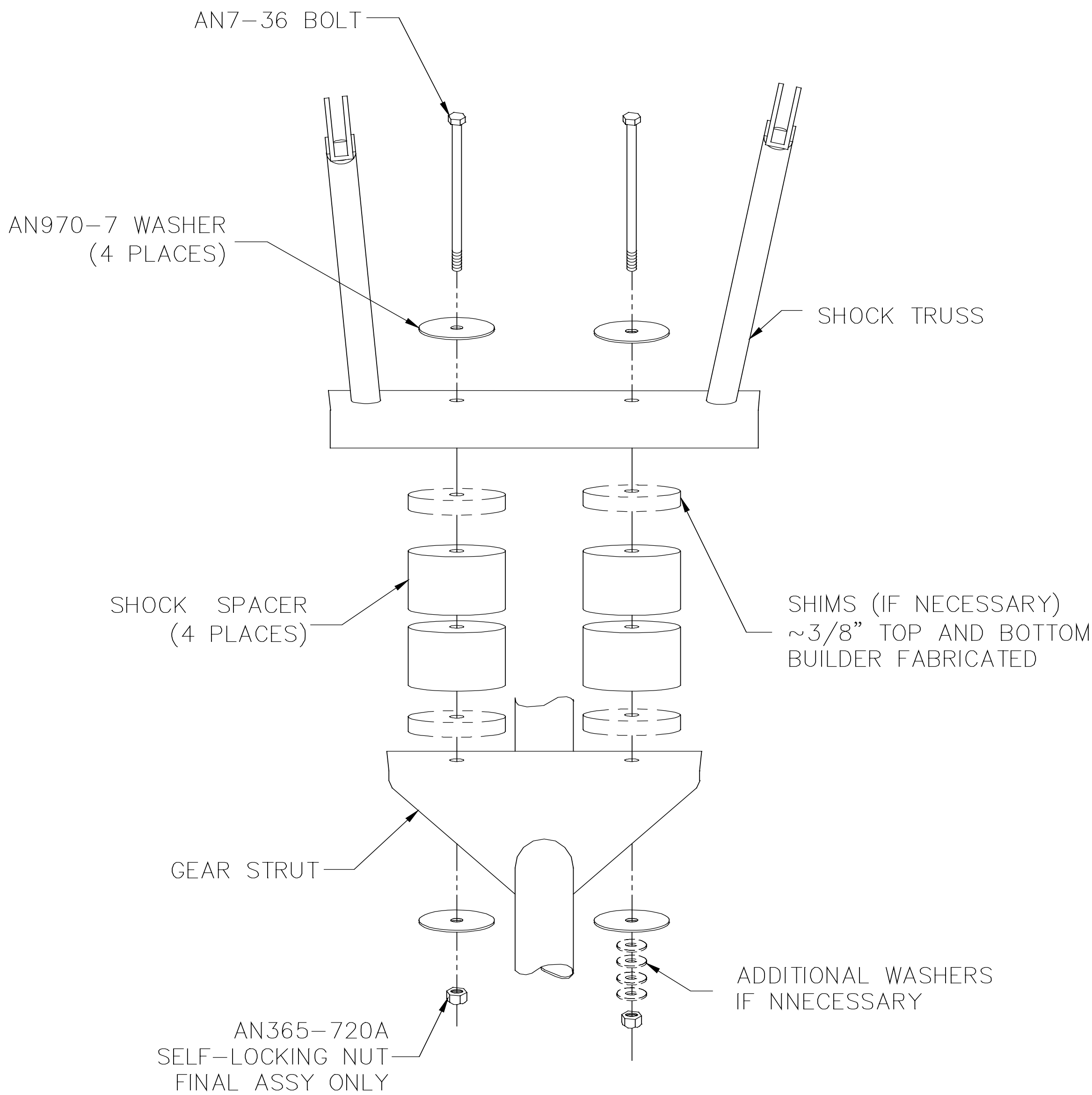

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Figure 135: Shock Damper Installation

Step 84: Mount the Nose Wheel Fork to the Strut Axle

The welded nose fork assembly pivots about the nose strut axle. A friction plate and Belleville washers are used to clamp up the assembly and allow the assembly to rotate, yet will be clamped tight enough to prevent the system from shimmy.

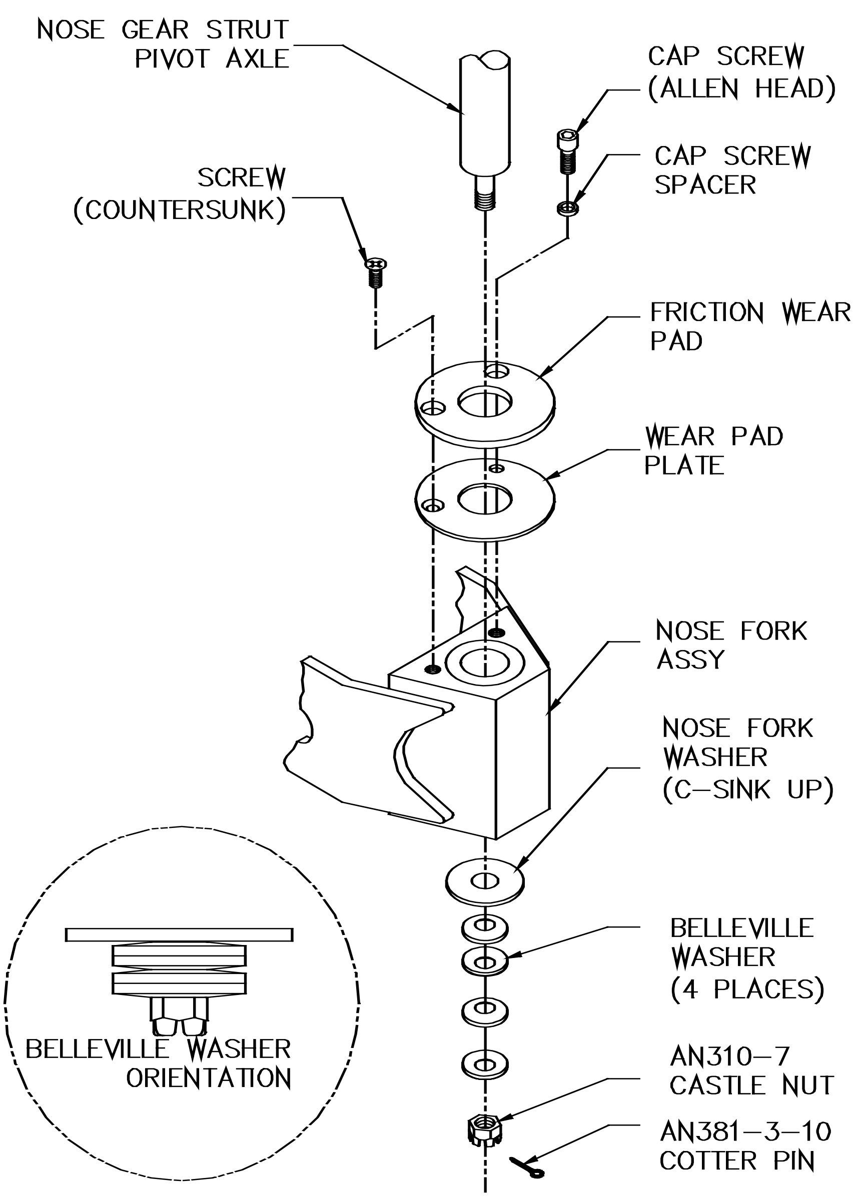


Figure 136: Nose Fork Assembly

ADVANCE NOTICE OF REVISION

(This notice **supplements** all earlier notices)

Section II: Tools and Techniques.

Page 76: In the control cable tensioning section, a recommendation of 10-15lbs under the maximum tension (rigging load in pounds) will be specified.

Page 101-104: Reference numbers for the primers used on the finish of interior and exterior composite parts will be provided. The exterior white primer used on the Sportsman is a Duratec 1794-005. The interior gray primer is Duratec 1799-005. The Zolatone finish is Zolatone 20-64 Gray Stone. [illegible] ss hole for inspecting the alignment pins. You may choose to install this access hole if your skins are without [illegible] e of [illegible] will be used. Refer to the [illegible]

[redacted]

Page 11-14: The inboard hinge bracket [9] will eventually become a 201-15005-03 part number which is slightly different in shape from the –01 part. The 5/16" dimensions from the

Begin by installing the aluminum **wear pad plate** [209] to the fork assembly using the **AN507-428R10** counter sunk screw [210], the **stop screw spacer** [211] and the **MS21262-38** Allen head cap screw [212]. Use a little dab of Loctite thread lock adhesive on the threads during installation. Next, center and bond the **friction wear pad** [213] to the aluminum wear pad plate with 5-minute epoxy and allow to cure.

Insert the axle thru the nose fork assembly and install the **nose fork washer** [214] with the countersink up, four **Bellville washers** [215] and an AN310-7 castle nut and the **AN381-3-10** cotter pin [213.08] as shown in Figure 136. Bend the cotter pin only enough to keep from falling out.

We won't torque down the Bellville washers at this time, because the extra friction in the system will just make moving your moving your assembly around more difficult. You can do this after the nose gear pant has been installed.

Completed: [ ]

Step 85: Mount the Nose Wheel and Axle to the Nose Fork Assembly.

Before the wheel assembly can be installed on the nose fork, the axle assembly must be sized to the correct length to fit precisely between your wheel bearings. The axle will act as a clamp up sleeve to keep from preloading the bearings too much.

Insert a 3/16" x 1/2" **roll pin** [216.01] into the each hole near one end of the **nose wheel axle** [216.02] as shown in Figure 137. Insert the smaller steel **axle plug** [216.03] into the axle and then the larger aluminum **axle hub** [216.04] over these parts. Slide the axle into the wheel assembly and then on the other side of the axle, insert the plug and the **laminated washer** [216.05] and then the other axle hub. Check the side to side play of the two outer hubs to the wheel bearings and then reduce the thickness of the laminated washer by peeling one layer (.003) off at a time until the axial play in the bearings has just been eliminated. (Use a sharp knife on the outer edge of the washer to separate a layer off.)

Now that the length of the axle is properly set, the wheel assembly can be installed on the nose fork assembly. Slide the entire wheel and axle assembly between the forks and from the outside of the fork insert a **nose wheel bushing** [216.06] thru the nose fork and the axle hub. Insert the **AN4-60A axle bolt** [216.07] thru the assembly and secure it with the **AN365-428A** nut as shown in Figure 138. Finally, insert the two other 3/16" x 1/2" **roll pins** through the fork and the axle hub.

Completed: [ ]

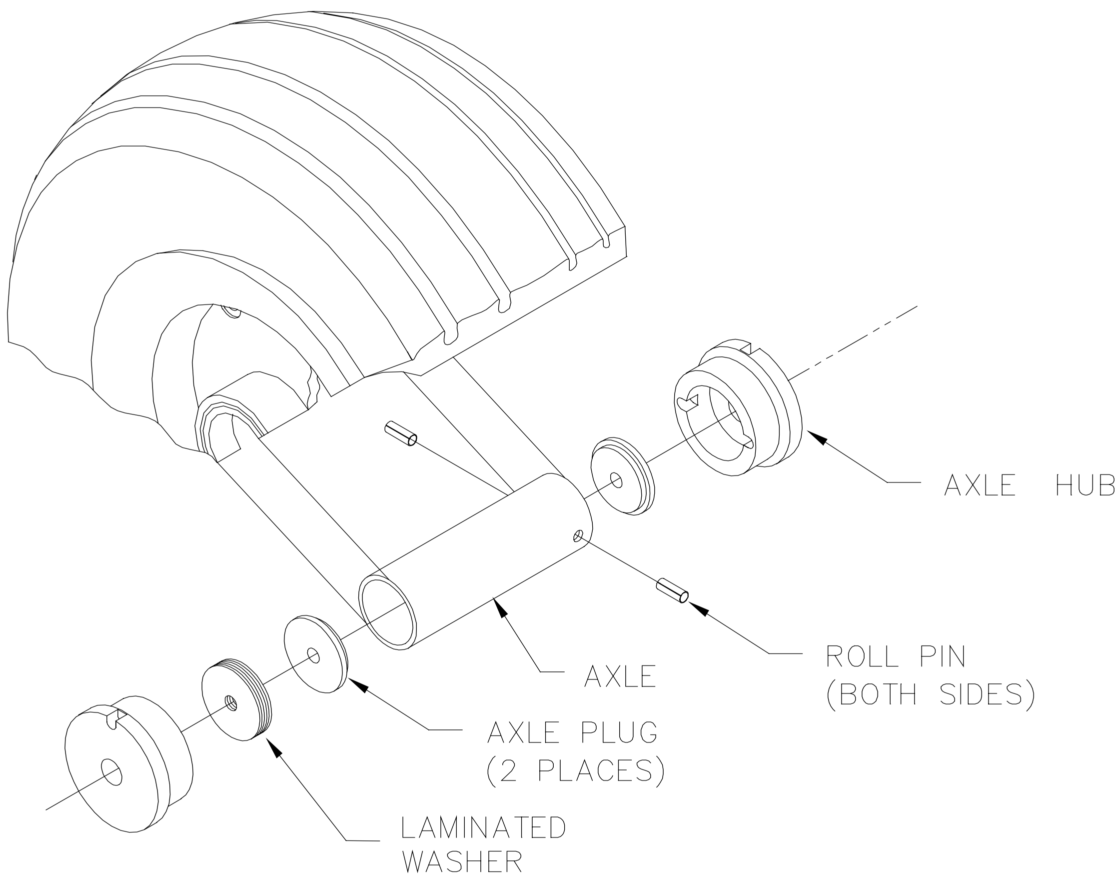


Figure 137: Axle Assembly

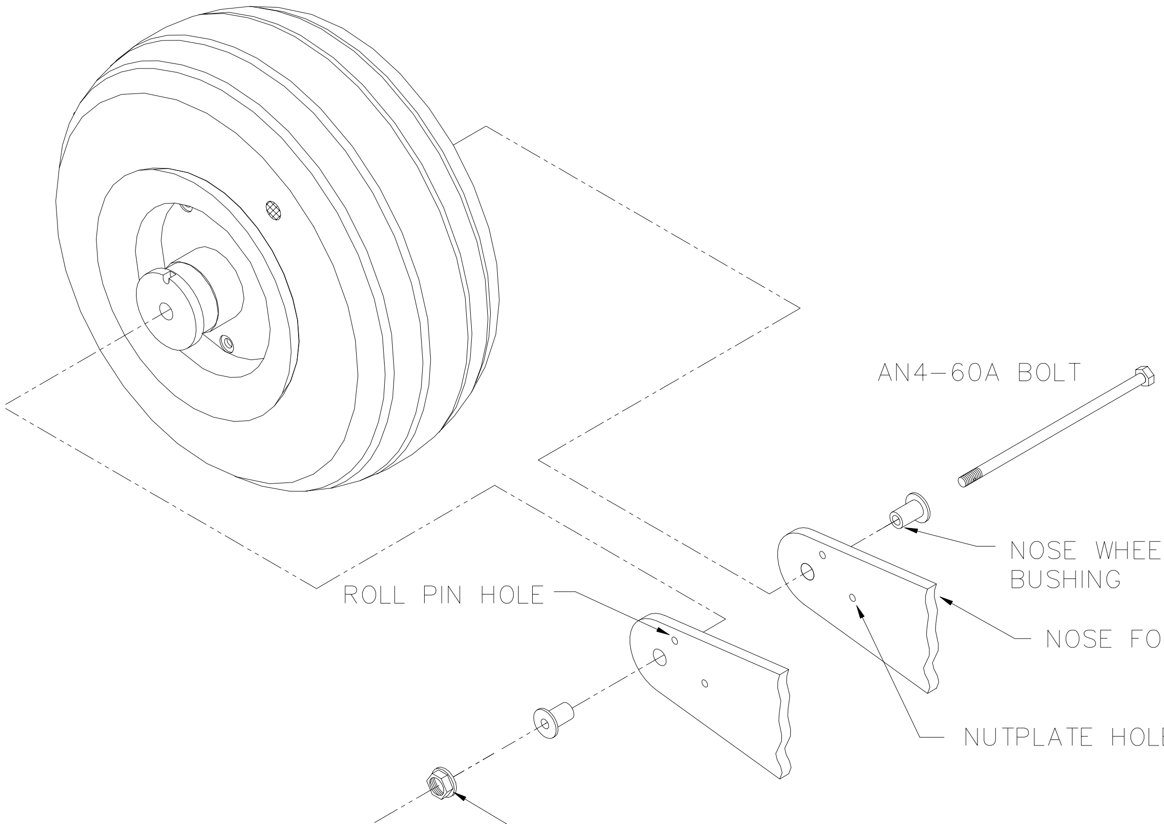


Figure 138: Installing the Nose Wheel Assembly

Step 86: Check Strut Alignment and Drill the Truss Support Link

Now that the airplane can sit on its gear, the two support links that stabilize the shock truss with the firewall can be cut and drilled. Begin first by checking the alignment of the nose strut itself. The goal is to have the pivot axle trail the vertical position by 1-3 degrees as shown in Figure 139. Final adjustment will be done when you have the engine, prop and the airplane virtually complete. But we can get the strut close to that point now.

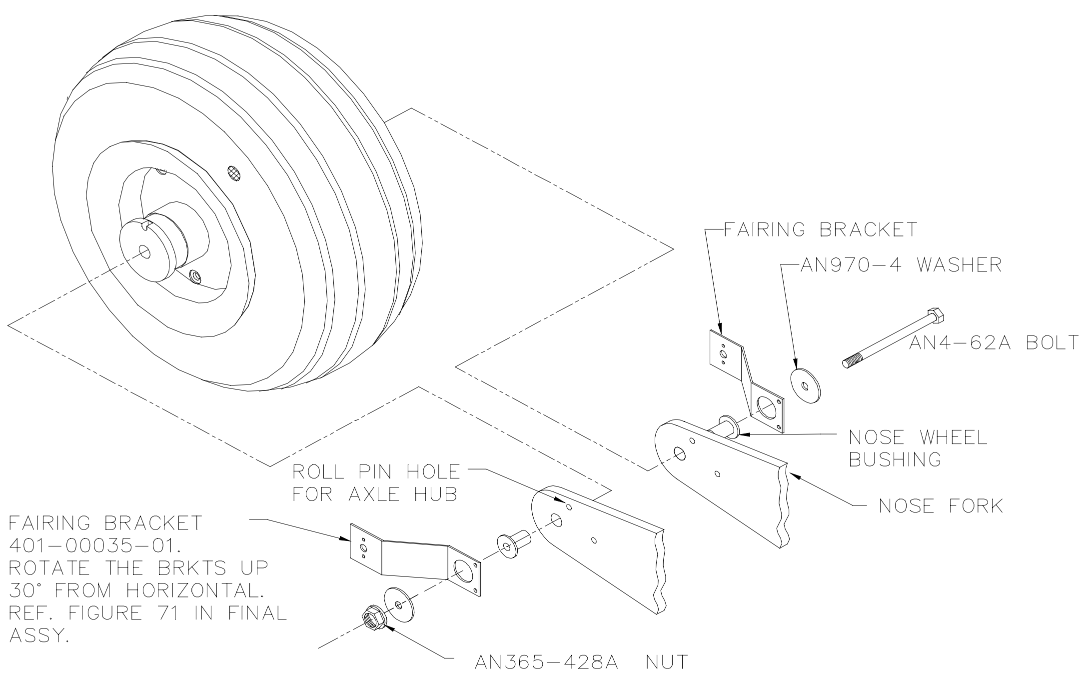
Make sure your aircraft is fairly level on the main gear and the gear have scrubbed out to their static position. Usually rolling the airplane back and forth allowing the gear to splay out will do this. Use a smart level or other means and check the angle from the front of the nose fork to perpendicular and verify that it trails by 1-3 degrees. Insert

Page 221-222: Reference to the seven degree clocking will be revised to better define what it is you are trying to achieve. The narrow two holes (identified at the one and eleven o-clock position on the brake flange) should be centered about the gear leg. Achieve this by inserting two 3/8" bolts through these holes and let the shank of the bolt center the flange about the gear leg. Keep these bolts installed during the drilling process. This applies for either the FT or TD gear. As long as you are set up for drilling, you may want to drill the cotter pin hole in the end of the axle as defined on page 232. Use a #21 drill instead of the #30 bit.

Page 272-277: In the Brake System Plumbing section, (10) 032-00310-01 Brake Line Inserts will be included in future kits. These inserts help prevent the ferrule from getting crooked and causing leaks. The small metal sleeve stiffens and supports the brake line internally and keeps the ferrule straight because it has a flat, flared end. It also keeps the brake line from collapsing. An additional (6) are required for dual brake installations.

Page 244-246: A new method will be used to install the nose wheel pant to the nose wheel fork, which has made the installation easier. This will require a longer axle bolt AN4-62A, two brackets 401-00035-01 and two AN970-4 washers. These will be included in later kits. Step 85 will be reworded to install the two brackets and larger washer. The bracket is oriented on the nose fork with the aft end up 30 degrees to horizontal per Figure 71 in Final Assembly. Drill one 1/8

diameter hole through each bracket and into the nose fork arms. Install (1) 1/8"diameter x 1/2" roll pin 450-0070-002 in each bracket. Figure 138 will be revised as follows:



Page 247:

shim spacers into the rubber shock as shown in Figure 134. Remember, just get it close for now, a final adjustment will be done after the engine is installed.

Now measure the distance between the main gear attach point on the firewall and the tab on the shock truss. Mark this point on your two support links where the new hole must be drilled. Make sure you add approximately 1/2" to the length for edge margin and cut the support links to length. Drill 1/4" diameter holes at the points you marked. Reposition the support link with the shock truss and pass drill those holes with the 1/4" drill as well. Deburr and touch up the new holes with a dab of corrosion proofing.

Reinstall the support link and secure them to the shock truss using AN4-7A bolts, AN960PD416 washers and AN365-424A lock-nuts.

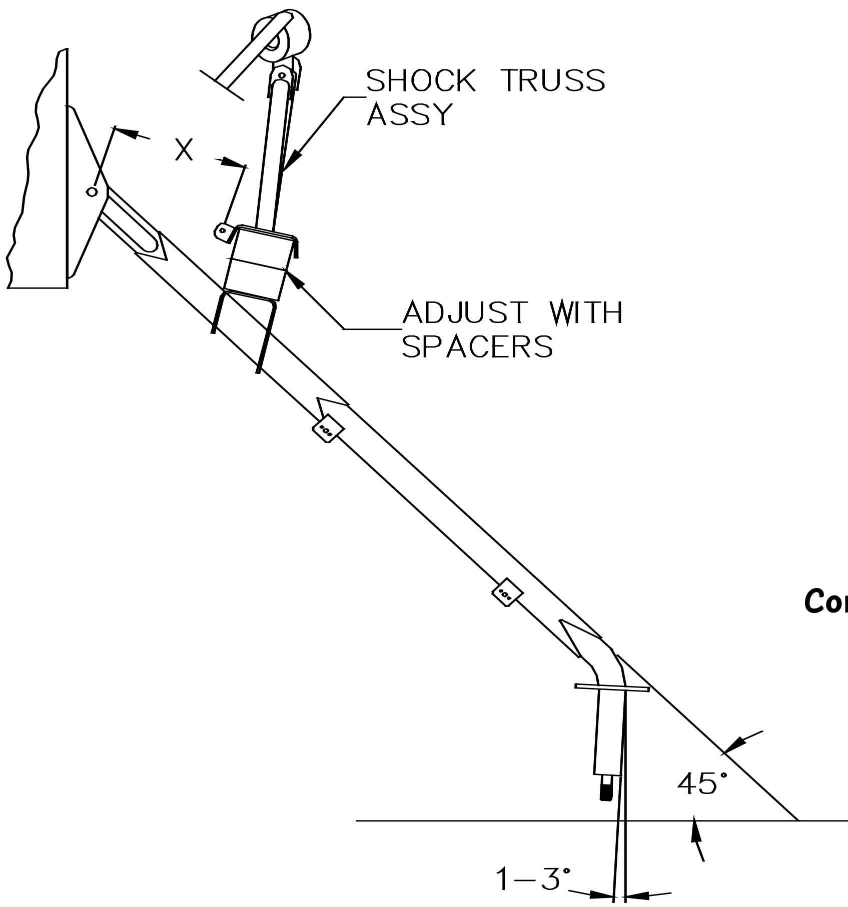


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Figure 139: Checking the Alignment of the Nose Gear Strut

TAILWHEEL INSTALLATION (OPTIONAL)

Tricycle Gear Option The entire tailwheel installation can be completed after the airplane has been finished and flown as a trike. However, if you're installing tricycle gear initially but contemplate converting to conventional gear someday, you may wish to complete at least some of the steps in this sub-section now. For example, installing the internal brackets and fiberglass reinforcements now will speed your conversion to conventional gear later. On the other hand, these steps will add time and weight to your project. You'll have to make your own judgment about what will work best for you. If you're sure you don't want to install a tailwheel, **skip to Step 99**.

Hint For installing the tailwheel, it's easiest to set the airplane on its main gear with a padded sawhorse or stool supporting the tail about **24"** forward of the tailcone. The fuselage should be roughly in a level-flight attitude.

Step 87: Fabricate the Forward Spring Attach Bracket

Figure 140 illustrates the configuration of the tailwheel installation. The three leaf springs are secured at the forward end by a bolt that goes through the bottom of the fuselage into the **forward spring attach bracket** [225], which in turn is bolted to the aft face of Bulkhead D. This bracket can be seen in Figure 141.
Rough angle stock is provided for fabricating the forward spring attach bracket; you

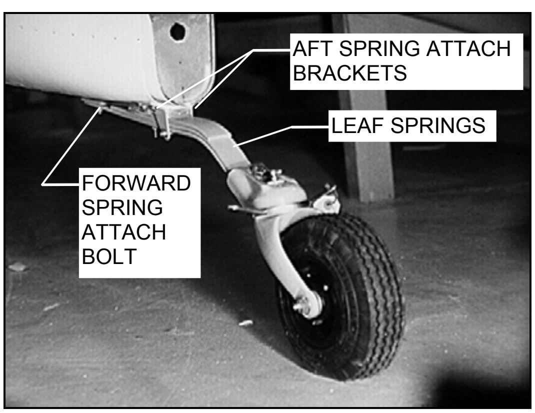


Figure 140: Tailwheel Installation

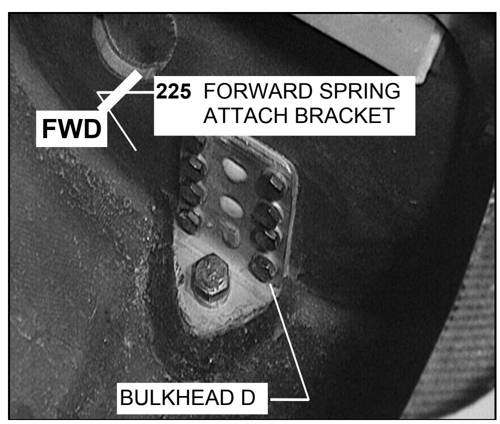
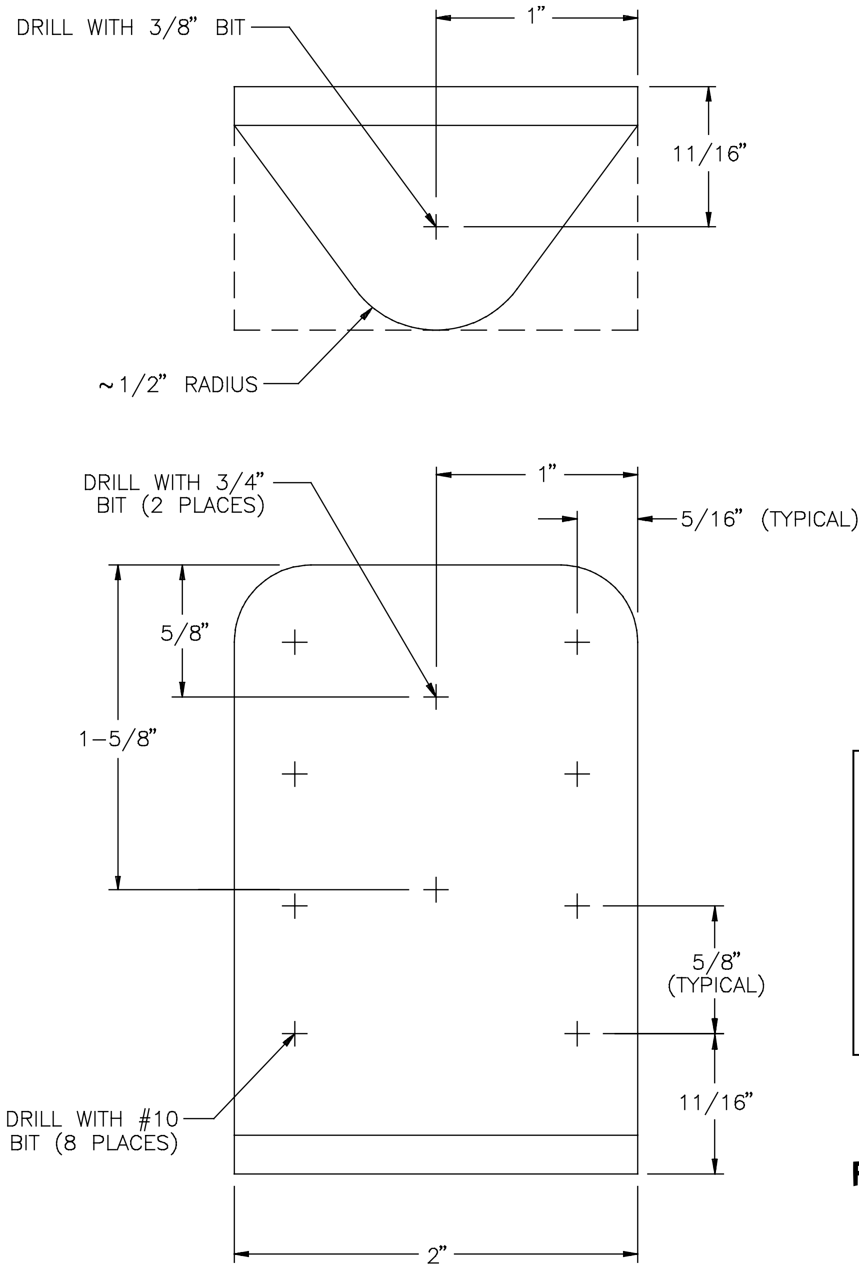


Figure 141: Forward Attach Bracket

must trim the bracket to shape and drill a number of bolt and lightening holes. The dimensions for this trimming and drilling are given in Figure 142.

Begin by trimming off the corners of the horizontal flange with a hacksaw or bandsaw. Then radius the forward edge as well as the upper corners of the vertical flange with a file or a belt sander.

Next, lay out the hole locations as shown and drill the holes. As indicated in the figure, use a **#10** bit for the eight bolt holes in the vertical flange, a **3/4"** hole cutter for the two lightening holes in the vertical flange, and a **3/8"** bit for the single bolt hole in the horizontal flange.



After drilling, deburr all the holes and smooth all the edges.

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If you plan on being a gear converter (FT-TD-FT), fabricate a plate-nut using an AN363-624 nut welded to a piece of steel (.05 min) and rivet this to the attach fitting.

Figure 142: Fabricating the Forward Spring Attach Bracket

Step 88: Install the Forward Spring Attach Bracket

When you install the bracket, you will bed it in a thick resin/mill fiber mixture, but nevertheless, for maximum strength, the bracket should be seated as closely to the fuselage floor as possible. The first step in achieving this is to radius the lower, aft corner of the bracket with a file or a belt sander. Your goal is to make the bracket nest as closely as possible into the fillet on the aft side of Bulkhead D, as shown in Figure 143. However, you shouldn't radius the bracket any more than about **5/16"** to avoid compromising its strength.

If you kept your Q-cell fillet fairly small when you installed Bulkhead D, the 5/16" maximum radius on the bracket should be sufficient to allow the bottom of the bracket within **1/8"** of the fuselage floor. If your fillet is too large to allow this, then you'll have to grind some of it away for about **1-1/4"** on either side of the aircraft centerline. Grind it down until the bracket sits within 1/8" of the floor. Then cut two small pieces of bi-directional cloth large enough to cover the entire ground-down area and laminate them in place to replace the DBM cloth you ground through to get at the Q-cell fillet.

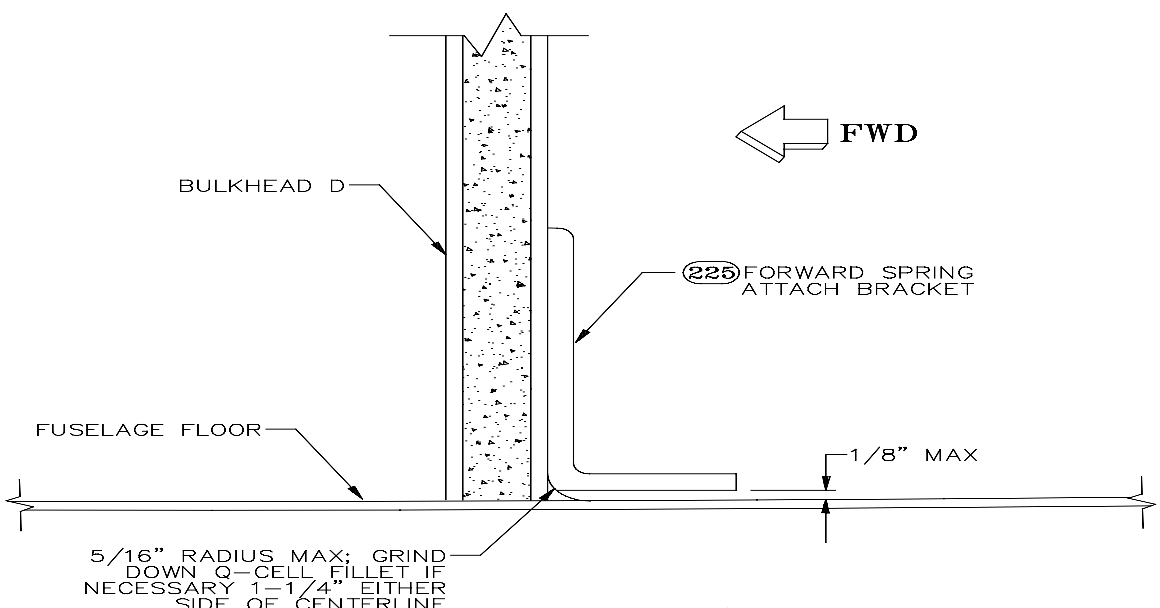


Figure 143: Seating the Forward Spring Attach Bracket Against the Fuselage Floor

Next, drill the eight bolt holes through Bulkhead D. Hold the bracket tightly in place against the bulkhead, within **1/8"** of the fuselage floor and aligned with the aircraft centerline. As shown in Figure 144, use a **#10** bit to drill through the bulkhead at each hole in the bracket. Pin the bracket in place temporarily with an AN3 bolt through each of the first two holes drilled to help maintain alignment while drilling the remaining six. After all the holes have been drilled, remove the bracket from the bulkhead. Thoroughly deburr the holes and corrosion-proof the bracket as you see fit.

Builder Hint: To accommodate quick removal of the tailwheel assembly, some builders create a 3/8 nutplate by tack-welding a 3/8 all metal **tension** locknut to a piece of .05 steel and riveting this "locknut" to the aluminum attach angle.

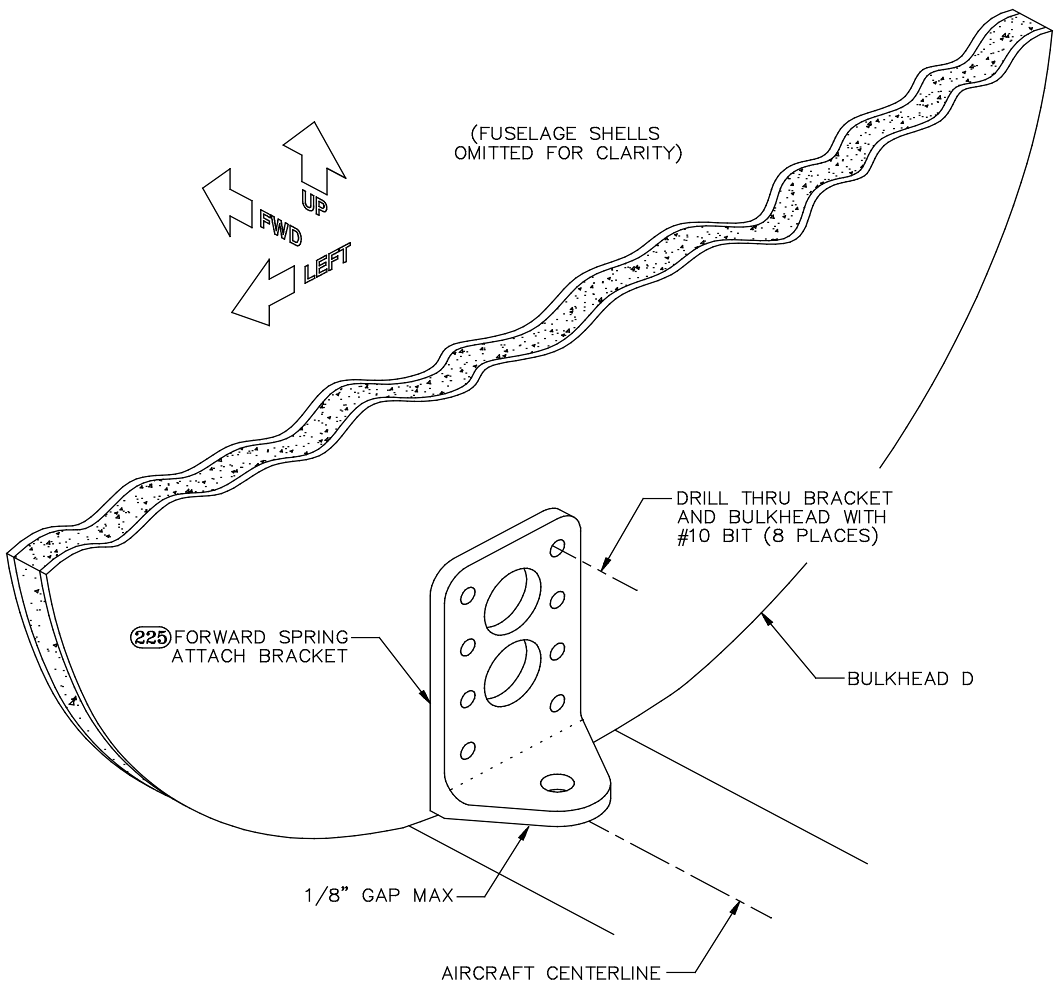
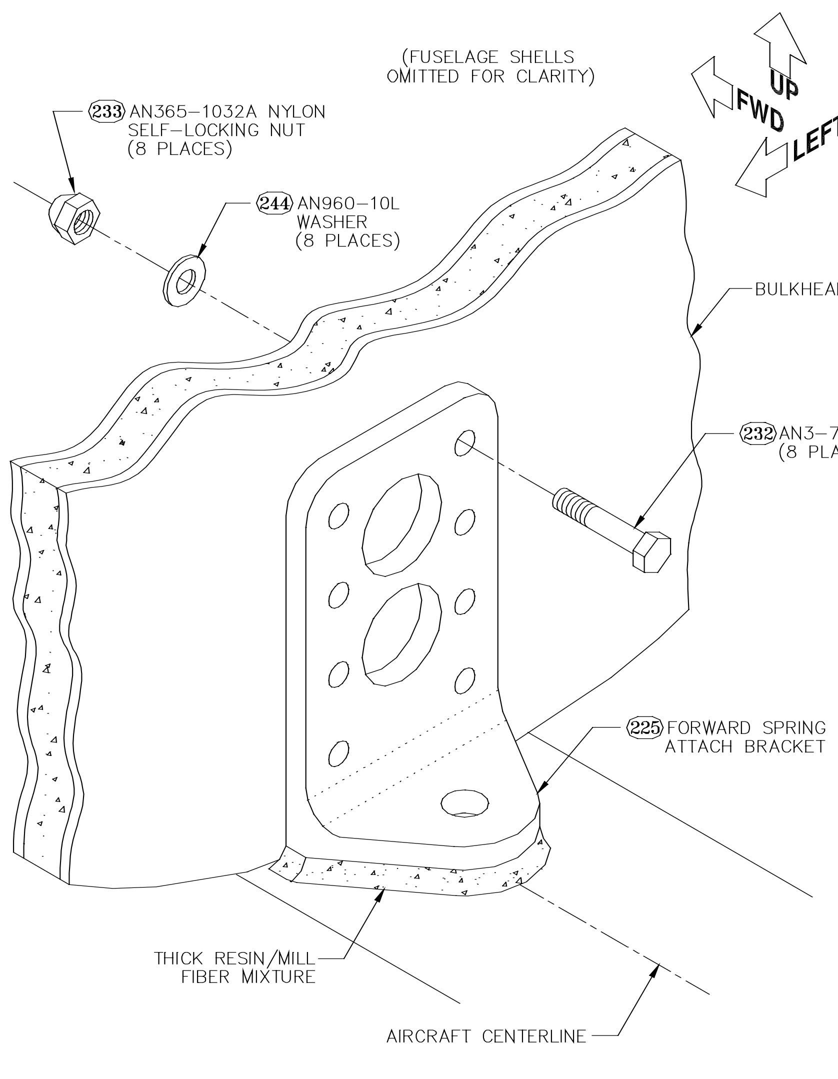


Figure 144: Drilling the Forward Spring Attach Bracket Bolt Holes

Next, prep the area of the fuselage floor directly under the bracket by roughening it with coarse sandpaper and wiping it with acetone. Mix a small batch of thick resin/mill fiber mixture and lay a thick bed of it over the area below the bracket. Push the bracket down into the mixture and, as shown in Figure 145, bolt it in place through each of the eight holes with AN3-7A **bolts** [252], AN960-10L **washers** [244] and AN365-1032A **nylon self-locking nuts** [233]. Use a popsicle stick or a rubber-gloved finger to remove excess resin/mill fiber mixture, leaving a smooth fillet around the bracket. Drill a 1/2" drain hole through Bulkhead D on each side of the forward Tailwheel spring attach bracket as close to the belly as possible.



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Step 89: Drill the Forward Spring Attach Bolt Hole

After the resin/mill fiber bed under the spring attach bracket has fully cured, drill downward through the bracket, the resin/mill fiber bed and the fuselage floor with a **3/8"** bit, as shown in Figure 146. Deburr this hole on the upper surface of the bracket and touch up with corrosion protection as necessary.

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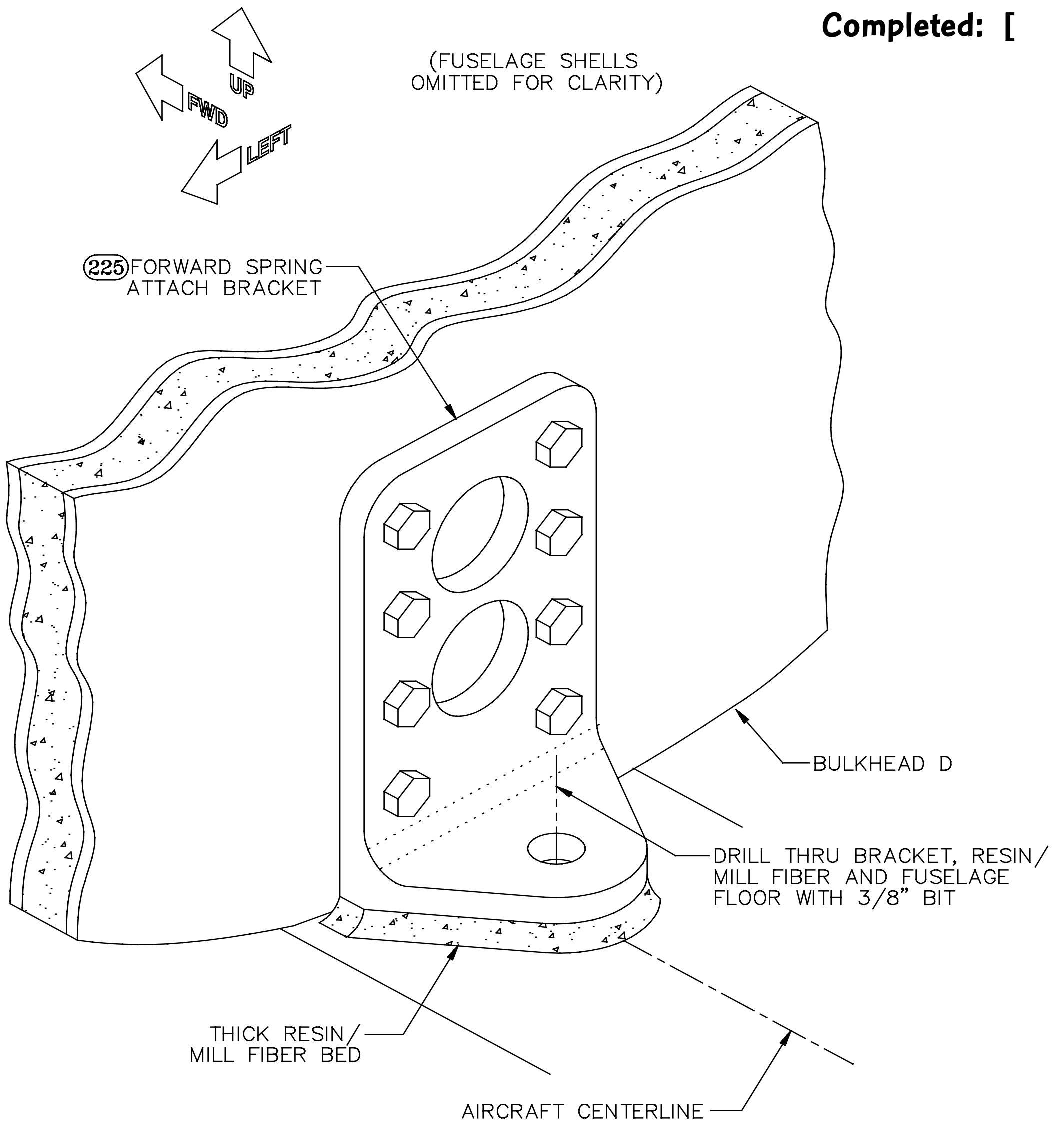

Figure 146: Drilling the Forward Spring Attach Bolt Hole

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Step 90: Fabricate the Forward Spring Block

In this step you will shape an aluminum block that serves as the forward bearing point for the tailwheel springs. The block is made from the supplied **1/4" X 1-1/2" X 1-1/2" aluminum block** [217]. You must shape the block so that its lower surface is parallel with the aircraft waterline plane when its upper surface is tight against the fuselage. As Figure 147a shows, the block will be located directly under the forward spring attach bracket.

Figure 147b illustrates in an exaggerated fashion what must be done to shape the block. First, it must be **tapered** in a fore-and-aft direction from its initial thickness of 1/4" at the aft end to about **3/16"** at the forward end. Second, it must be **hollowed out** to match the curvature of the fuselage. These tasks can both be accomplished most easily using a bench-mounted belt sander. Use the flat of the belt to taper the block to the approximate dimensions shown, and then use the rounded end of the belt to hollow out the upper surface. Stop frequently to trial fit the block against the fuselage.

When you have the block shaped to your satisfaction, mark and drill a **3/8"** bolt hole in the exact center of the block, as shown in Figure 147c. The hole should be centered laterally and drilled **perpendicular** to the **lower** surface of the block. Next, you need to prepare the block for bonding to the fuselage. You will use a thick resin/mill fiber mixture for this bonding, and this will grip the block more effectively if you drill some blind holes in the upper surface of the block. As shown in Figure 147c, use a **#30** or a **1/8"** bit to drill roughly **halfway** through the block in about twelve places. Use a drill stop to avoid drilling all the way through; you don't want holes in the lower surface of the block. Space the holes roughly evenly, but don't bother being too precise about this.

After all the holes have been drilled, deburr them and corrosion-proof the entire block as you see fit.

Completed: [ ]

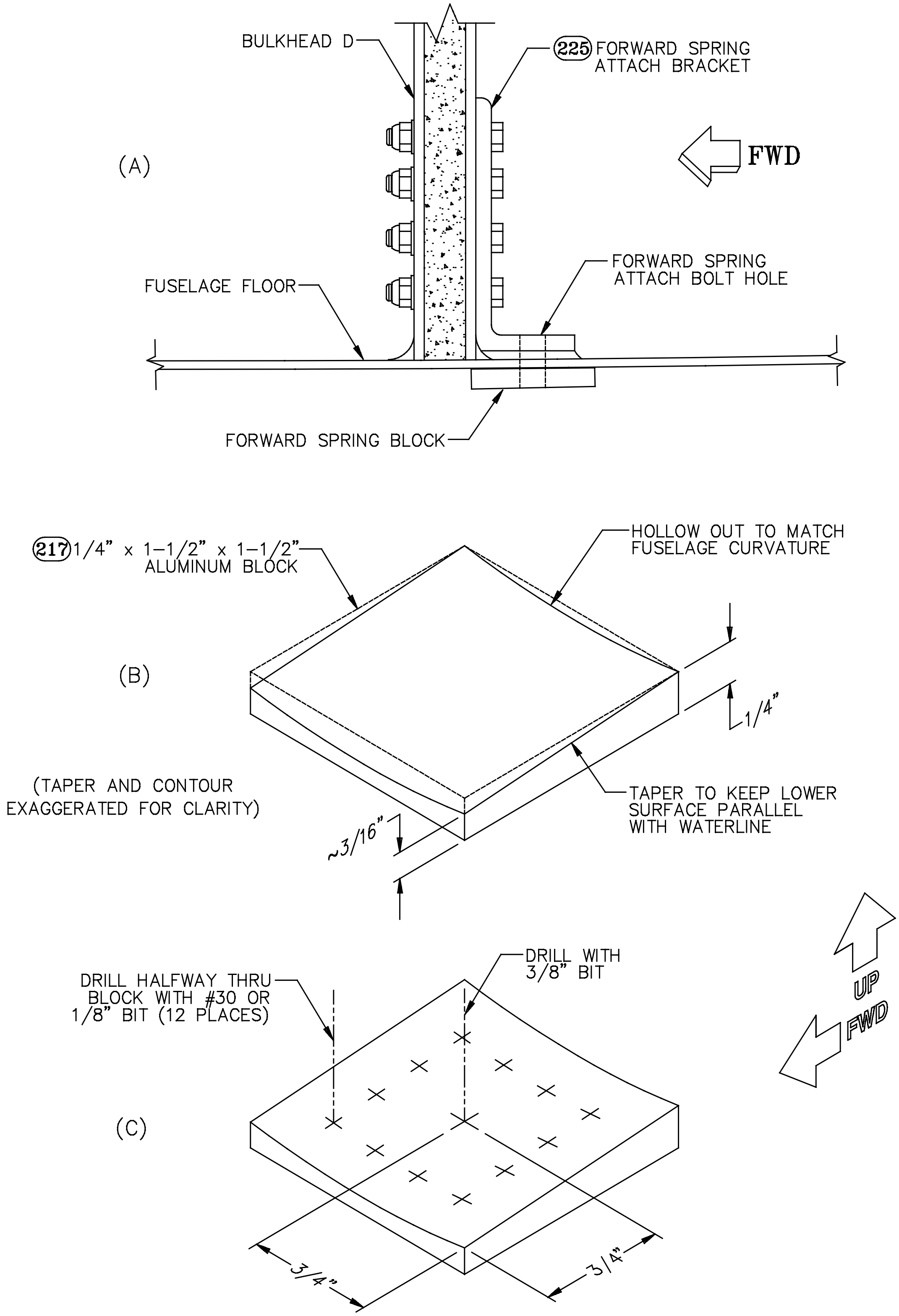

Figure 147: Fabricating the Forward Spring Block

Step 91: Stack the Tailwheel Springs

Three leaf springs are stacked together to form the tailwheel spring assembly. As shown in Figure 148, nest the **upper** [224], **middle** [223] and **lower tailwheel springs** [222] together. To distinguish the springs, the **upper** spring is the shortest of the three; the **middle** spring has a 1/2"-diameter hole at the aft (shorter) end; the **lower** spring has a 5/8" X 3/4" slot at the aft end.

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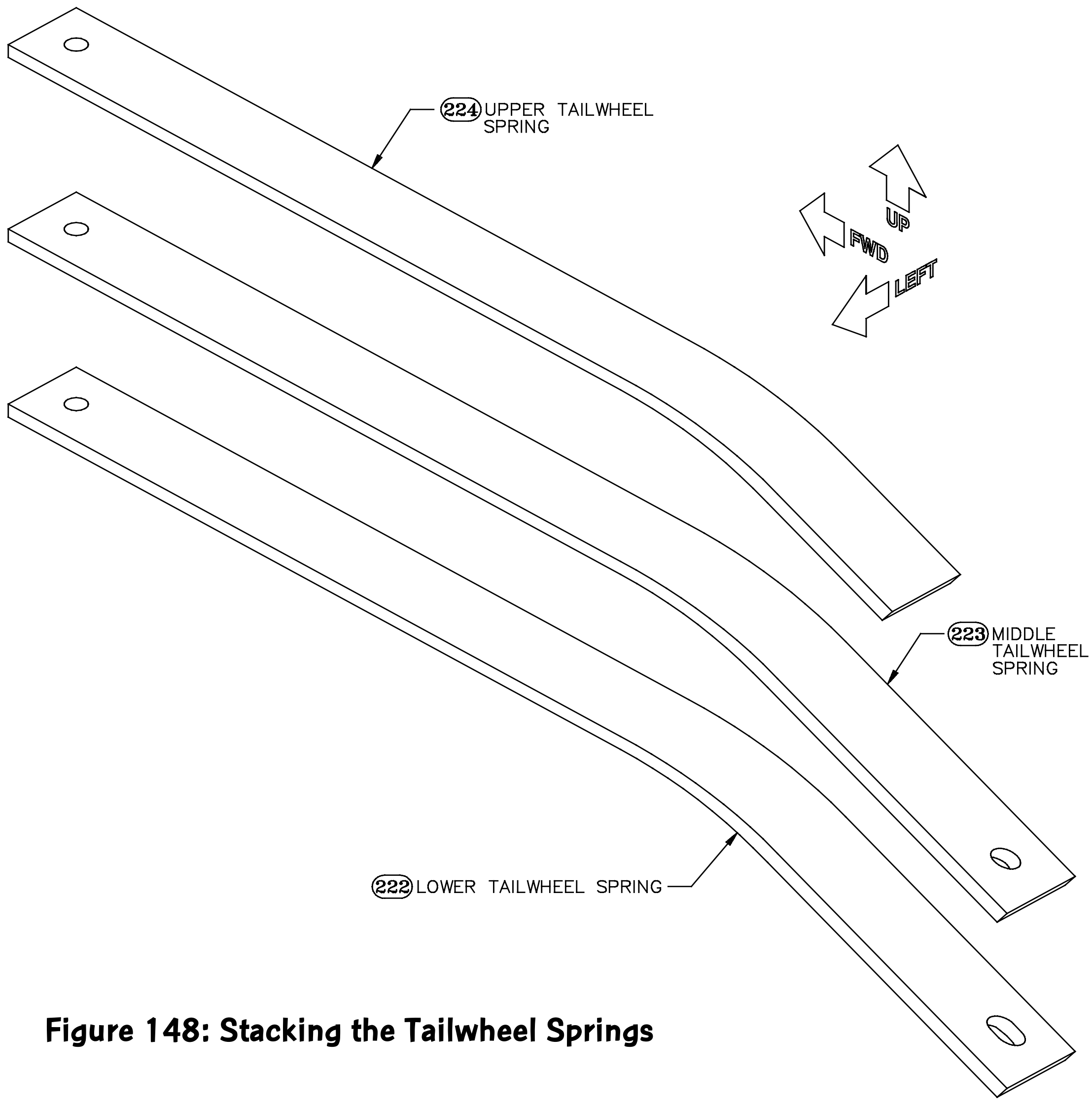

Figure 148: Stacking the Tailwheel Springs

Step 92: Bolt the Springs in Place and Position and Drill the Aft Spring Attach Brackets

As can be seen back in Figure 140, the **left** and **right aft spring attach brackets** [226 and 227] are triangular brackets that come down from the bottom of the fuselage on either side of the spring stack. A 1/4" bolt between the lower ends of the two brackets keeps the springs tight against an aft aluminum spring block.

It's easiest to position these brackets with the spring stack in place. As shown in Figure 149, temporarily bolt the stack in place under the forward attach bracket. Insert an AN6-23A **bolt** [279] through the spring stack and the forward spring block, and secure it with an AN960-616 **washer** [280] and an AN365-624A **nylon self-locking nut** [276].

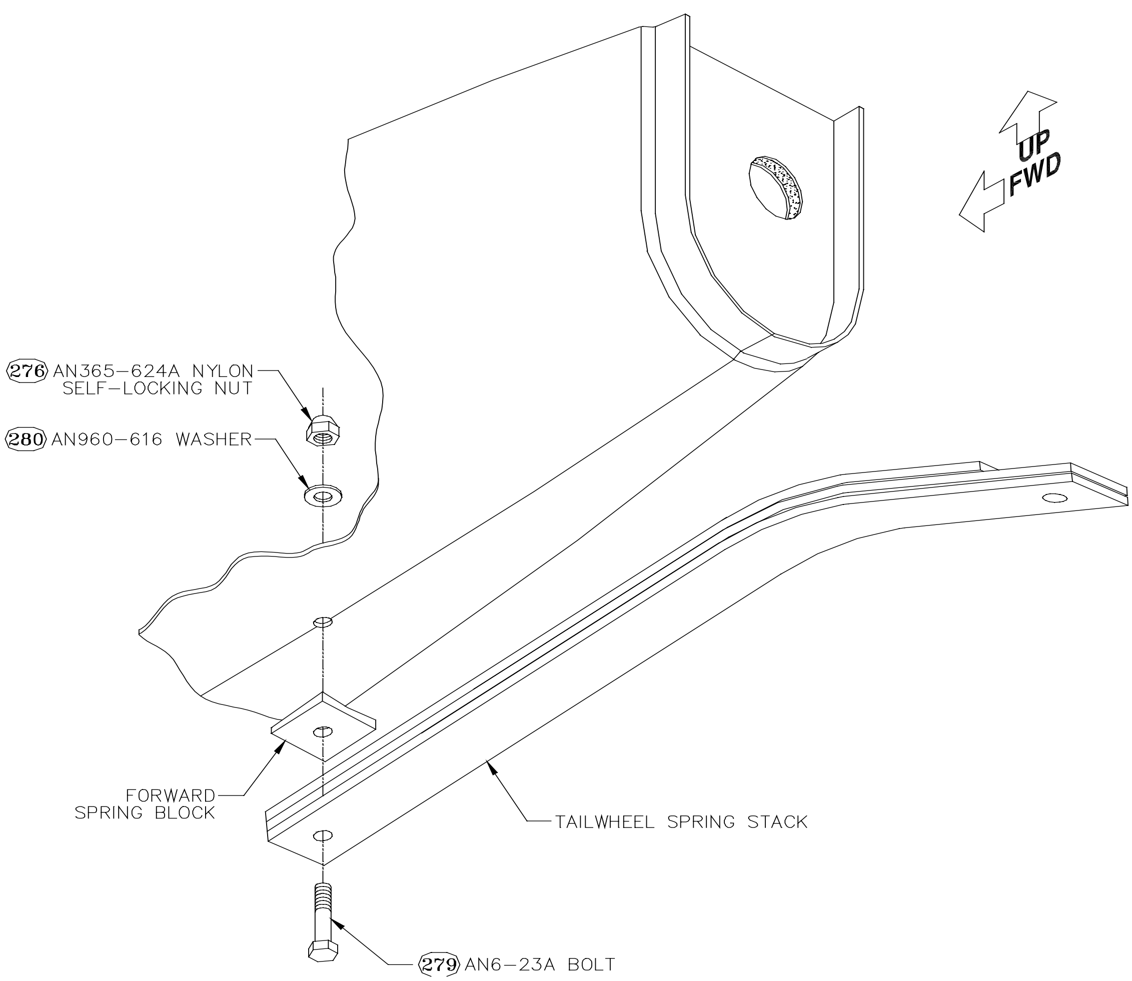

Figure 149: Temporarily Bolting the Tailwheel Spring Stack in Place

With the spring stack bolted to the fuselage bottom at its forward end, rotate it left or right as necessary to bring it into alignment with the aircraft centerline. Verify the springs are level at the aft end to ensure the tail wheel assembly sits straight and true. Some shimming may be required or adjust the level of the forward spring block.

The next step is to bring the aft spring attach brackets together on either side of the spring stack and to position them against the fuselage for drilling, as shown in Figure 151. First, as shown in the detail in the lower, right-hand corner of the figure, join the left and right brackets by inserting an AN4-22A **bolt** [240] through the bottom holes in each. Use AN960-416 washers under both the bolt head and the AN365-428A nylon self-locking nut. The purpose of this bolt at this stage is simply to help align the brackets fore-and-aft relative to one another, so there's no need to tighten the nut. Just finger-thread it on a few turns.

Next, position the joined brackets on either side of the spring stack. The lower, vertical flanges of the brackets should be tight against the springs and the upper, bent flanges should be tight against the fuselage. Slightly bend the brackets in a vise if necessary in order to get the upper flange to align with the fuselage shell. As shown in Figure 150, the brackets should be positioned fore-and-aft so that the **center** of the bottom bolt hole in each is **1/4" forward** of the tailcone joggle. A small C-clamp is useful to help hold the brackets in place. An aft spring block will be fabricated in Step 93 to fill the void between the springs and fuselage.

When you're satisfied that the brackets are properly aligned, drill through the brackets and the fuselage with a **1/4"** bit, using the two holes in each upper flange as guides. Insert an AN4-10A **bolt** [239] into each hole after it's drilled and secure it temporarily with an AN970-4 **large washer** [248] and an AN365-428A nylon **self-locking nut** [234]. When the drilling is completed, remove the brackets, deburr them and apply corrosion protection. Leave the springs bolted in place for now.

Completed: [ ]

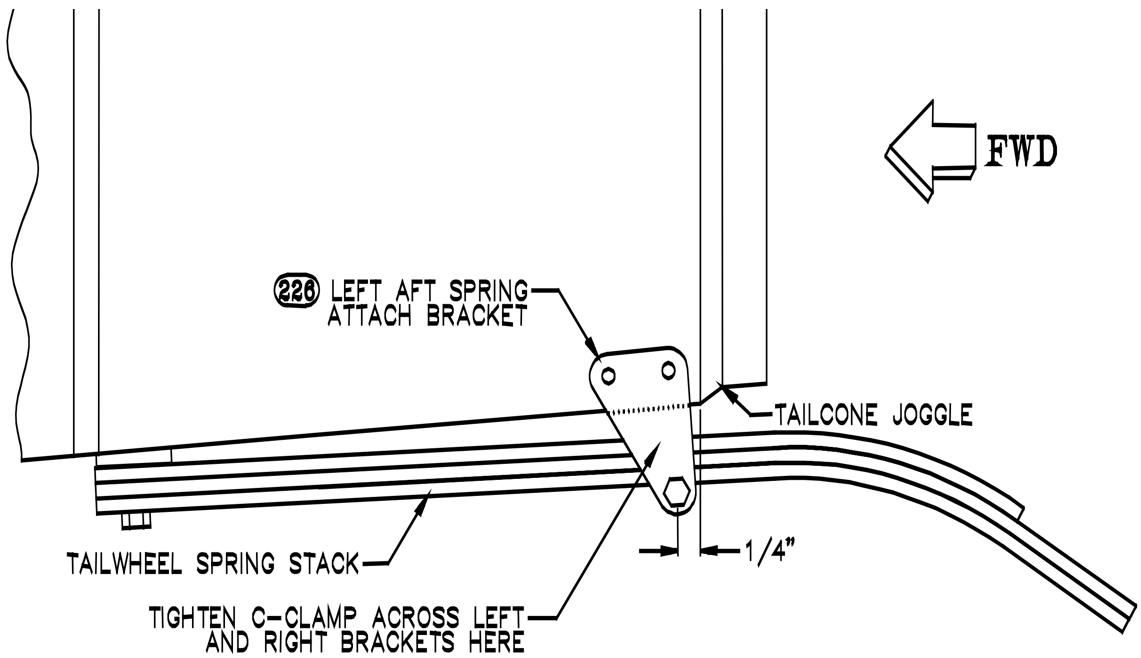

Figure 150: Fore-and-Aft Position of Aft Spring Attach Brackets

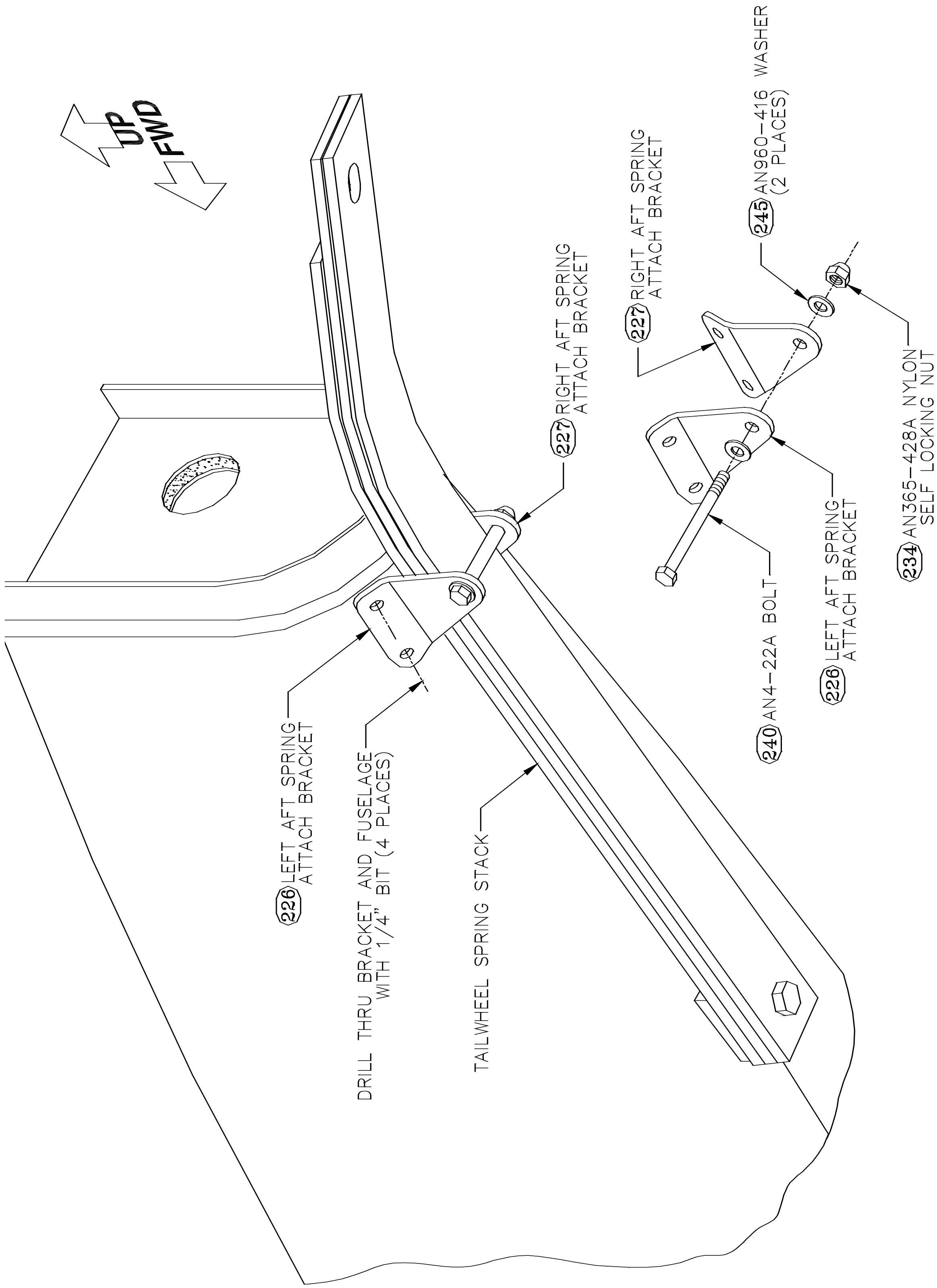

Figure 151: Positioning and Drilling the Aft Spring Attach Brackets

Step 93: Fabricate the Aft Spring Block

A second spring block, fabricated from the supplied **1/2" X 1-1/2" X 2" aluminum block** [218], serves as the aft bearing surface for the stacked springs, as shown in Figure 152. As with the forward block, the aft one must be both tapered and hollowed out to conform to the shape of the fuselage.

Use the same techniques you used on the forward block to shape this one. Since the position of the springs in part determines the shape of the block, begin by bolting the aft spring attach brackets in place around the springs. Also, tighten a C-clamp on the spring stack at the aft-most end of the flat portion of the springs, as indicated in Figure 152. This compresses the springs as the weight of the Sportsman tail compresses them, and this is the condition you want to fit the aft spring block for.

Figure 152 illustrates where the spring block must be made to fit. It must fill the vertical space between the fuselage and the springs, with the springs tight against the bolt between the attach brackets. Furthermore, the **lower, aft edge** of the block must be **no further aft** than the center of the cross-bolt.

Caution If the lower, aft edge of the aft spring block is aft of the center of the cross-bolt between the brackets, unacceptably high shear loads may be imposed on this bolt. You may wish to slightly chamfer or radius the lower, aft edge of the block in order to ensure that this condition is met. If necessary, it is also permissible to shorten the block by up to **1/4"**.

Note You may find in fitting the aft block that the forward block needs to be adjusted slightly. Feel free to unbolt the springs and reshape the forward block as necessary to get the best fit for the aft block.

When both blocks fit the fuselage contour to your satisfaction, locate and mark the center point of the aft block. At this location, use a **#10** bit to drill a hole all the way through the block. As indicated in Figure 153, the hole should be drilled **perpendicular** to the **lower** surface of the block. After it's drilled, countersink the hole on the lower surface to accommodate an AN509-10R flush-head machine screw. Next, drill twenty-eight blind holes for resin adhesion. As before, use a **#30** or **1/8"** bit and drill about halfway through the block at each hole location.

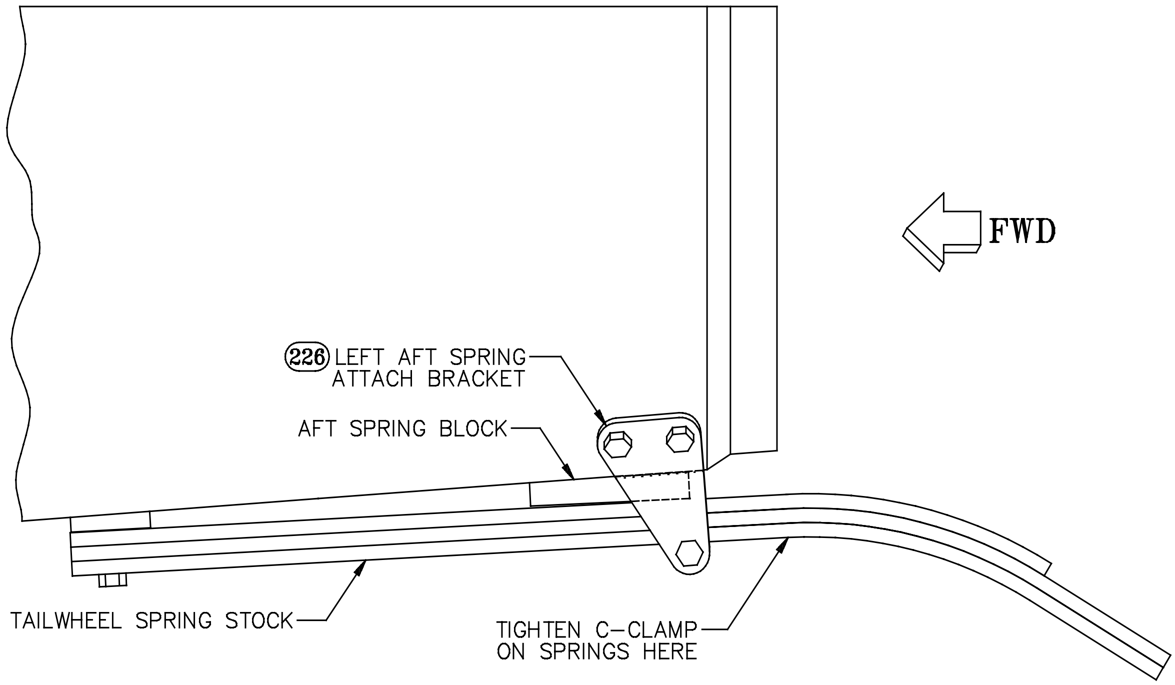

Figure 152: Positioning the Aft Spring Block

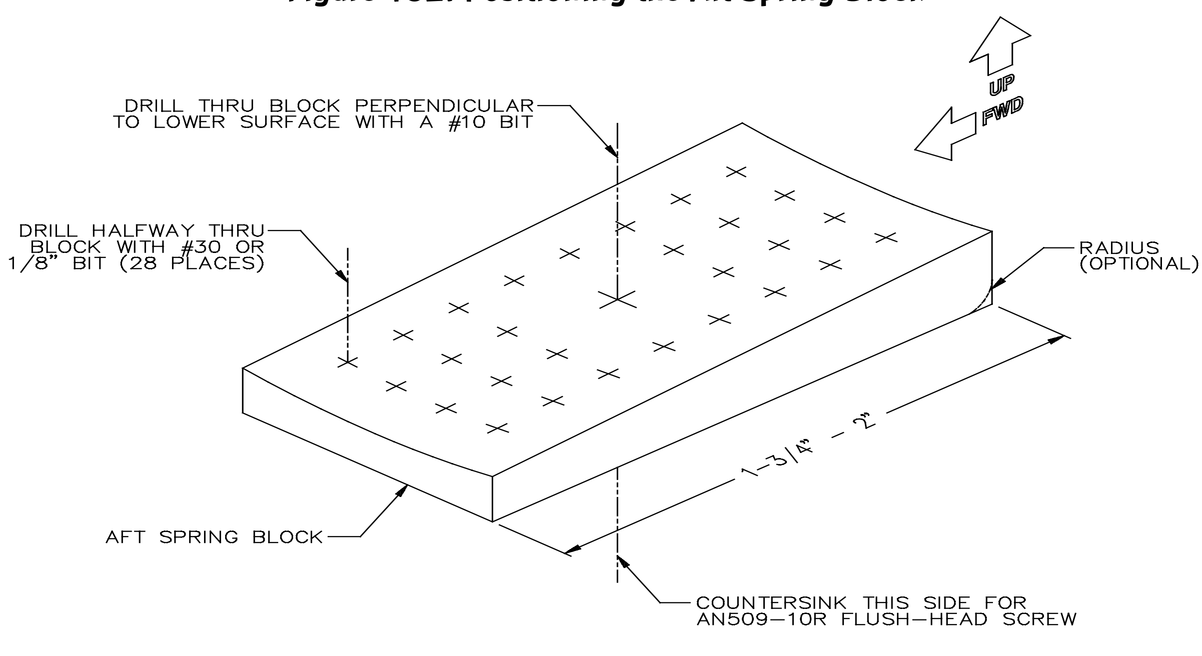

Figure 153: Fabricating the Aft Spring Block

After all the holes have been drilled, deburr them, and then corrosion-proof the block as you see fit.

Completed: [ ]

Step 94: Install the Spring Blocks and Attach Brackets

Remove the springs, blocks and aft brackets, and use coarse sandpaper to remove the primer from the areas on the fuselage where the blocks and brackets will be attached. Then mix a small batch of thick resin/mill fiber mixture.

Spread the mixture liberally on the upper surface of the forward spring block. Insert the AN6-23A bolt through the springs and the block, and secure it permanently with an AN960-616 washer and an AN365-624A nylon self-locking nut. Remove excess resin/mill fiber that squeezes out from between the block and the fuselage.

> **Note** If you have removed it, replace the small C-clamp that you used in Step 97 to compress the springs.

Next, loosely join the two aft spring brackets with the hardware specified in Figure 151. Apply a moderate layer of resin/mill fiber mixture to the inside faces of the upper, bent bracket flanges and press the brackets into place around the springs, aligning the upper holes with the corresponding holes in the fuselage. Insert AN4-10A bolts in these holes, with AN960-416 washers under the bolt heads. Inside the fuselage, apply a thick layer of resin/mill fiber mixture around each bolt where it emerges from the fuselage floor. Place an AN970-4 large washer over each bolt end and tighten an AN365-428A nylon self-locking nut down over it, pushing it into the resin/mill fiber bed, as shown in Figure 154.

After the brackets are bolted in place, apply a liberal layer of resin to the upper surface of the aft spring block. Slide the block into position between the fuselage and the springs, making certain that the lower, aft edge is forward of or even with the cross-bolt between the brackets. Support the aft end of the fuselage directly under the aft spring block just forward of the brackets. Let the resin fully cure.

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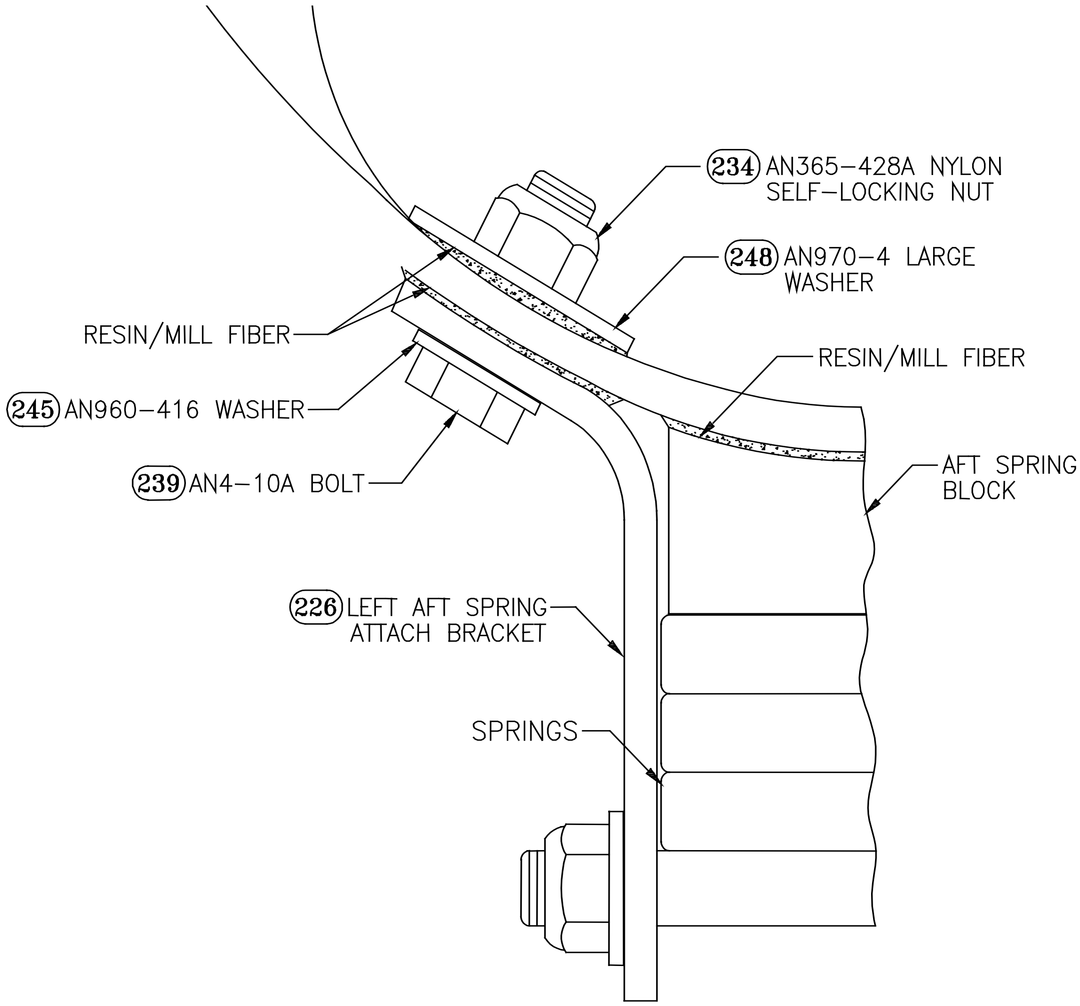

Figure 154: Installing the Aft Spring Attach Brackets

Step 95: Install the Aft Spring Block Retainer Screw

As a supplement to the resin/mill fiber bond holding the aft spring block in place, it's a good idea to install a screw through the block and the fuselage shell. That, of course, is what you drilled and countersunk the #10 hole for in Step 93. Remove the springs to gain access to the underside of the block and, again with a **#10** bit, drill up from below through the resin/mill fiber and the fuselage shell. If necessary, ream out the countersink as well and touch up the corrosion protection.

When you're done, insert an AN509- or AN507-10R flush-head machine screw of the appropriate length. Secure this on the inside of the fuselage with an AN960D10 aluminum washer and an AN364-1032A nylon self-locking nut.

Note You will have to determine the appropriate screw length for your particular aft spring block, as the thicknesses of the block, of the resin/mill fiber bed and of the fuselage floor can all vary from Sportsman to Sportsman. There should, however, be an ample selection of screws left over from the fuselage assembly

Completed: [ ]

Step 96: Re-Install the Springs

Re-bolt the spring stack to the fuselage at the forward attach point using the hardware specified in Step 92 and Figure 149. Use a C-clamp to compress the stack, if necessary, and install the cross-bolt between the aft spring attach brackets. Refer back to Step 96 and Figure 151 for the required hardware. Tighten the nut on this bolt until the brackets are clamped firmly against the sides of the springs, but not so tightly that the brackets bend.

Completed: [ ]

Step 97: Install the Tailwheel Assembly

Installing the **tailwheel assembly** [219] couldn't be simpler: as shown in Figure 155, stack the assembly and the **tailwheel spacer** [220] on top of the middle and lower tailwheel springs. Apply a coating of waterproof wheel-bearing grease to the shank of an AN8-23A **bolt** [243] and insert the bolt from above (the grease helps prevent wear to the bolt when the springs slide over one another). Secure the bolt with an AN960-8 **washer** [247] and AN365-820A **nylon self-locking nut** [236]. Additionally a **NAS75-8-011** steel bushing [246] is installed between the large washer and the middle Tailwheel spring.

Note There must be a minimum of **1/4"** clearance between the aft end of the upper spring and the tail wheel assembly to allow spring movement while in service.

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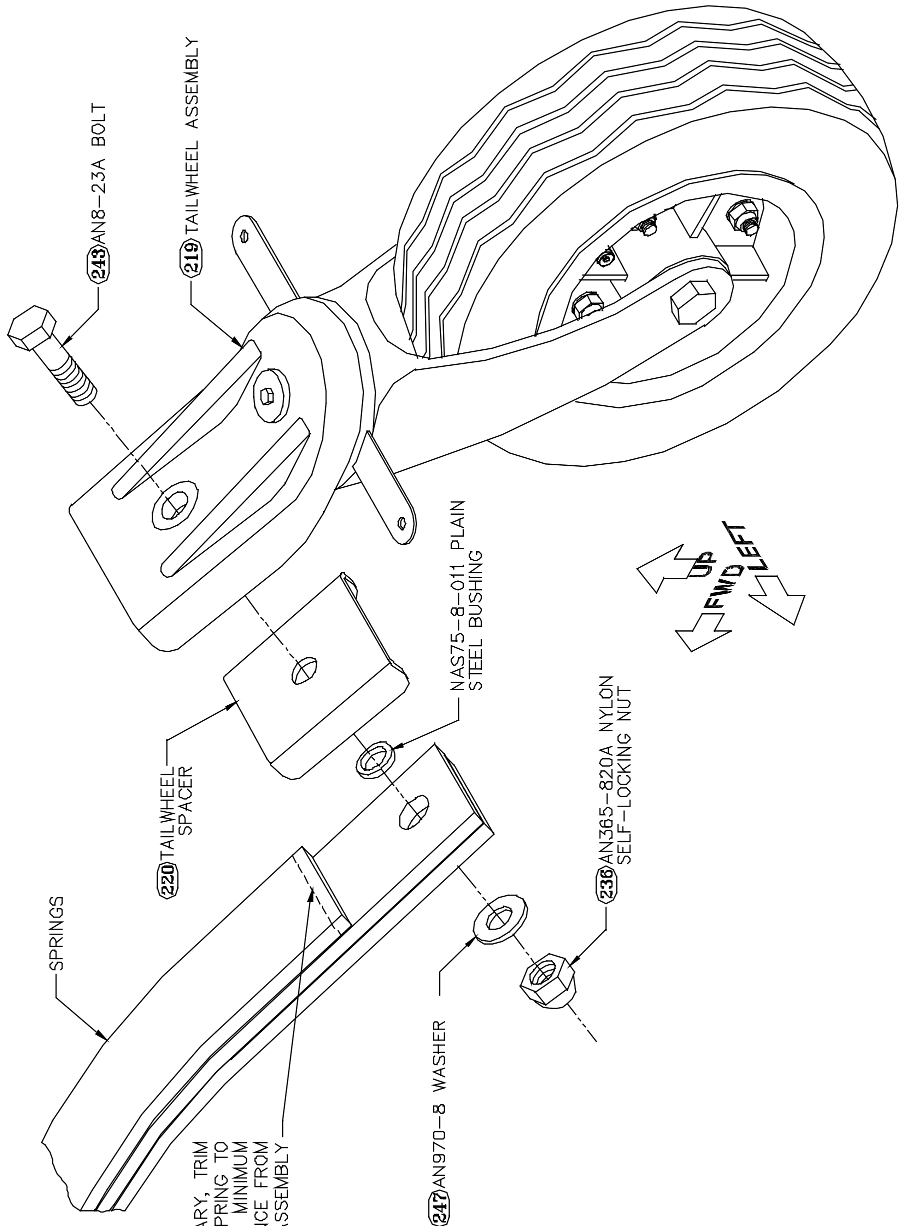


Figure 155: Installing the Tailwheel Assembly

Step 98: Install the Steering Cables (Taildragger Only)

Earlier, in Step 64 of "SECTION VIII: FUSELAGE ASSEMBLY," you installed a pair of NAS77-3-014 bushings in the arms of the rudder stop plate. Now you can connect the tailwheel steering linkage to the bushings. You should set the tail wheel on the ground so the weight of the plane is on it. Reference Figure A on page 317 for a great idea of a jig to locate the cable pass through holes described herein. The jig sits on the steering attach arm on the wheel assembly and the rudder stop arm.

Bulkhead templates now come with the steering cable holes marked for ease, so you may have drilled the holes already. If not, the first step is to drill holes in Bulkhead D and in the fuselage sides for the **steering cables** [230]. These run aft from the bushings in the rudder stop plate to the steering arms on the tailwheel assembly. These holes can most easily be located more or less by eye. Hold a straightedge on the outside of the fuselage on each side with one end on the steering arm and the other approximately aligned on the rudder stop plate (see Figure 156a). Mark this line on the outside of the fuselage. Then, looking down from above, again hold a straightedge (or stretch a string) on the line between the two cable attachment points (see Figure 156b). Make marks where this line intersects Bulkhead D and the fuselage sides. Refer to the first line you marked and transfer the new marks downward on Bulkhead D and on the fuselage sides to the height of the first line. These intersection points indicate where the cable holes should be drilled.

Because this method is not completely precise, there are likely to be some slight misalignments in these hole locations. The solution to this problem is to install abrasion-resistant fairleads in Bulkhead D and in the fuselage shell where the cables pass through. With fairleads in place, the cables can make slight bends in their runs from the rudder stop plate to the tailwheel steering arms without any difficulty.

Short pieces of nylon tubing make good fairleads for the 1/8" steering cables. The Bulkhead D fairleads don't need to be any longer then the thickness of the bulkhead; the fuselage fairleads will have to be a bit longer because of the acute angle at which the cables pass through the shell. Drill appropriate holes through Bulkhead D and the fuselage shell at the marked locations, and bond the fairleads in place with thick resin/mill fiber mixture. After the mixture has cured, trim the fuselage fairleads where they emerge from the shell.

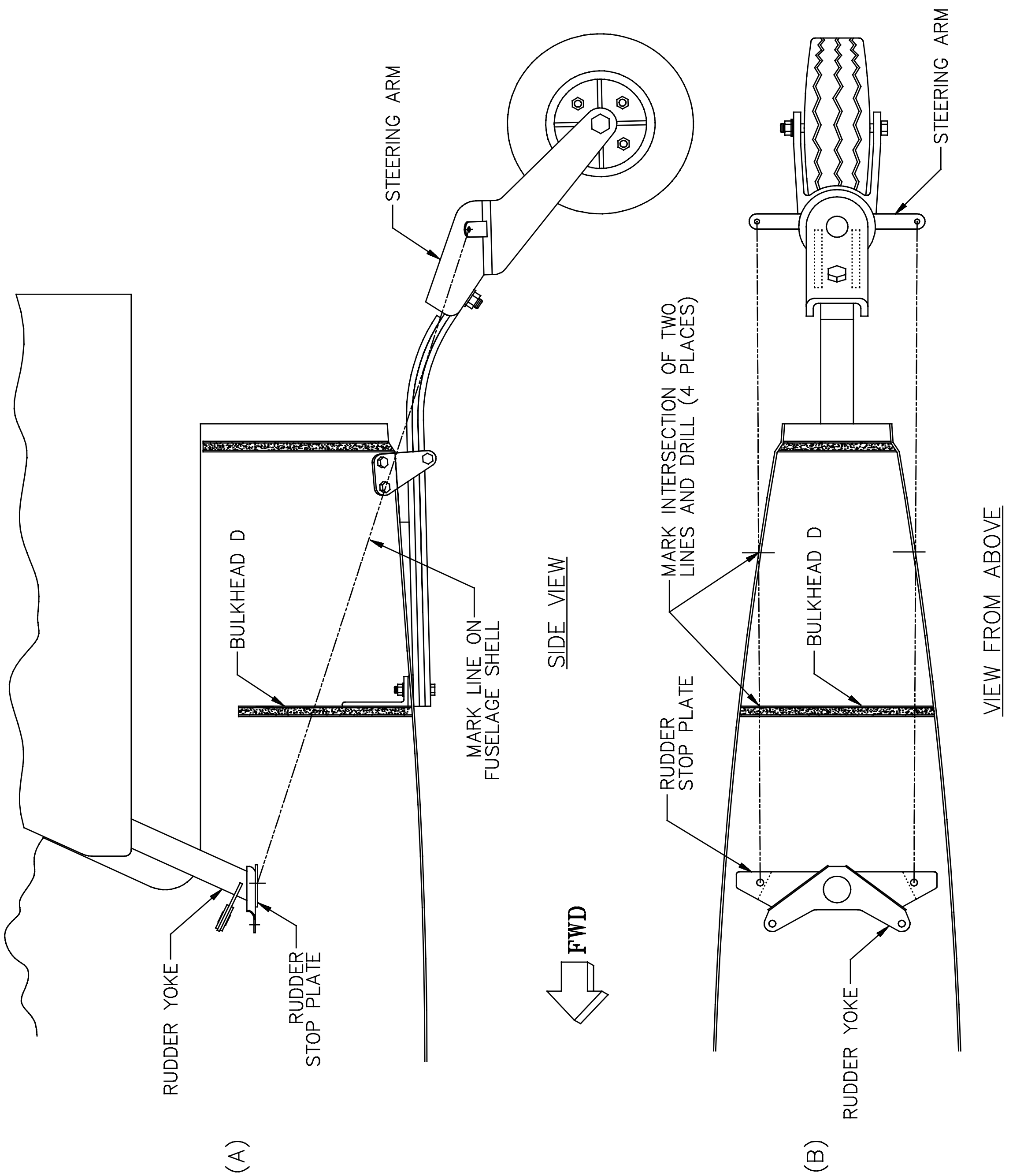


Figure 156: Locating the Tailwheel Steering Cable Holes

Begin the cable installation by sliding an NAS1435K4 **strap shackle** [249] onto the swaged end of the steering cable, as shown in the lower, left-hand corner of Figure 157. Secure this to the bushing in the rudder stop with an AN393-13 **clevis pin** [238], an AN960-10L thin washer and an AN380-2-2 **cotter pin** [237]. Then run the cable aft through the fairleads.

Your **tailwheel steering spring kit** [221] consists of three components for each side—a steering spring, a steering chain and a connector clip. Begin by cutting the supplied length of chain into two equal segments. Next, as shown in the upper portion of Figure 157, fasten the **larger** hook on the spring to the tailwheel steering arm. Attach one of the segments of chain to the other end of the spring and attach the connector clip to the free end of the chain. (The chain will be too long, but don't worry about that for now; you will adjust the tension and length in "SECTION X: FINAL ASSEMBLY.")

Note The steering chains and connector clips may look somewhat flimsy to you, but this is by design. To avoid transferring unacceptably high loads from the tailwheel to the rudder control system, it's important to have a weak link in the system that will give before more important components. The chains and clips serve this purpose.

Next, slide an AN100C-4 **thimble** [231] inside the connector clip. Slide a **NicoPress sleeve** [228] over the unswaged end of the steering cable and run the cable around the thimble and back through the NicoPress sleeve.

At this point, make sure the tail of your Sportsman down on the floor so that the tailwheel is taking the airplane's weight. In this configuration, pull the cable around the thimble tight enough to take up all the slack in the cable, but not so tight as to compress the spring, and then crimp the NicoPress sleeve.

Completed: Left [ ] Right [ ]

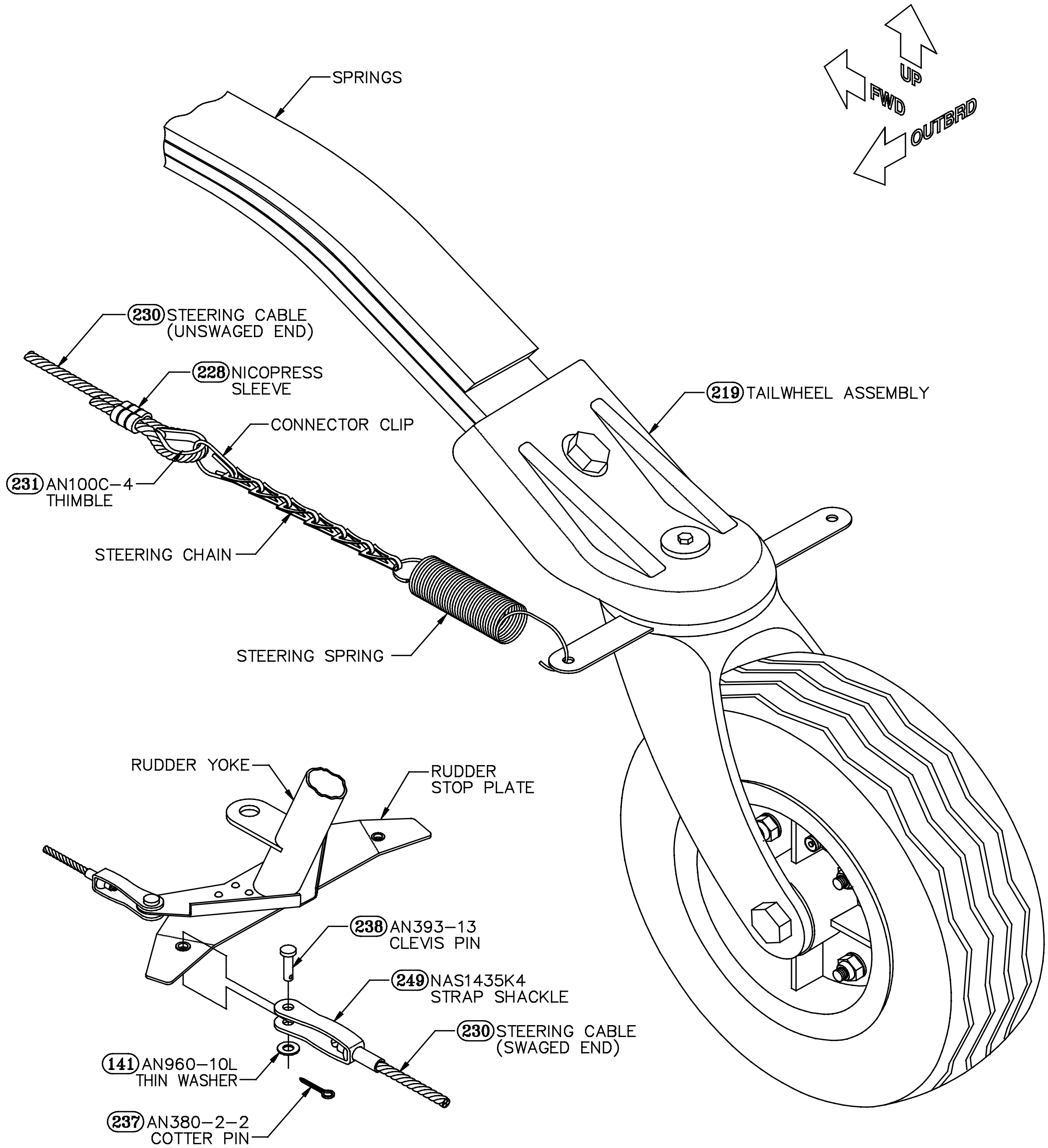


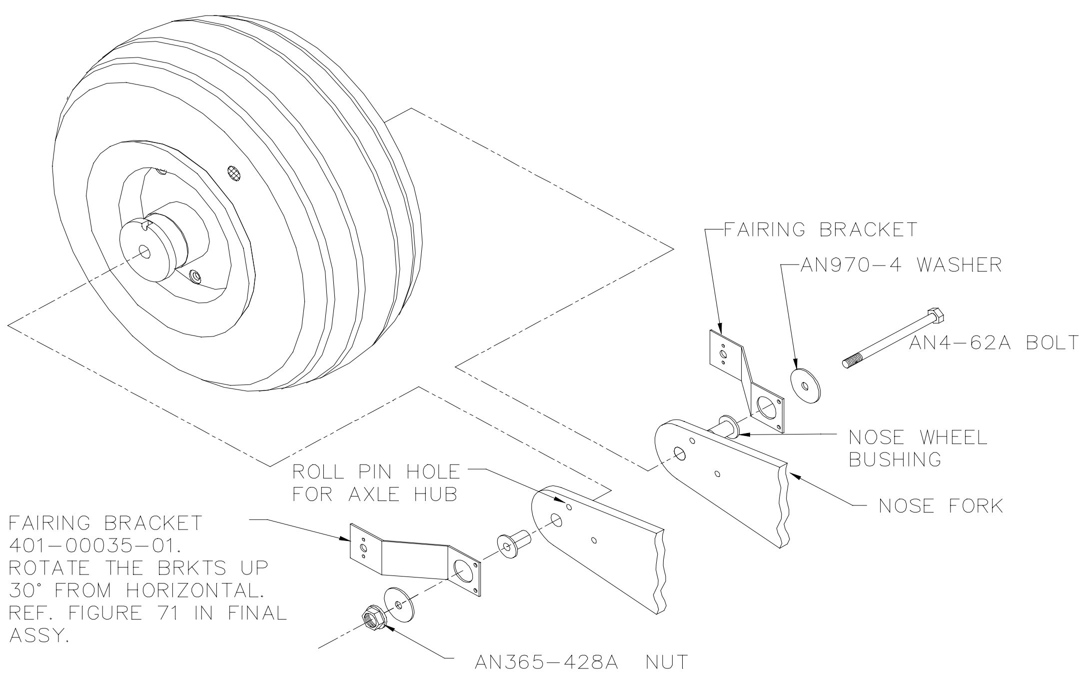
Figure 157: Installing the Steering Cables

Page 221-222: Reference to the seven degree clocking will be revised to better define what it is you are trying to achieve. The narrow two holes (identified at the one and eleven o-clock position on the brake flange) should be centered about the gear leg. Achieve this by inserting two 3/8" bolts through these holes and let the shank of the bolt center the flange about the gear leg. Keep these bolts installed during the drilling process. This applies for either the FT or TD gear. As long as you are set up for drilling, you may want to drill the cotter pin hole in the end of the axle as defined on page 232. Use a #21 drill instead of the #30 bit.

Page 272-277: [redacted]

Page 244-246: A new method will be used to install the nose wheel pant to the nose wheel fork, which has made the installation easier. This will require a longer axle bolt AN4-62A, two brackets 401-00035-01 and two AN970-4 washers. These will be included in later kits. Step 85 will be reworded to install the two brackets and larger washer. The bracket is oriented on the nose fork with the aft end up 30 degrees to horizontal per Figure 71 in Final Assembly. Drill one 1/8

diameter hole through each bracket and into the nose fork arms. Install (1) 1/8"diameter x 1/2" roll pin 450-0070-002 in each bracket. Figure 138 will be revised as follows:



Page 247: The last sentence should refer to AN960-416 steel washers, not AN960PD416.

Brake System Plumbing

Step 99: Install Fittings in the Caliper Assemblies

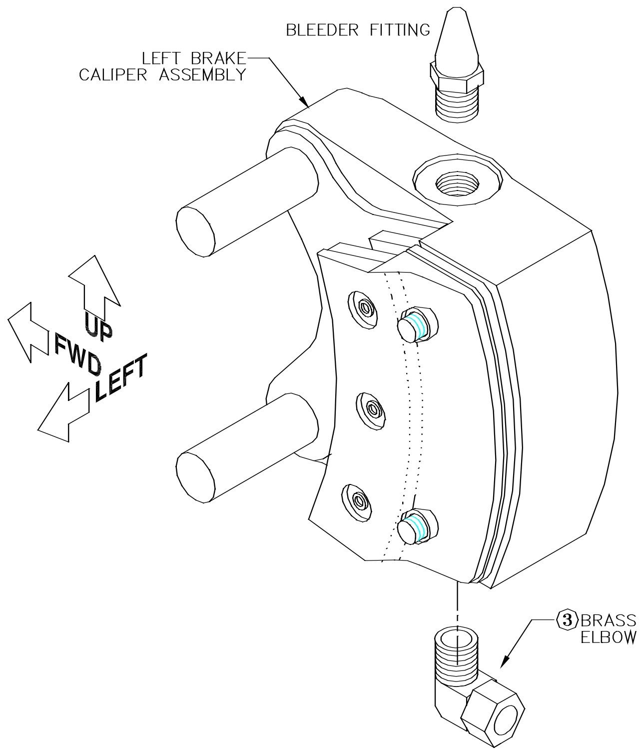


Figure 158: Installing Fittings in the Brake Caliper Assembly

You will plumb the brake system from the calipers up. As shown in Figure 158, you need to install a **brass elbow** [3] in the lower port and a bleeder fitting in the lower port of each caliper assembly. The bleeder fittings come with the calipers, and in fact on one side, the fitting will already be installed in the upper port. On the opposite caliper, however, you will find the bleeder fitting in the lower port and a plastic plug in the upper. Remove the plug and swap the bleeder fitting into the upper port. Then install an elbow in the lower port. Thread the elbow in several turns, stopping with the elbow pointing aft, as shown in the figure.

Then remove the plastic plug from the other caliper and install an elbow there in the same fashion.

Note Use of a thread sealant is recommended for all metal-to-metal fitting connections in the brake system.

Completed: Left [ ] Right [ ]

Step 100: Install Fittings in the Master Cylinders

Remove the plastic plugs from the upper and lower ports of each master cylinder and replace them with brass elbows, as shown in Figure 159. When installed, both elbows should point downward and slightly forward.

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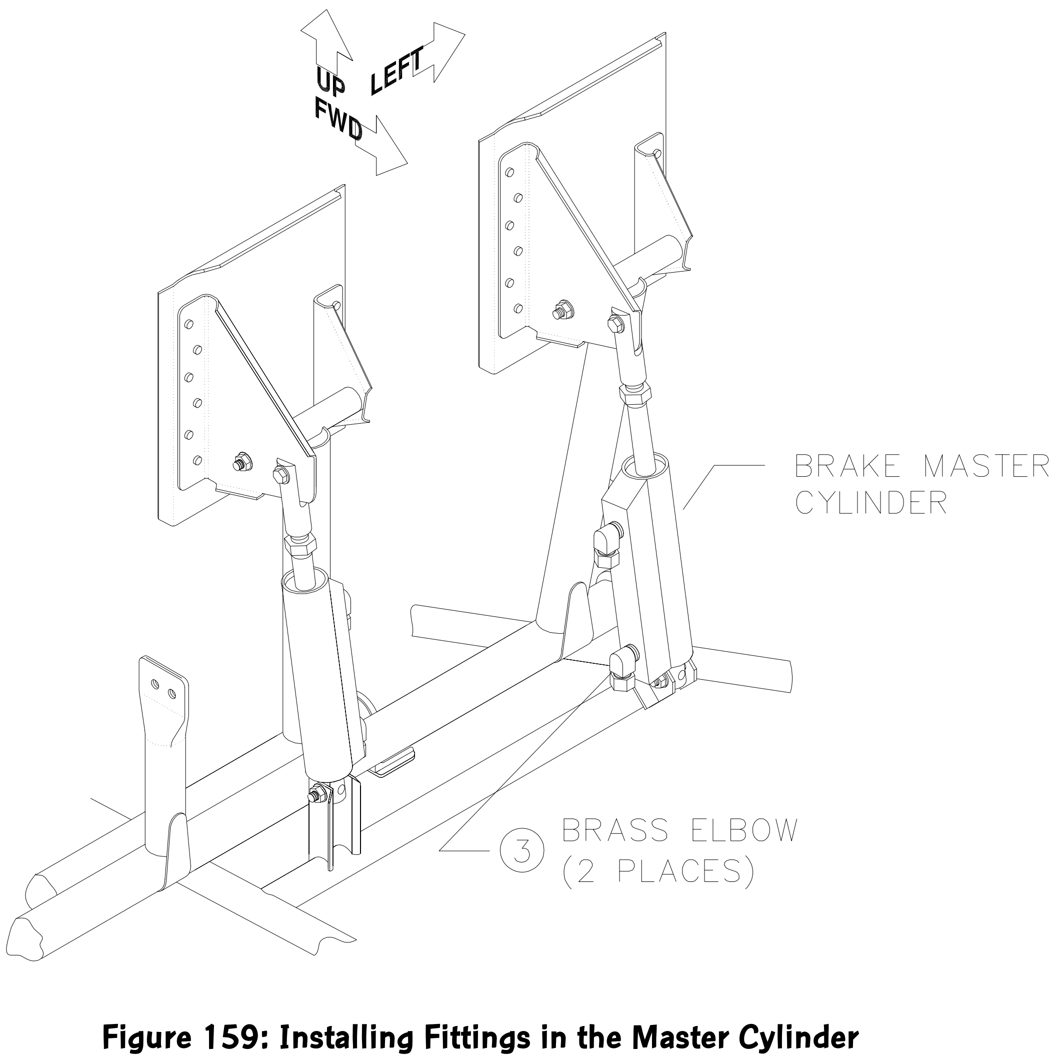

Figure 159: Installing Fittings in the Master Cylinder

Step 101: Route the Brake Lines from the Calipers to the Master Cylinders

Dual Brake Option If you are installing copilot-side brakes, **turn to the *Option Instructions* now**. These pedals should be a mirror image of Figure 159.

The routing of the 3/16" nylon tubing brake lines varies depending on whether you're building a tricycle-geared or taildragger Sportsman, as well as which side your master cylinders are on. In any case, the lines should run from the elbow on the **left** caliper to the **lower** elbow on the **left** master cylinder and from the elbow on the **right** caliper to the **lower** elbow on the **right** master cylinder.

Begin by making the connections shown in Figure 160 at the bottom end of each line. For each side, cut a piece of blue **5/8" rubber tubing** [15] about **6"** long. Slip this over the end of the brake line. This tubing prevents the brake line from chafing against the gear leg fairings and wheel pants that you'll install later and prevents damage from rocks and other debris encountered in ground operations. Remove the nut from the elbow on the caliper and slide it over the end of the nylon tubing. Seat the tubing end in the elbow and tighten the nut over it, crimping the fitting's internal ferrule over the tubing. Finally, slide the outer rubber tubing down tightly against the elbow nut.

Just **aft** of where the gear leg enters the fuselage, grind or drill a **1/2"** pass-through hole for the tubing. The hole should be drilled to this larger-than-necessary size so that you can pot the tubing in place with RTV to prevent the fuselage shell from chafing on the tubing. (Because the oversized hole is big enough for the nut from the elbow at the caliper, it also allows the brake lines to be rerouted more easily if you should ever change gear configurations.) Use a liberal amount of sealer; any excess on the outside of the shell will be covered by the gear leg fairings.

At the upper end of each line, connect it to the master cylinder elbow in the same way as at the lower end. No anti-chafe tubing is needed at the master cylinders, but be sure you leave enough slack in the line as it enters the cylinder to allow it to flex as the rudder pedals are operated.

Secure the brake lines to the gear legs and the cage structure with the supplied 4" cable ties every six or eight inches and avoid making tight bends that might cause the tubing to kink. Also, avoid bundling the brake lines with electrical wiring.

Hint On the Sportsman prototype, we imbedded the brake line inside a laminated composite fairing that is bonded to the gear. If you intend to do the same, you may wish to jump ahead to the Gear Fairing Installation section in the Final Assembly manual.

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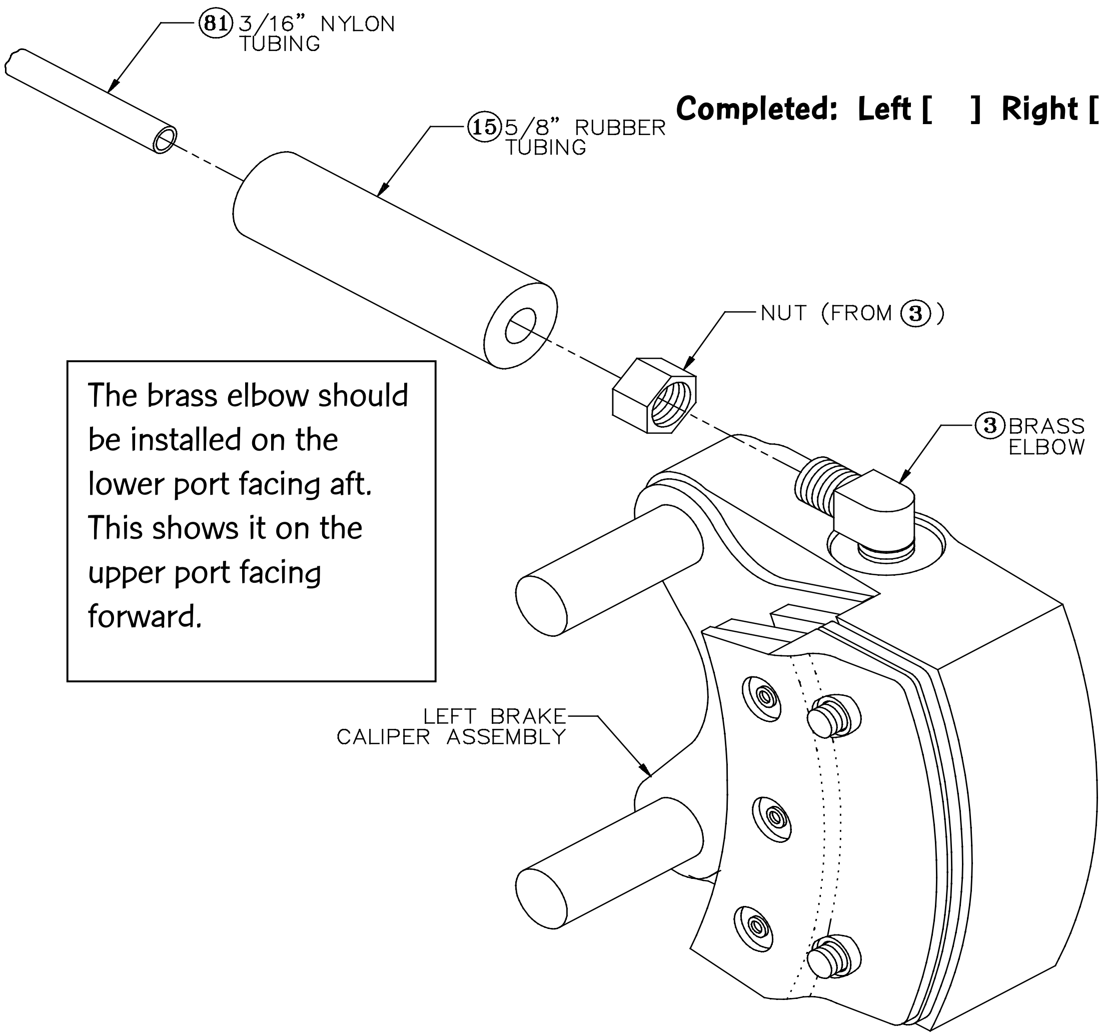

The brass elbow should be installed on the lower port facing aft. This shows it on the upper port facing forward.

Figure 160: Connecting the Brake Line to the Caliper

Step 102: Route the Brake Lines from the Master Cylinders to the Reservoir

Figure 161 shows schematically the connections to be made between the master cylinders and the **brake reservoir** [19]. From the upper elbows in the master cylinders, lines must be run to join at the **brass union tee** [269]. Depending on your preference, this tee can be installed down low, fairly near one or the other of the master cylinders, or up high, close beneath the reservoir. The tee can also be oriented in any direction you find convenient. The orientation depicted in Figure 161 is handy if you want to mount your reservoir offset to one side, but an inverted orientation (┴) might be better if you'll be mounting your reservoir centered above the rudder pedals. Consideration should be made for ease of inspection.

The brake reservoir will be mounted on the firewall, and for this reason, it can't be installed until "SECTION X: FINAL ASSEMBLY." As the preceding paragraph implies, there is a good deal of flexibility in its exact side-to-side placement. However, as Figure 161 indicates, the bottom of the reservoir should be about **19"** above the fuselage floor when installed. Cut your tubing to length accordingly. Install the tee on the ends of the tubing from the master cylinders and secure it to the airframe. Then install the tubing between the tee and the **brass union** [273] fitting, but don't yet secure this run to the airframe.

You can then either screw the union into the bottom of the reservoir and tape the whole assembly out of the way for the time being, or you can simply put the reservoir aside for later. If you chose the latter option, however, seal the open end of the union with tape to keep foreign matter out of the brake line.

> **Note** Be sure not to over tighten the brass union fitting into the bottom of the plastic reservoir. It is easy to over-stress and crack the plastic. Using a dab of silicone sealant on the threads will help to prevent leaks.

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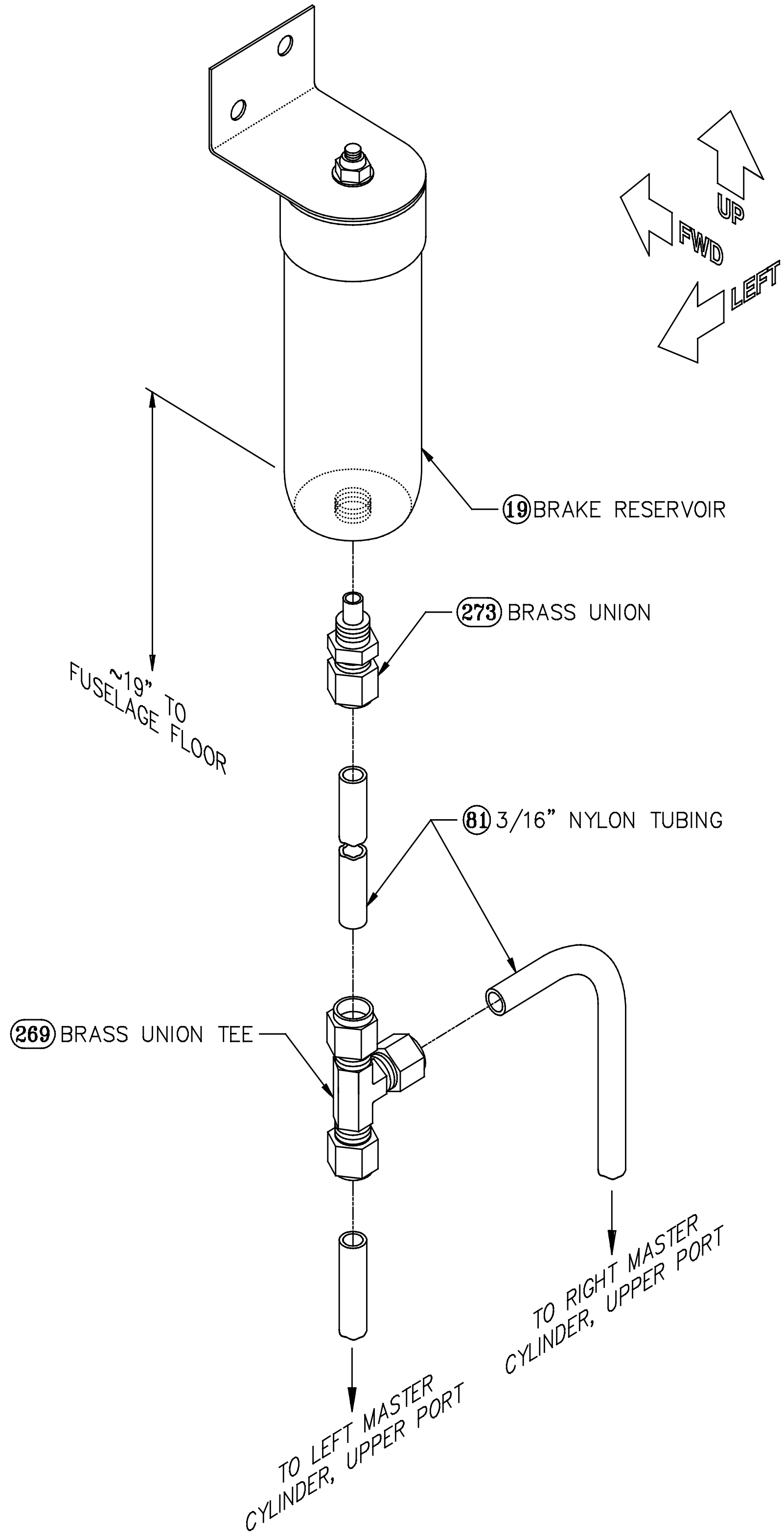
Figure 161: Connecting the Master Cylinders to the Brake Reservoir



FUSELAGE FUEL SYSTEM PLUMBING

This section describes the installation of aluminum tubing fuel lines from the area of the header tanks on the fuselage cage to a shut-off valve mounted on the center cage truss forward of the flap handle. A drain valve will be installed at the low point of the system to allow water and sediment to be purged from the fuel lines.

Clearances with control cables and fuel cables can be very tight in some places. It is recommended that you have the control cables in place BEFORE routing the fuel lines.

Note When installing the fuel system, all fuel lines must be routed so that water or sediment in the lines will flow to the drain valve at the low point in the system. This means that the fuel lines must slope continuously upward from the drain valve to the fuel tanks and to the fuel shut-off valve. Between components or fittings in the system, there must not be any intermediate low points where water or sediment could collect.

Warning Provide a minimum of **3/8"** clearance between the fuel lines and any control cables. Pull the cables tight during fuel line routing to check for clearance. In addition, we recommend protecting the fuel line from cable vibration by installing spiral wrap or an equivalent protective sleeve over the fuel line in the vicinity of the cables. Provide a minimum of **1/8"** clearance between the fuel lines and other moving parts.

Step 103: Reinforce the Drain Valve Mounting Area

The fuel system requires a drain valve at its lowest point for draining condensation from the system. The drain should be located on the fuselage floor just inboard and forward of the left-hand tricycle main gear socket. This is a more convenient location than the aircraft centerline, where fuel drains are often found on other aircraft, because it doesn't force you to reach as far under the airplane to get at the drain. (The right side would work just as well, but the following text and illustrations assume a left-side installation.)

This drain valve will be mounted on the inner laminate of the fuselage floor, but since the inner laminate is only one layer thick, an additional reinforcement laminate is required. As shown in Figure 162, this laminate should be **3" X 3"** in size. It can be laid up of **one** layer of DBM cloth **or two** layers of bi-directional cloth cut on the 45° bias.

Prep the area of the fuselage floor indicated in the figure with coarse sandpaper and an acetone wipe, and apply the reinforcement. Let it cure thoroughly.

Note All Sportsman kits delivered after 6/18/04 will have the 3" x 3" inner laminate factory installed on the left side as shown in figure 162.

Completed: [ ]

Step 104: Drill the Drain Valve Holes in the Fuselage Floor

After the reinforcement laminate has cured, use a **#40** bit to drill a pilot hole through the fuselage floor at the **center** of the reinforced area. Next, you need to drill larger holes through the inner and outer fuselage laminates, as can be seen in the installation shown in figure 163. These holes must **not** be the same size, however. First, use a piloted **11/16"** hole cutter to drill from the outside through the **outer laminate and the foam core only**, stopping **before** cutting into the inner laminate. Then use a **3/8"** bit to drill from the inside through the inner and reinforcement laminates.

After both holes have been drilled, use sandpaper to smooth the edges on both the inside and outside skins. If necessary, use an awl or a thin utility knife blade to remove clean up any foam remaining within the 11/16" cylinder under the inner laminate. Then seal the foam inside the hole with a small amount of thin-mix Q-cell and resin applied with the tip of your finger.

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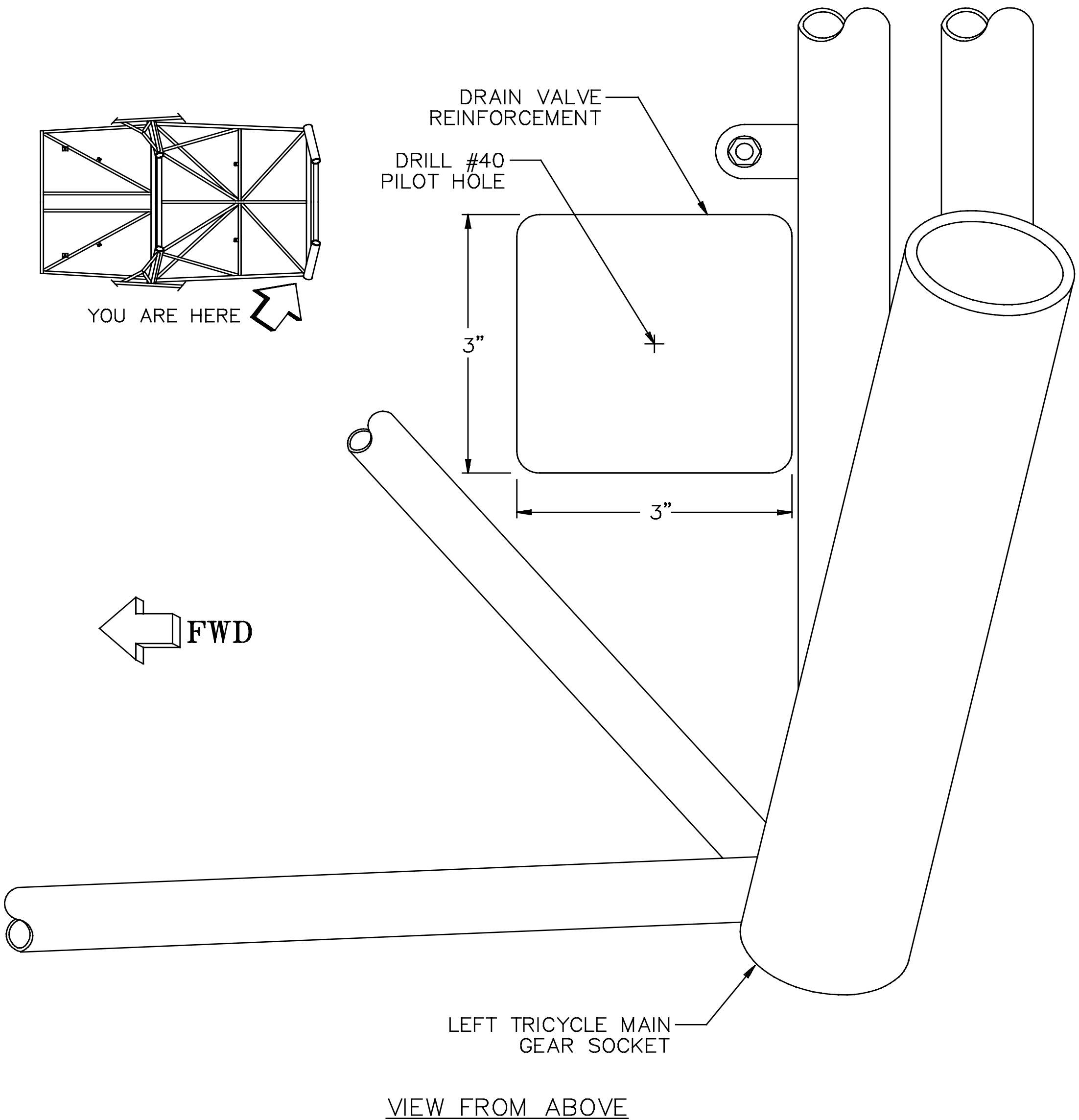


Figure 162: Drain Valve Mounting Area Reinforcement

Step 105: Install the Drain Valve

Figure 163 shows how the **drain valve** [37] is installed in the hole you just made. The larger hole through the outer laminate and the foam core allows the valve to be recessed inside the fuselage floor, keeping it almost entirely out of the slipstream. The smaller hole through the inner and reinforcement laminates serves as a mounting collar.

As the figure shows, put an **AN960D616L** thin aluminum washer [153] over the drain valve, and then insert it up through the fuselage floor. Secure it on the inside with one or more **AN960D616** aluminum washers [152] and an **AN912-1D** reducer bushing [138]. Use only one washer if you can tighten the reducer bushing down that way, but you may need to add another in order to get the fuselage laminates firmly clamped between the bushing and the valve. This is your goal.

Finally, once the bushing is tight, install a **Swagelok female branch tee** [5]. Thread the tee several turns onto the bushing, stopping when the tee is oriented perpendicular to the aircraft centerline.

> **Note** Use of a thread sealant is recommended for all metal-to-metal fitting connections in the fuel system.

Completed: Left [   ] Right [   ]

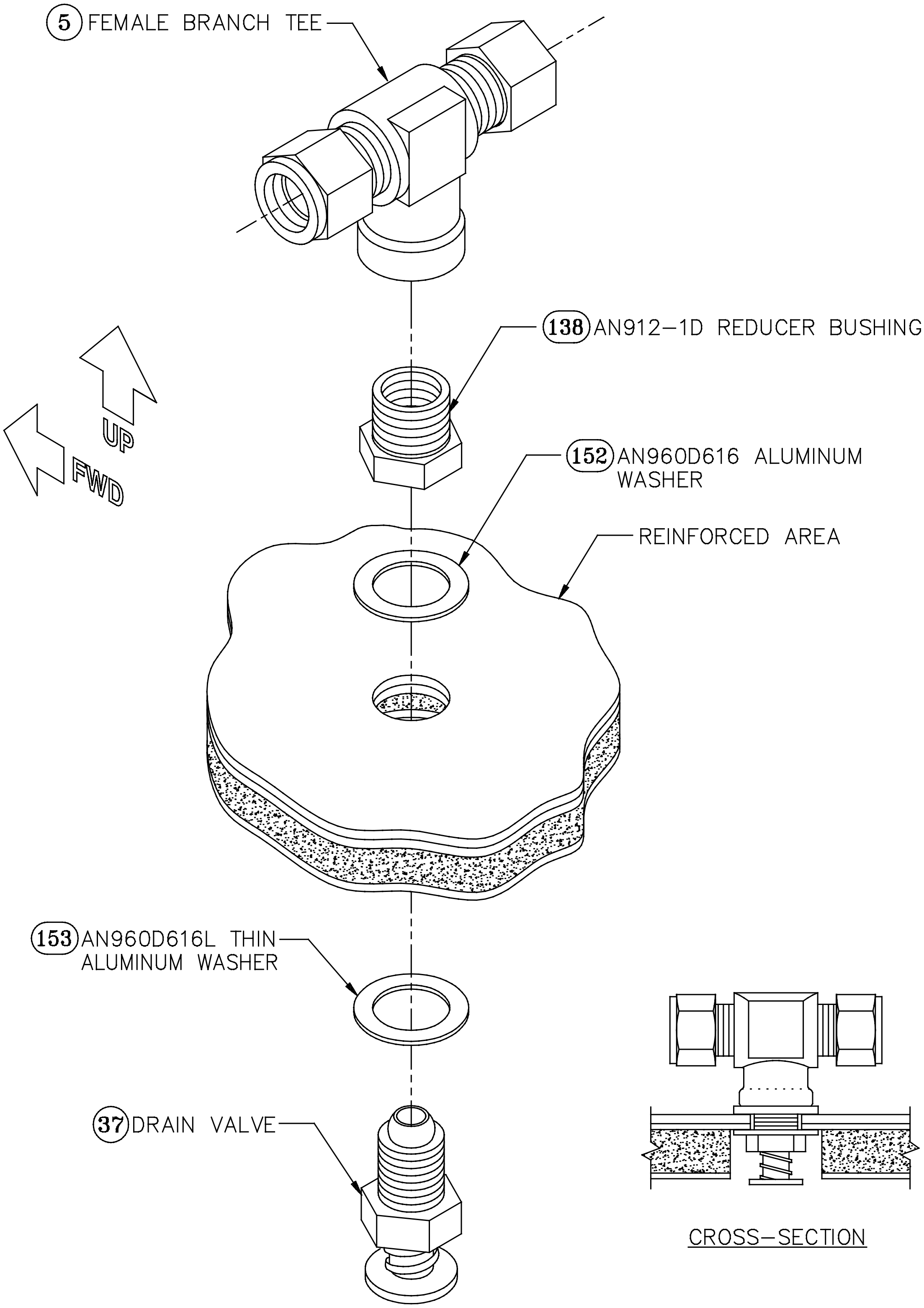


Figure 163: Installing the Drain Valve

Step 106: Mount the Header Tanks and Route the Fuel Lines From the Left Wing to the Drain Valve

Two header tanks are mounted between the fuselage shells and the cage on the vertical truss just aft of the pilot and copilot. The tanks are secured to the cage using Adel clamps. Each tank is vented back to the main tank.

The installation is slightly different for the left and right sides. The left side is routed down to the fuel drain valve tee whereas the right side is routed first to a Swagelock union tee near the center of the cage before being routed to the drain valve tee. The left side installation is also tighter due to the pilot door latch and the baggage door hinge. **It is recommended that you have the cabin door latches and the baggage door hinges in place before performing this installation.** Make sure you read this entire section completely before beginning.

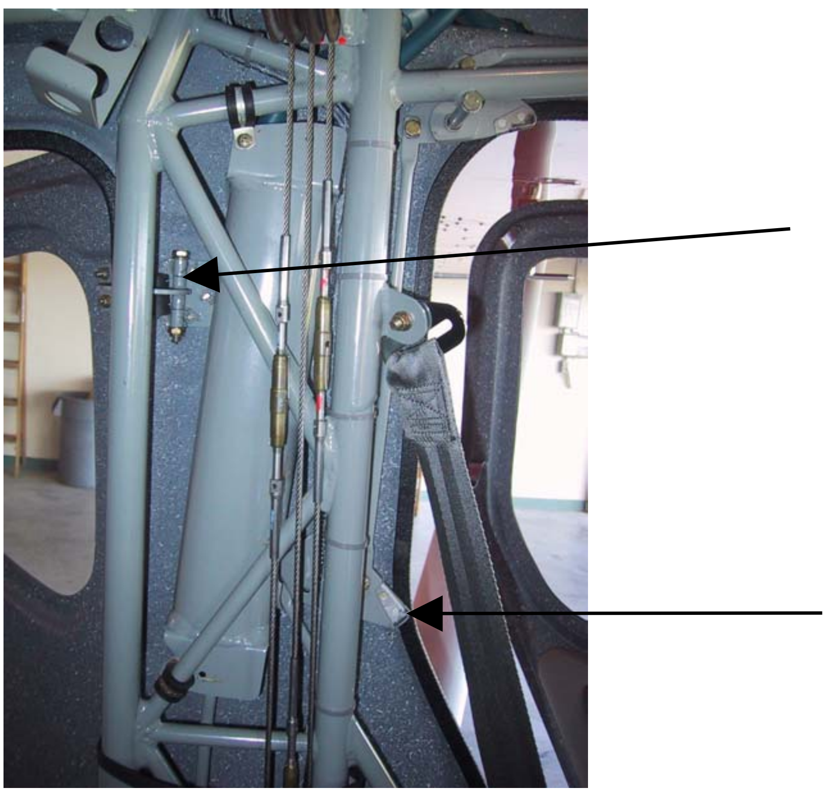


Figure 164: Left Header Tank Installation

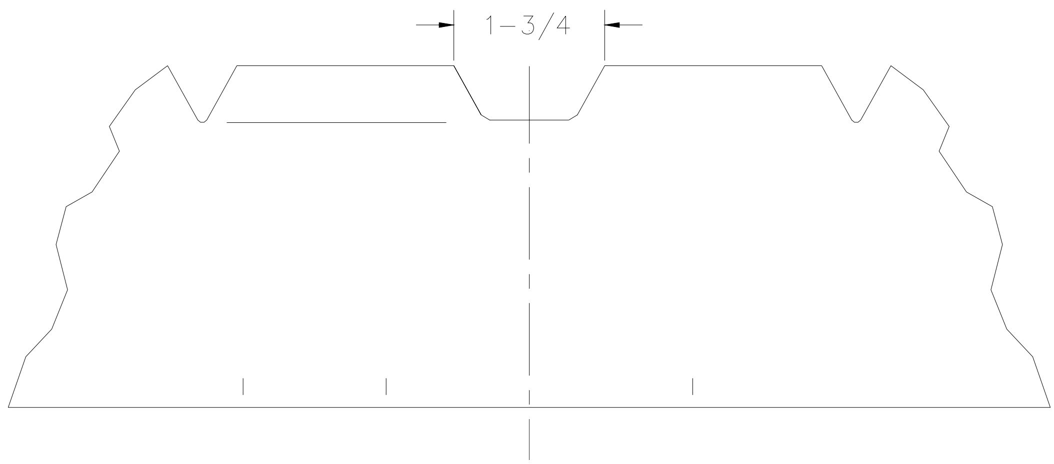
Page 285: [redacted]

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33, the following options will be added/revised in the options table.:

Sportsman Option	Part Number
Induction System, O-360	**922-07050-01 ~~922-07000-01~~**
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

Key No.:	Part Name:	Qty:	Part No.:
1	Connector, Male, 1/4NPT X 3/8 Tube	2	033-00004-01
2	Hose, Rubber, 3/8ID X 5/8OD	3.0 ft	083-00001-01
3	Hose, Rubber, 1/4ID X 1/2OD	3.5 ft	083-00002-01
4	Clamp, Hose, SS, 7/32-5/8	4	450-0190-004
5	Header Tank Assembly, GS, LH	1	510-01200-01
6	Header Tank Assembly, GS, LR	1	510-01200-02
7	Nut, Self-Locking, Tension, 10-32	6	AN365-1032A
8	Elbow, 45°, Hose, Al, 1/4ID X 1/8 NPT	2	AN844-4D
9	Washer, Thin Steel, #10	12	AN960-10L
10	Clamp, Cushion, 1/2"	6	MS21919DG8
11	Screw, Pan-Head, #10 X 5/8	6	NAS603-10P

The above parts list applies to the parts for the header tank installation.

Prior to **installation**, prep and paint the **header tanks** [5 & 6] as desired. PPG DP50LF Epoxy Primer is what was used as a base-coat under the Zolatone. Temporarily thread the **Swagelok fitting** [1] in the outlet port of the header tank, and tighten it finger tight.

Hold the left-hand **header tank** [5] up against the outside surface of the vertical truss, so that the upper forward edge of the tank sits about 1" behind the aft edge of the Main Door Post Tube and the lower edge of the tanks sits about 1" forward of the aft tube on the truss as shown in Figure 164. The mounting flanges on the tank go against the cage, with the large diameter inlet on the aft side. This is the intended location of the tank, but you can trim the mounting flanges and drill new holes if you desire to mount it differently then as shown.

All the fuselage fuel lines are made of **3/8" aluminum tubing** [79]. However, to accommodate the Sportsman's wing-fold feature, short segments of 5/8" rubber tubing are used at the wing roots to connect the fuel tanks to the header tanks. In this step, you will cut and bend a segment of aluminum tubing to go from the bottom of the header tank to the outboard boss of the drain valve tee. Cut the lines about 10" below the aft spar pivot bracket for now, so they are slightly higher than the bottom of the header tank. This will leave excess for trimming later, but make forming easier for now.

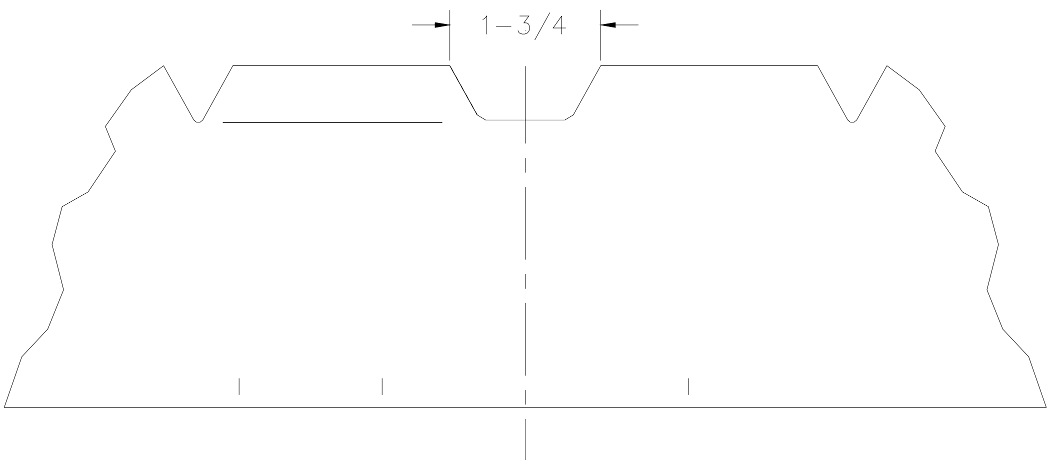
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: [redacted]

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33, the following options will be added/revised in the options table.:

Sportsman Option	Part Number
Induction System, O-360	**922-07050-01 ~~922-07000-01~~**
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

Starting at the drain valve, bend and rout the line up to pass underneath the flap cables and thru the cage as shown in Figure 165. Using a Sharpie, mark the fuel line exactly even with the bottom of the Swagelok fitting assembly. Measure up from this mark 11/16" and make second mark to cut by.

Remove the header tank from the frame at this point, in order to gain clearer access to the fuel line and **Trim the fuel line at this upper mark**. If necessary, remove the line from the airplane to make the cut.

Once this cut has been made, deburr and square the end. Remove the Swagelok assembly from the tank and the drain valve and install it on the fuel line per the Swagelok instructions in the manual. Install the fuel line in the aircraft and, using thread sealant, install and torque the fittings.

Figure 165: Routing the Fuel Line Below the Header Tank

Note The fuel line must also be routed to clear the seat tracks. Refer to "SECTION X: FINAL ASSEMBLY" to see where the seat tracks go.

Warning Provide a minimum of **3/8"** clearance between the fuel line and all control cables. Pull the cables tight to check for clearance.

Note Bending and fitting the tubing, in this run and those that follow, is a trial-and-error process, more art than science. Just remember to keep your bend radii as large as practical, and try to avoid overbending—that is bending beyond the required angle and then having to bend the tubing back again. Use of a tubing bender is **highly** recommended; successful hand bending is extremely difficult with this size tubing.

Hint Try using 1/8" aluminum welding rod to make a three-dimensional "template" of the fuel line to determine the optimum routing and the best positions of the tubing bends. Also, you may find it easiest to slide the tubing in from above through the quarter window or baggage door opening while trial fitting it.

Hint For better vibration resistance, we recommend standing the fuel line tubing off from the cage tubes rather than securing it directly to them. A good method for accomplishing this is to run the loose end of a cable tie through a **1/2"**-long piece of nylon tubing left over from the brake or pitot lines, then around the fuel line, back through the nylon tubing, and finally around the cage tube. Figure 166 illustrates this technique. **Caution: Make sure the attachment is rigid and will not move, rub or interfere with any moving parts.**

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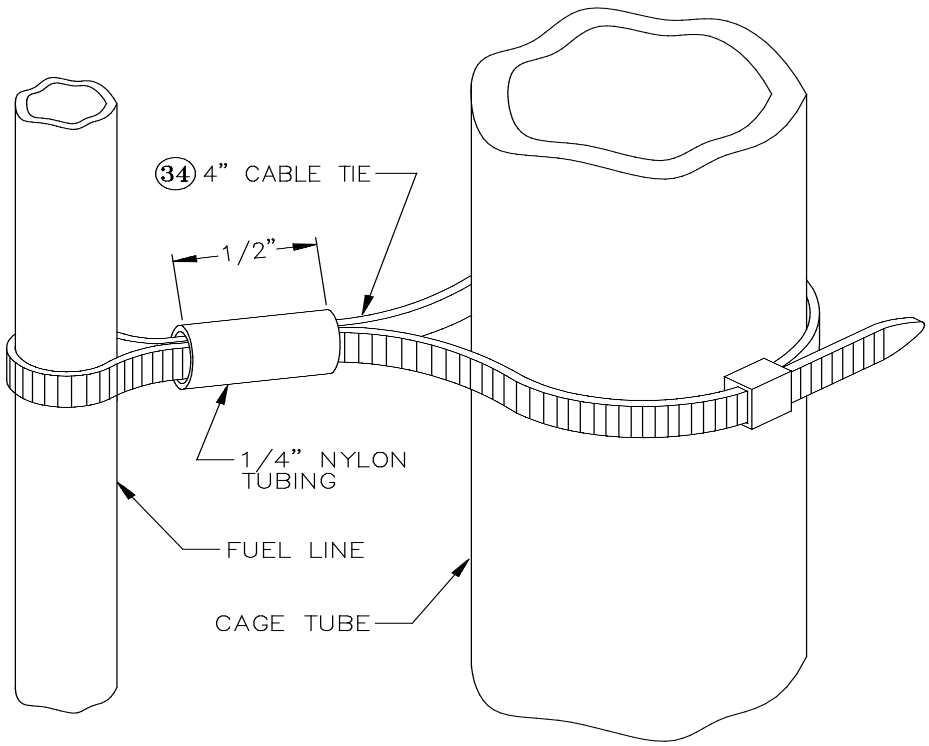

Figure 166: Method for Standing Fuel Lines Off from Cage Tubes. Make sure the fuel line connection is rigid and cannot move and rub against any moving parts.

Step 107: Route the Fuel Line from the Right Wing to the Drain Valve

The line from the right wing is routed just as the left one was, except that rather than running directly to the drain valve tee, the right-hand line first runs to a Swagelok **union tee** [4] at the center of the aircraft just above the fairlead cluster on the tricycle main gear truss, from which lines run across and down to the drain valve tee and forward and up to the **fuel shut-off valve** [6]. Figure 167 illustrates the location and function of this union tee. Additionally, there is no need to "tilt" the header tank in order to miss the aft baggage door hinge as was done on the left side.

Note When properly installed, the forward port of the union tee must angle slightly upward so that the fuel line can slope continuously upward to the fuel shut-off valve (described in the next step) from the drain valve. Otherwise, a local low spot would exist in the line forward of the tee where water or sediment could collect.

Cut, bend, connect and secure the line from the wing root to the union tee just as you did before. This run will require approximately **46"** of tubing

Finally, bend and install a length of tubing between the left-hand port of the union tee and the inboard port of the drain valve tee.

Completed: [ ]

Step 108: Route the Fuel Line from the Union Tee to the Shut-Off Valve

From the union tee, the fuel line must be routed forward along the left side of the central longitudinal cage truss to the fuel shut-off valve. As Figure 167 shows, the tubing coming out of the tee must be bent slightly to the left in order to remain within 1/4" clear of the flap handle. It must not be bent so far to the left, however, as to interfere with the installation of the seat pans in "SECTION X: FINAL ASSEMBLY." Besides avoiding interference with other components, the most important goal in routing the fuel line is to slope it continuously upward from the union tee to the shut-off valve.

Manual Trim or Electric Trim Option The position of the fuel shut off valve as shown in Figure 175 is positioned for the manual trim installation. Figure 169 shows the valve installed at the suggested position for the electric trim option, but you have much more freedom with the electric trim than what is shown. In any case, start considering how **you** plan to finish (detail) the interior covers for this forward truss now. The Final Assembly Manual covers this in some detail in Step 15.

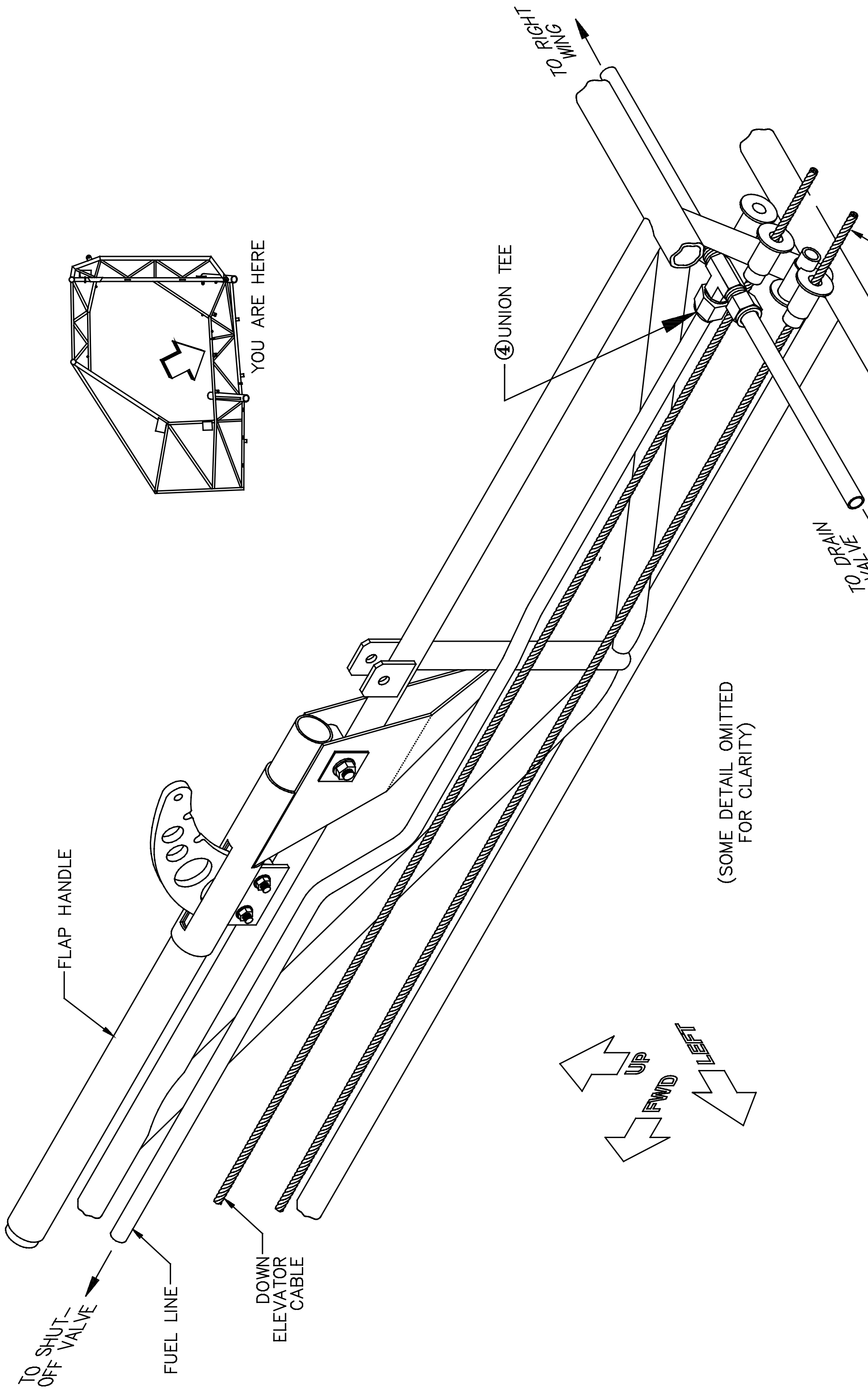

Figure 167: Placement of the Union Tee and Routing of the Fuel Line Around the Flap Handle

Figure 175 shows the suggested location of the shut off for **manual trim installations**. Figure 168 shows the suggested location of the shut-off valve for the **electric trim option**, centered in the space between the cage tubes of the center truss forward of the main cross-tube between the taildragger gear sockets. In either case, use the side view as shown in Figure 168 to set the height of the valve relative to the cage.

Note This space is a bit tight. Before you secure the valve permanently, be sure to check that the handle clears the cage tubes when it is in its OFF as well as its ON position.

Warning If you install the valve between straight sections of tubing and secure these lengths of tubing directly to the cage tubes, as shown in Figure 168, the valve handle will barely protrude above the cage truss. Do **not** raise the valve any higher than this. To do so raises the risk of closing the valve inadvertently in flight by snagging the handle on loose clothing, headphone leads, etc. When you install a metal cover over the cage truss in this area in "SECTION X: FINAL ASSEMBLY," you'll provide a cutout to give convenient access to the valve.

The total length of tubing required for the run from the union tee to the shut-off valve will vary a bit depending on the exact positioning of the valve and how you bend the tubing around the flap handle, but figure in the neighborhood of **39"**.

Note The ends of the valve are **not** interchangeable. Make sure that the arrow engraved on the side of the valve housing points forward.

The fuel line from the shut-off valve forward to the firewall should not be installed until the firewall itself is fabricated and installed in "SECTION X: FINAL ASSEMBLY."

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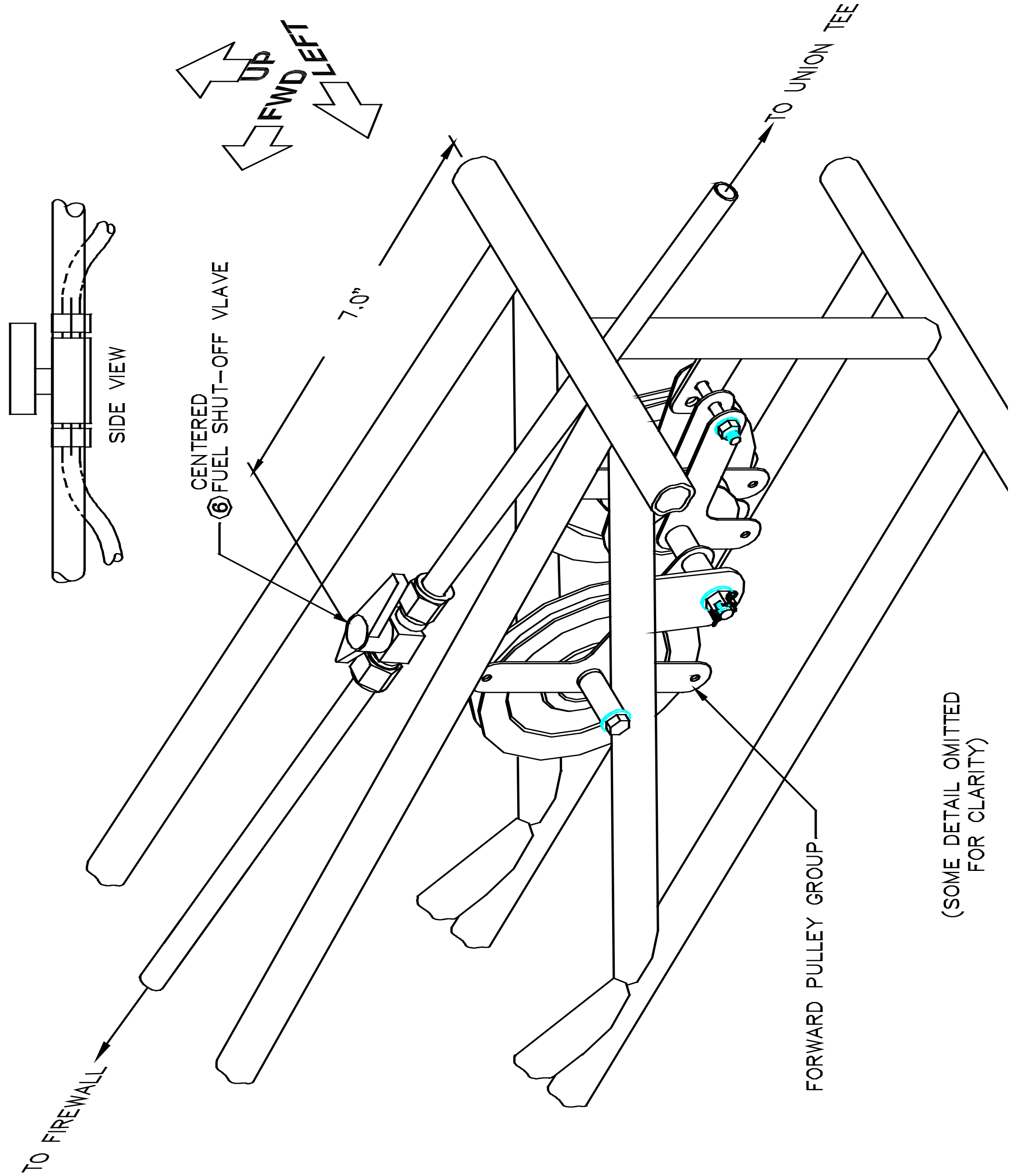

Figure:168: Suggested Placement of the Fuel Shut-off Valve for the Electric Trim Option

MANUAL ELEVATOR TRIM SYSTEM INSTALLATION (OPTIONAL)

Electric Trim Option If you're installing an electric trim system, **skip to Step 115**.

Step 109: Drill Trim Cable Holes in the Bulkheads (Manual Trim Only)

The manual trim system activates the trim tab via a sheathed, push-pull cable. This cable runs from the elevator forward to a gear box mounted on the cage truss forward of the flap handle. In order to minimize slop in the cable, it's essential that the sheath be firmly secured to the airframe along its entire length, which in practice means that the cable must be routed along the fuselage floor and sidewall. Therefore, the cable can't pass through the large, center cutouts in Bulkheads A, B and C; you need to provide small pass-through holes near the fuselage shell instead.

Figure 170 shows where the **9/16"** hole in Bulkhead A should be drilled. Its location isn't really critical, but keep it as close to the fuselage floor as possible. These holes were marked on the bulkhead templates.

Figure 170: Drilling the Trim Cable Hole in Bulkhead A

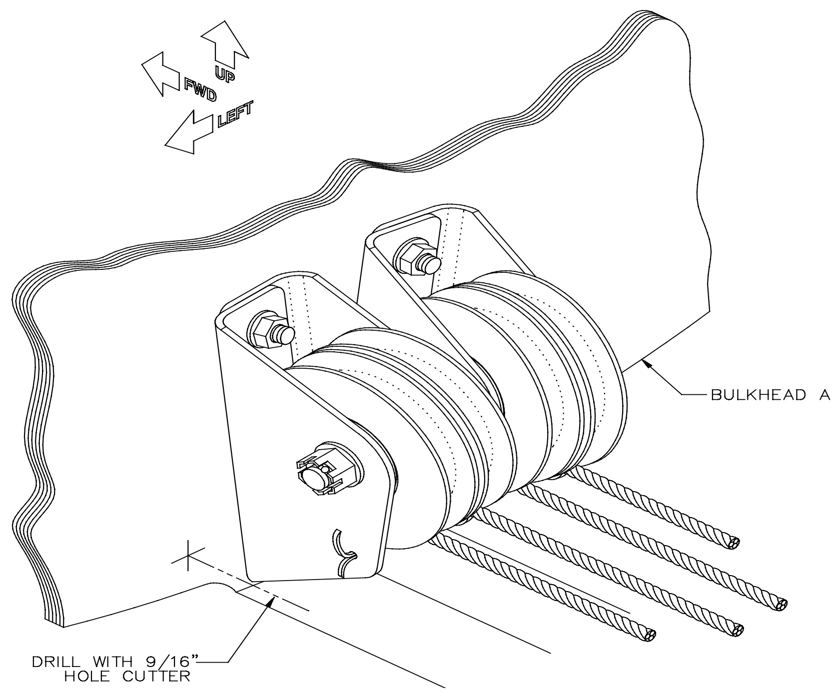

Figure 171 shows the location of the **9/16"** hole through Bulkhead B. Keep this hole as close to the fuselage sidewall as possible. And, yes, we're afraid drilling this hole **does** require crawling back into the aft fuselage!

Finally, the Bulkhead C hole location is shown in Figure 172. Again, this hole doesn't need to be located with any great precision. Fortunately, it can easily be drilled from outside the airplane! Use a **5/8"** bit. After drilling, insert a **snap bushing** [250] into the hole from the aft side. This will provide anti-chafe protection to the cable sheath.

Note Figures 170, 171 and 172 show the cable holes on the left-hand side of the fuselage, but this is entirely arbitrary, as the cable can be run along the right-hand side with identical results. Just be sure to drill all the holes on the same side!

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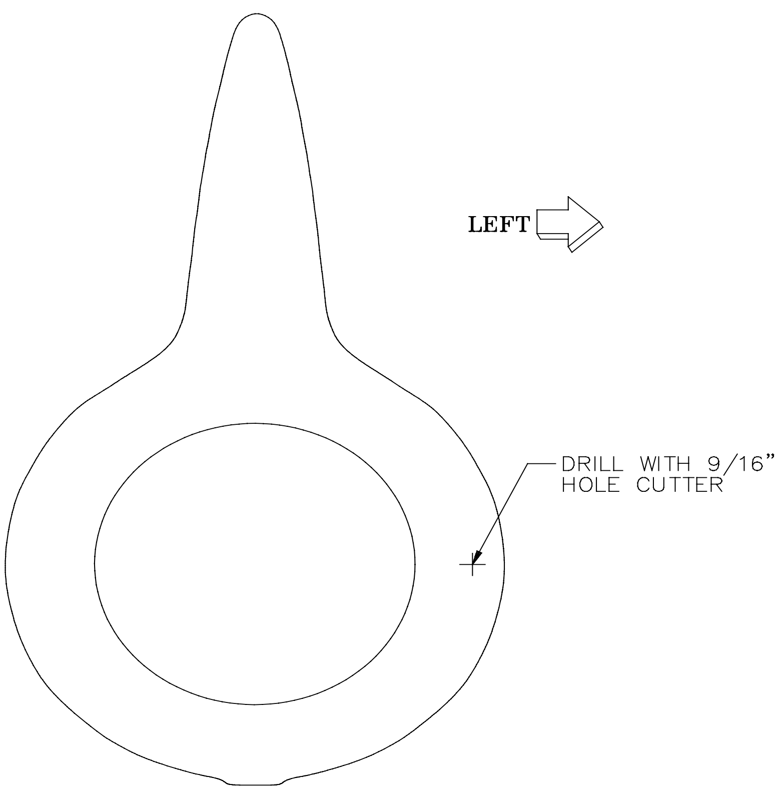

Figure 171: Drilling the Trim Cable Hole in Bulkhead B

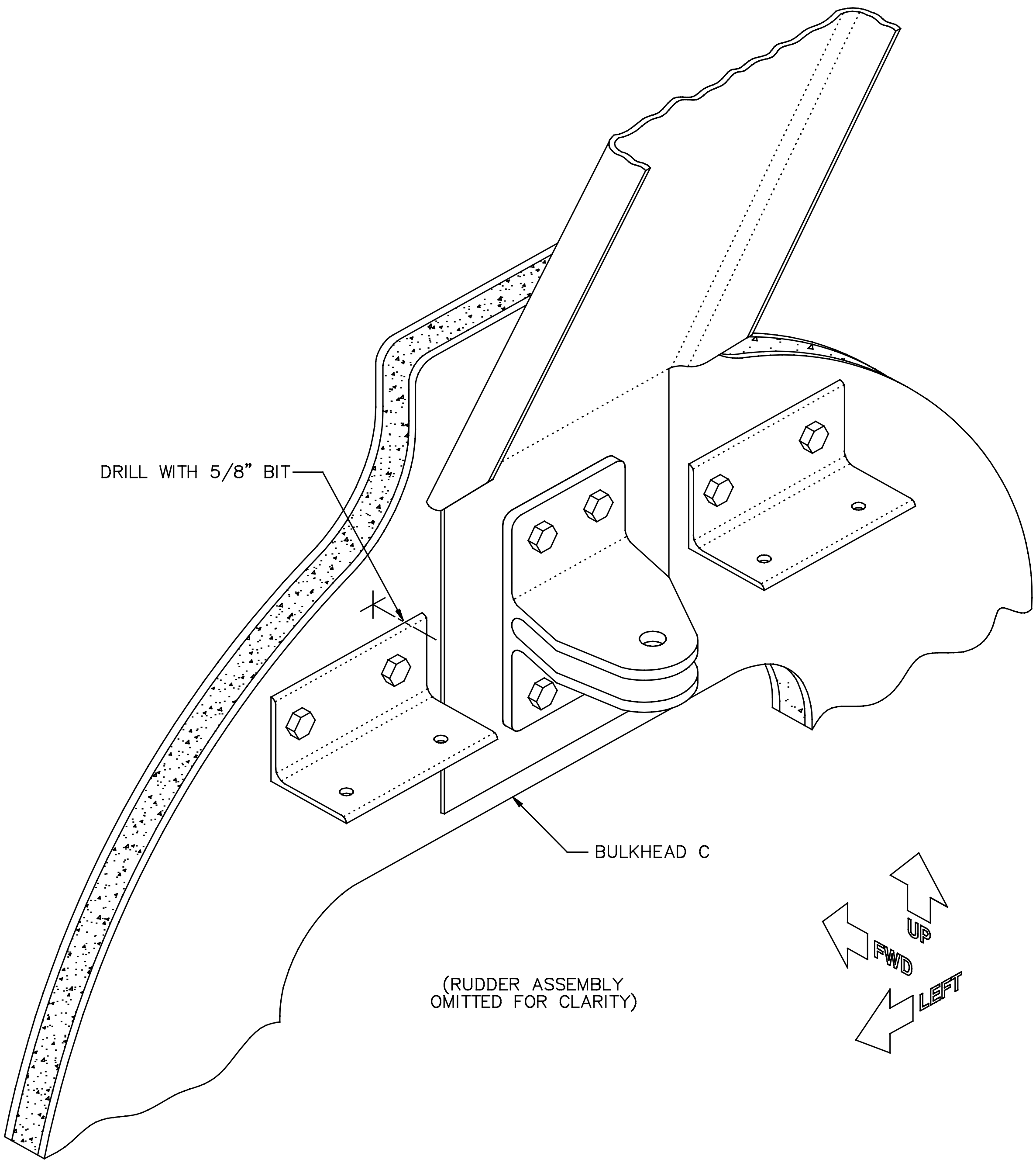

Figure 172: Drilling the Trim Cable Hole Through Bulkhead C

Step 110: Route the Trim Cable Through the Fuselage (Manual Trim Only)

Now it's time to route the **trim cable** [258] through the fuselage. Begin at the tail and feed the forward end of the cable through the hole in Bulkhead C. Have your assistant fish the cable through the holes in Bulkheads B and A, and then pull it forward to the cabin area.

> **Note** The forward end of the cable is the one with the unthreaded wire protruding out of the plastic sheath and the jam nuts and washer. Remove the nuts and washer and set them aside before trying to feed the cable through the holes. The wire will also have two screw-type **cable clamps** [252] on it. Remove these and set them aside. They will be re-installed in "SECTION X: FINAL ASSEMBLY" when you adjust the cable travel.

The cable should first be secured at the elevator. Thinking way back to "SECTION V: ELEVATOR ASSEMBLY," you'll recall that you installed a trim cable bracket between the center pair of elevator ribs. You also cut a pair of slots in the upper and lower skins of the elevator to accommodate the cable. Now it's finally time to see if they work!

Install your horizontal stabilizer/elevator combo on the fuselage, if they're not already in place. Remove the two screws holding the trim cable retainer clip in place on the bottom of the elevator. Then insert the aft (threaded) end of the trim cable down through the slots in the upper and lower elevator skins. Finally, as shown in Figure 173, engage the groove near the end of the trim cable in the bracket slot, and then screw the retainer clip back in place to clamp the cable end tight.

> **Note** The 3/16"-wide groove in the trim cable is between the black plastic sleeve and the crimped metal ferrule where the plastic sheath ends.

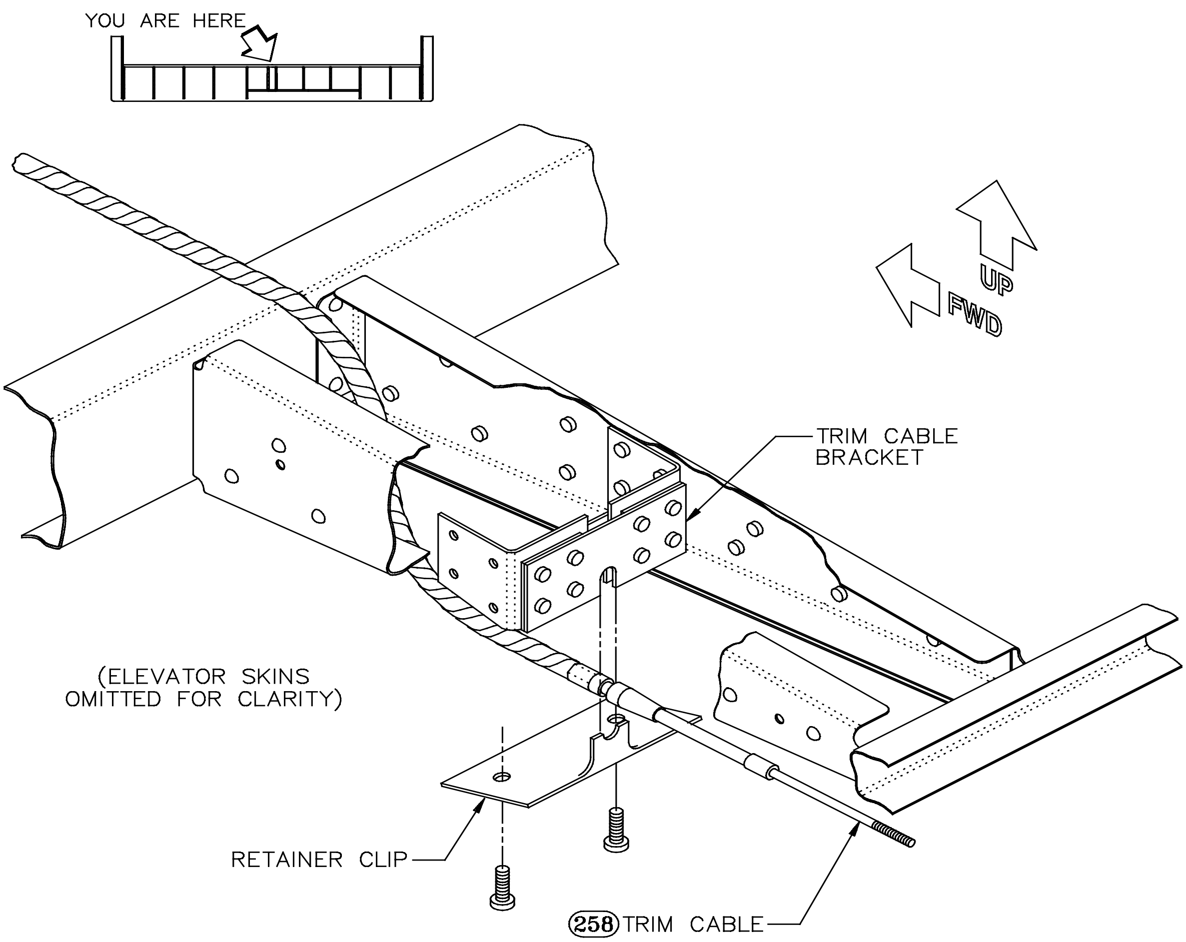

Figure 173: Engaging the Trim Cable End in the Bracket

The trim cable must remain unsecured between the elevator and Bulkhead B in order to allow free elevator movement. However, your goal is to leave as little slack as possible without interfering with free travel. Therefore, once the cable end is secured in the elevator, deflect the elevator fully downward, and then have your assistant pull the cable tight at Bulkhead B. The hole through Bulkhead B was drilled oversized to allow the cable to be potted in place with a liberal amount of RTV silicone sealer. Apply the sealer around the cable on both the forward and aft faces of the bulkhead and allow it to dry thoroughly before proceeding.

Eventually, you will also pot the cable into the hole through Bulkhead A and secure it to the fuselage floor forward and aft of Bulkhead A. However, because the cable cannot be lengthened or shortened, you must first ensure that the forward end of the cable is secured where it belongs. Once that has been accomplished, then any slack that remains can be taken up while securing the cable elsewhere.

Figures 174 and 175 illustrate the recommended routing of the cable through the cage structure. As Figure 174 shows, the cable enters the cage just to the **right** of the central vertical tube in the truss between the tricycle gear sockets. (Although the figure doesn't show this level of detail, this is the tube that bears the control cable fairleads. This routing takes the trim cable directly over the top of the right-hand pair of center flap pulleys.) From a point just forward of the union tee to the point forward of the flap handle ratchet plate where the fuel line bends upwards toward the shut-off valve, the trim cable can be bundled directly **under** the fuel line. When the fuel line begins its upward bend, the trim cable should be bundled **alongside** it on the **right-hand** side, as shown at the forward end of the figure.

Figure 175 shows that the trim cable should then pass to the **right** of the central vertical tube in the truss between the taildragger gear sockets, alongside the fuel shut-off valve, and then up through the aft corner of the second triangular space between the tubes of the center truss.

Don't secure the cable to any of the cage structure yet, but make sure that you have it routed as shown in the figures and described above before moving on to the next step.

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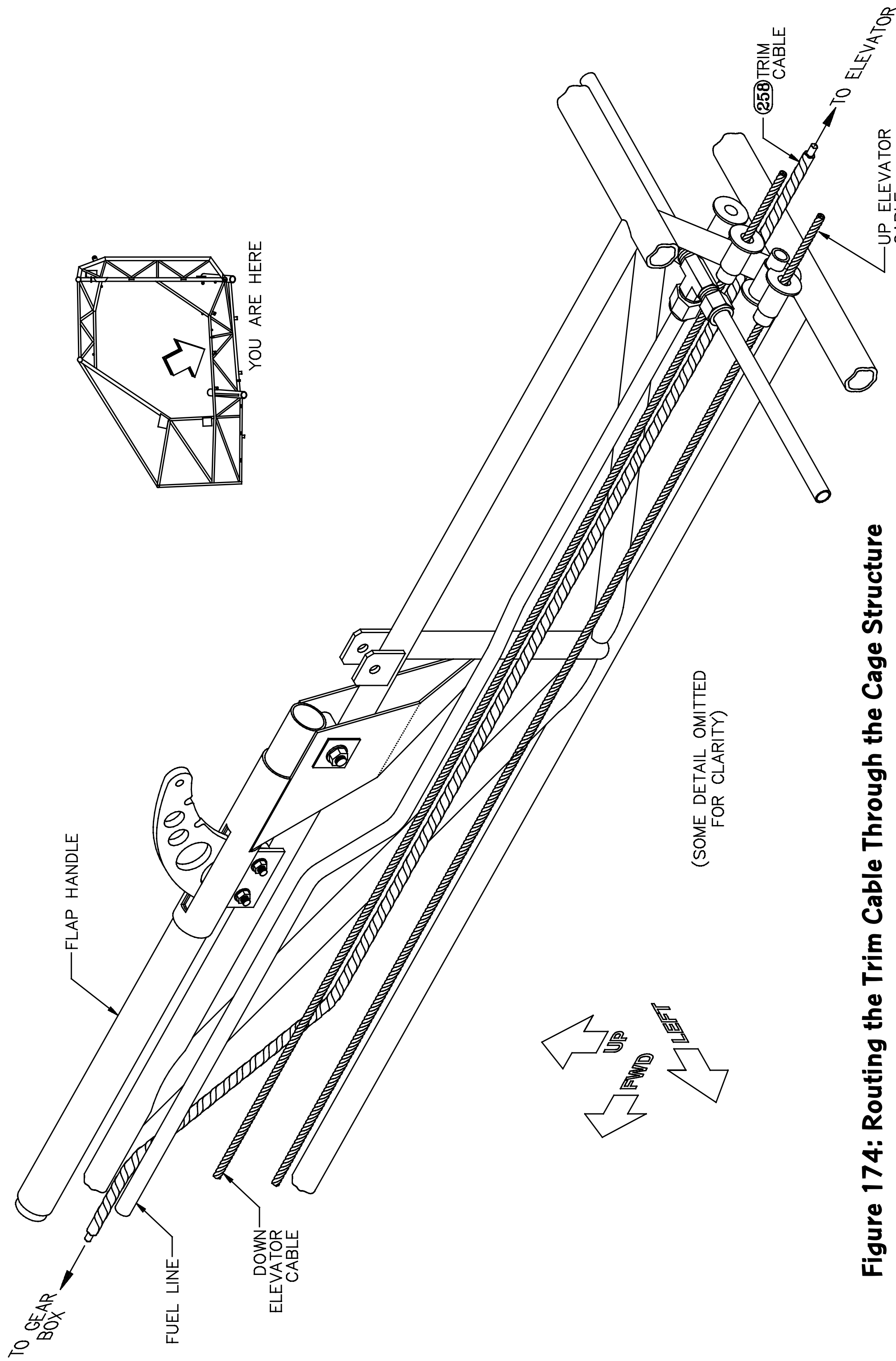

Figure 174: Routing the Trim Cable Through the Cage Structure

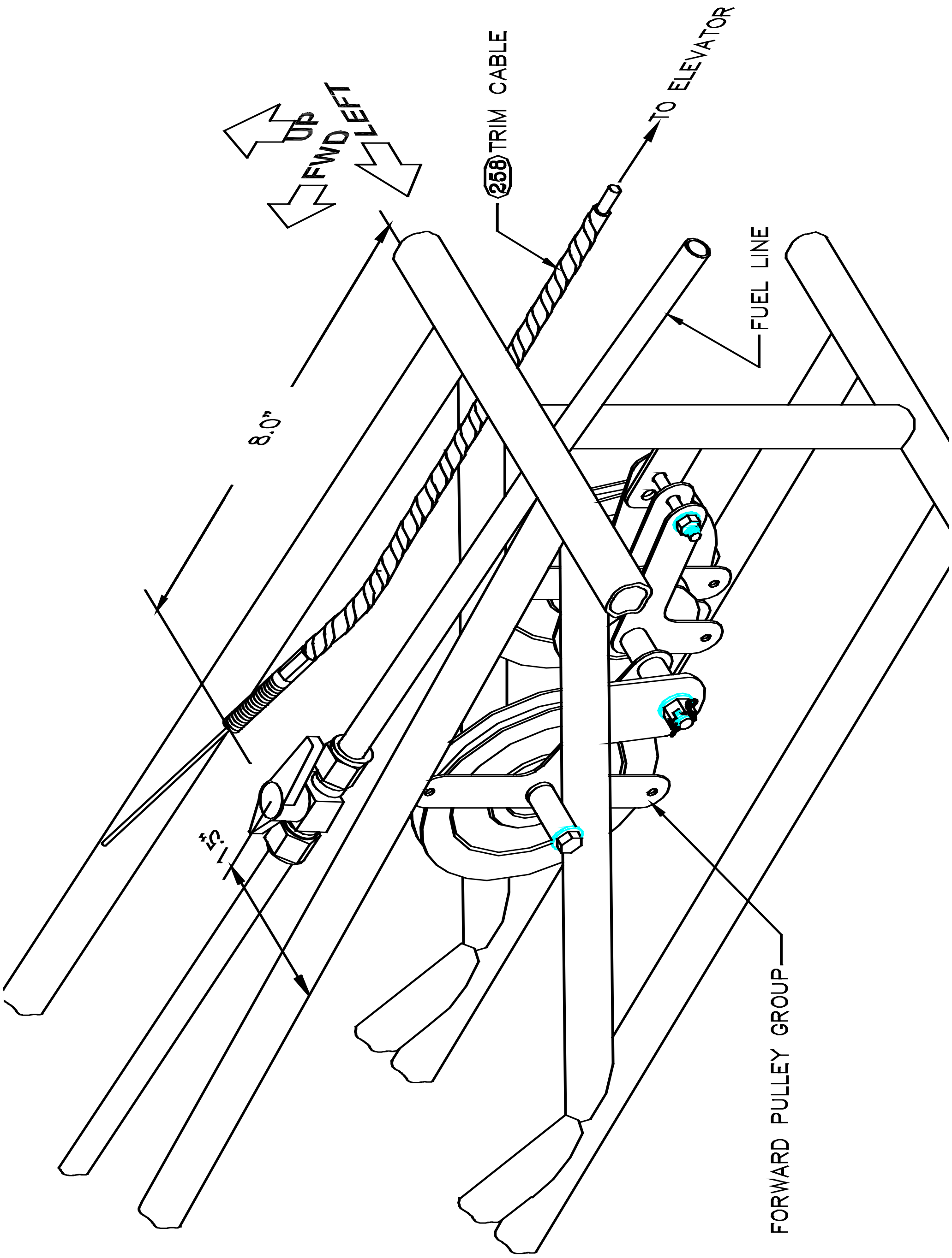

Figure 175: Routing the Forward End of the Trim Cable for Manual Trim Installations

Step 111: Fabricate the Trim Gear Box Brackets

The cable must next be secured at its forward end. The easiest way to establish the location of the forward cable end is to go ahead and temporarily mount the **trim gear box** [251], which determines where the cable end belongs. The gear box is mounted directly to the cage truss via two sheet-aluminum brackets. To keep the gear box within easy reach, it should be located as far aft as possible, but not to impinge the actuation of the flap handle. Because the actuation forces on the flap handle are light, it is possible to trim perhaps 1" off the handle length, but you should do this only as a last resort.

Figures 176 and 177 are **full-sized** templates for these brackets. Figure 176 is left long on the bottom to allow for final trimming during installation. Trace each shape and cut out of the supplied **.032" X 6" X 6" aluminum sheet** [253] using a bandsaw or scroll saw, and sand or file the cut edges smooth. Lay out the hole locations shown on the templates and drill the holes with the bits indicated—a **#40** for the four holes in the top half and a **#19** for the two holes in the bottom half of each bracket. Leave the #19 holes on the LH bracket undrilled until the exact position of the gearbox has been determined. Deburr these holes and radius the corners of the brackets, being careful to leave an adequate edge margin of at least **3/32"** around each of the top two holes in each bracket.

Finally, mark the indicated bend line on the **left-hand** bracket only. The lower half of the bracket must be bent **upward 90°** to the upper half along this line. A bend radius of **1/8"** should be maintained. Unless you have a bench brake, we recommend making this bend using the same techniques outlined earlier in the sub-section "RUDDER CONTROL ASSEMBLIES INSTALLATION" for bending the rudder pedals: make a wooden form block, clamp the bracket in a vise with the bend line aligned over the form block radius, and bend the bracket with a hammer.

Corrosion-proof the brackets now, if you wish. They will be exposed parts when the trim installation is complete, so you may also want to give the brackets a finish coat of some kind. However, you might want to wait to do this until you're ready to install the brackets permanently in "SECTION X: FINAL ASSEMBLY."

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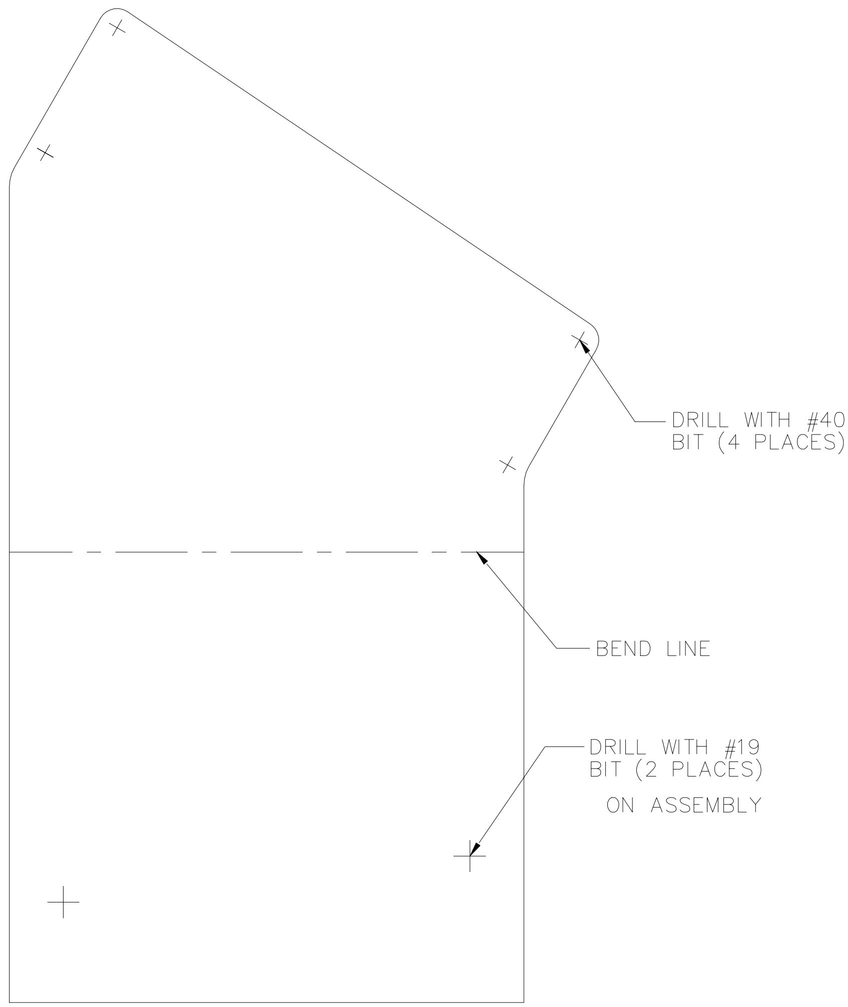


Figure 176: Template for the Left-Hand Trim Gear Box Bracket (Full Size)

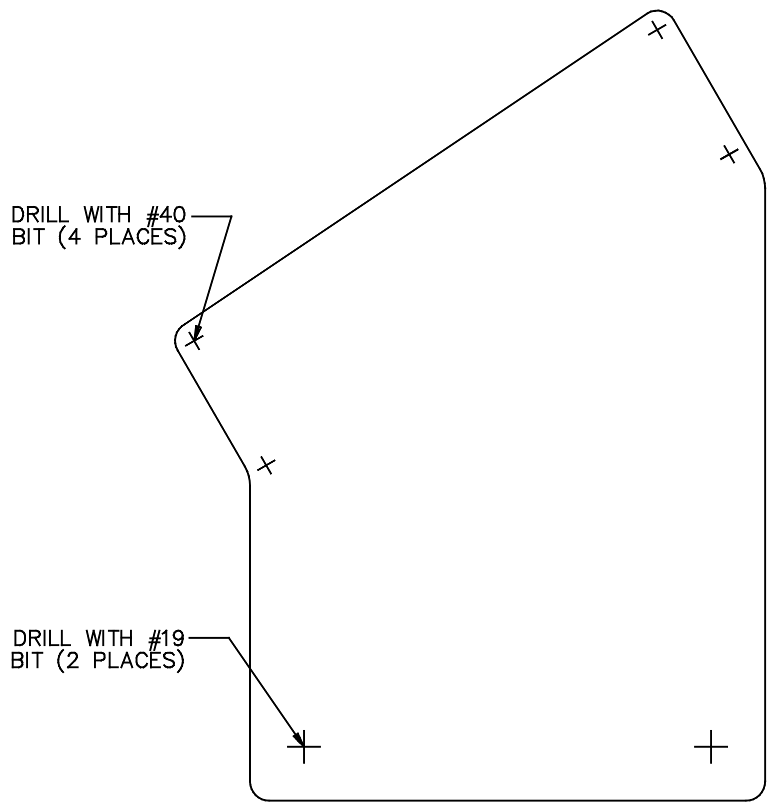


Figure 177: Template for the Right-Hand Trim Gear Box Bracket (Full Size)

Step 112: Temporarily Mount the Gear Box on the Cage (Manual Trim Only)

The #19 holes in the lower half of each gear box bracket will accommodate #8 screws into **8-32 nutclips** [257], which will be clipped to AN742D10 **aluminum loop clamps** [263] fastened around the cage tubes. Figure 178 shows the locations of the four clamps. Mount the clamps and gear box as far aft as possible while providing adequate clearance for the flap handle. Slip two clamps over the left-hand tube and position them fore-and-aft roughly as shown in the figure—the exact positions aren't important at this stage. Orient these two clamps so that their tabs are **horizontal** and pointing **inboard**. Squeeze the tabs together tightly and slip a nutclip over both tabs, as shown in the detail view of Figure 178, until the screw hole in the nutclip is centered over the hole in the clamp tabs. The nutclip will hold the tabs together, and thus hold the clamp in position on the tube.

The remaining two clamps should be installed in a similar fashion on the right-hand tube of the central truss. However, these clamps should be oriented with their tabs **vertical** and pointing **downward.**

Hint A simple wrap of electrical tape under each clamp will protect the powder coat or primer on your cage tubes from abrasion by the clamps.

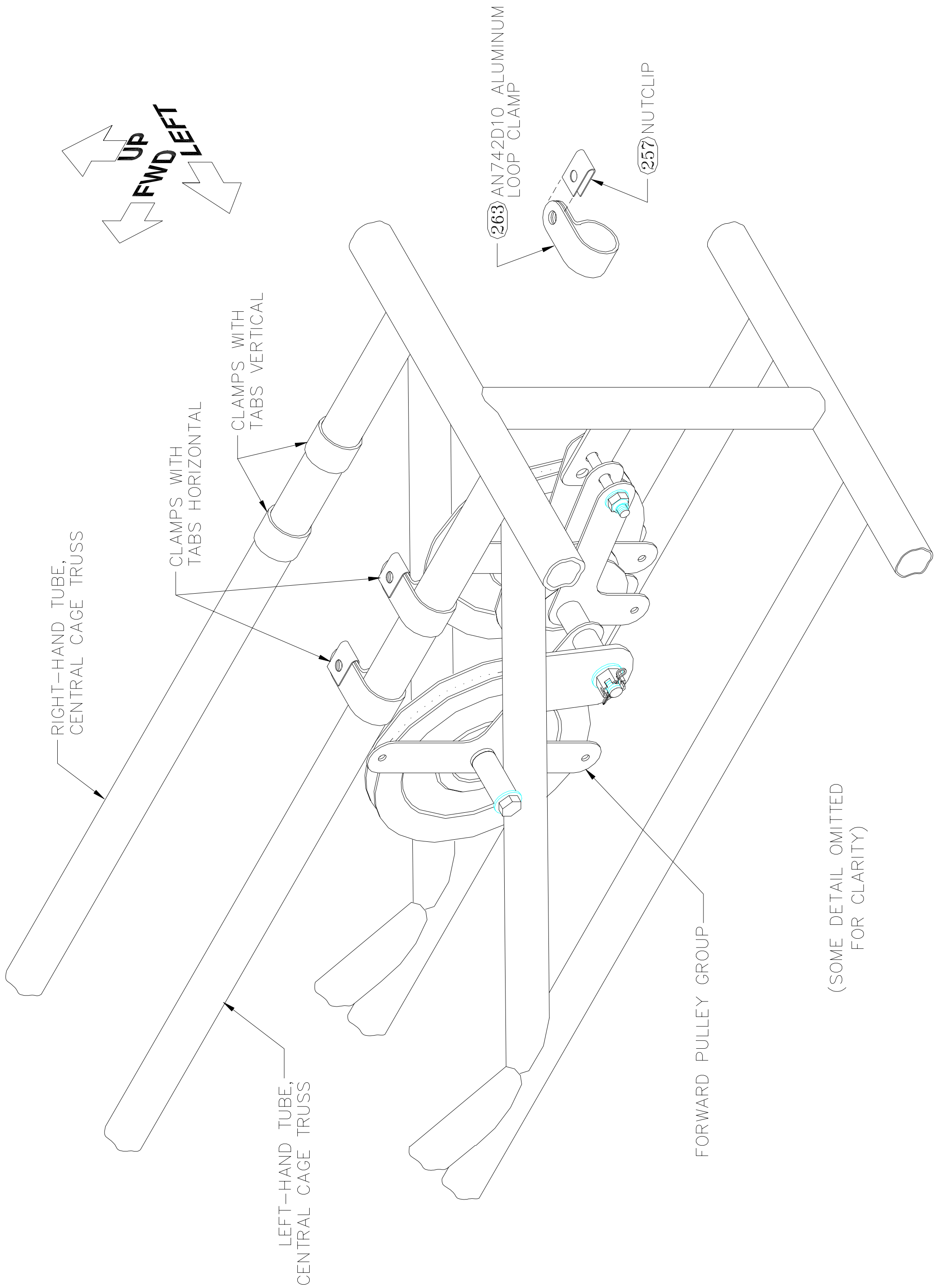


Figure 178: Installing the Gear box Mounting Clamps

Next, replace the two jam nuts and the washer that you removed from the forward end of the trim cable. Thread these all the way onto the ferrule, with the washer between the two nuts. Then thread the gear box **at least 1/2"** onto the ferrule, stopping when the box is right-side up—that is, with the wheel to the right and the red trim position indicator bar up, as shown in Figure 179. In order to thread the ferrule into the box, you'll have to insert the solid cable end through the small hole in the center of the plastic traveler block; use an Allen wrench to back the set screw out a bit if necessary. With the box in this position, tighten the jam nuts against it to hold it in place.

Now install the brackets on the sides of the gear box. Starting with the left side, remove the four small screws from the box, as shown in Figure 179. Position the left-hand bracket against the box so that the holes match up and re-install the four screws. Then repeat the process on the right side of the box with the right-hand bracket.

> **Note** To gain access to the forward-most pair of right-side screws, simply rotate the trim wheel until the access hole lines up with each screw in turn. **Don't** remove the screws from both sides of the gear box at once, as this will allow the entire worm gear mechanism to fall out of the housing.

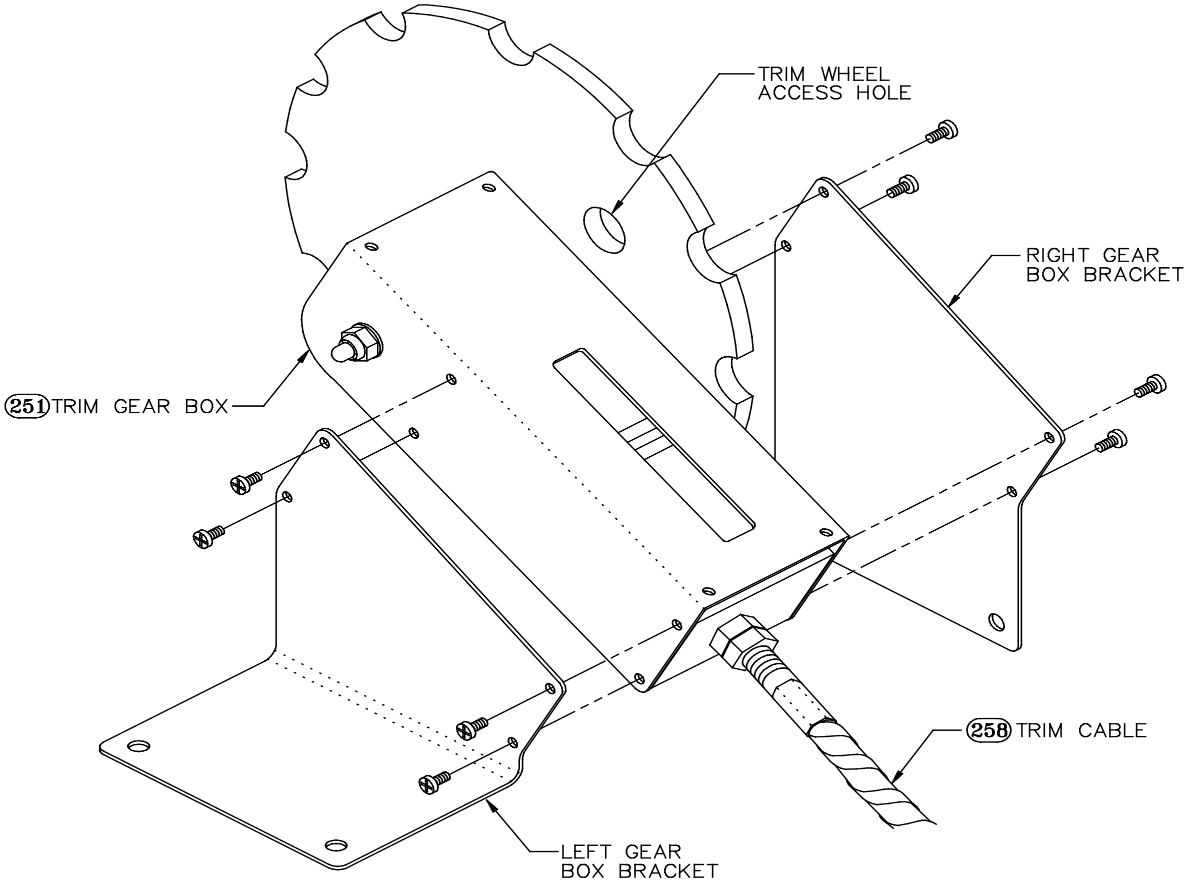


Figure 179: Mounting the Brackets on the Gear Box

Finally, with the brackets in place on the box, use AN526-8R8 **round-head machine screws** [264] to screw the brackets to the nutclips on the tube clamps, as shown in Figure 180. Move the clamps fore and aft as necessary to locate the gear box in the optimum position, then locate and drill the remaining #19 holes in the LH bracket.

Completed: [ ]

Step 113: Secure the Trim Cable to the Airframe Between the Gear Box and Bulkhead B

Now that both ends of the trim cable are anchored, you can secure it in between. Start from the gear box aft. Use cable ties to bind the cable to the cage structure at several points between the gear box and the aft end of the cage. Be sure that it is secured well clear of all control cables and pulleys. As mentioned before, for much of the run from the gear box to the aft end of the cage, the cable can be bundled along with the fuel line.

From the aft end of the cage to Bulkhead A, the cable must be secured to the fuselage shell about once every **24"**. Small **nylon loop clamps** [256] and AN530-6R4 **self-tapping screws** [265] are provided for this purpose. Drill a **#40** pilot hole through the **inner fuselage laminate only** at each clamp location, loop the clamp over the cable and secure it with the screw, which will penetrate the inner laminate but not the outer. Use an AN960D6 **washer** [267] between the screw and the clamp. The cable should be routed right alongside the belly seam, **but keep it over the foam-core portion of the shell**. Failure to do so will result in a bunch of unsightly screw points hanging out the bottom of your fuselage!

At Bulkhead A, again use a liberal dollop of RTV to pot the cable in place on both sides. Aft of Bulkhead A, use more clamps and screws to secure the cable to the shell—again, about every two feet. The cable should be routed in a gentle curve up the fuselage sidewall toward the pass-through hole in Bulkhead B. However, this is where any remaining slack in the cable must be taken up. Don't make a beeline for Bulkhead B only to end up with a large loop of slack cable when you get there.

Completed: [ ]

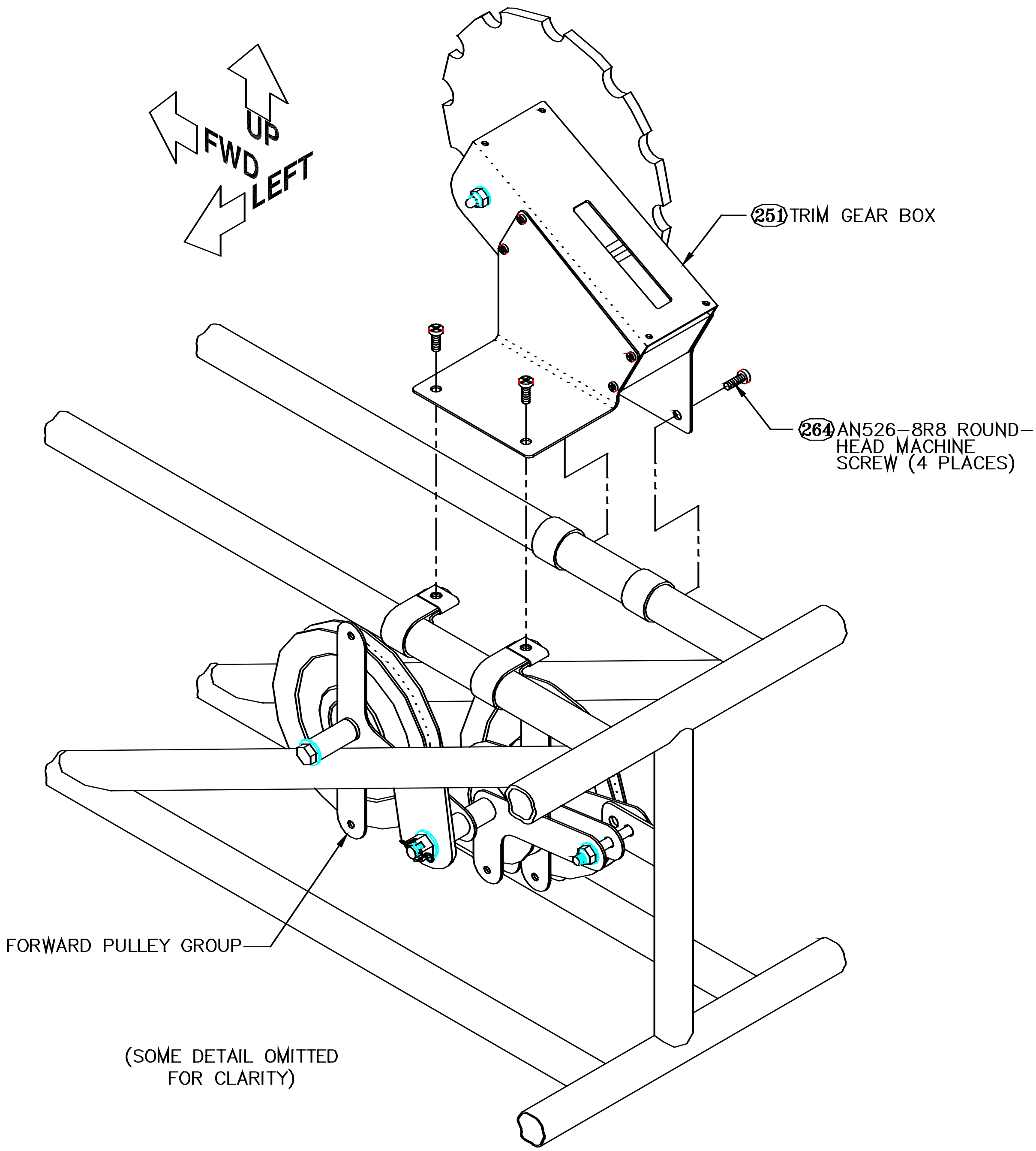


Figure 180: Temporarily Mounting the Gear Box on the Cage

Step 114: Install the Terminal Hardware on the Aft End of the Cable (Manual Trim Only)

Secure the aft, threaded end of the trim cable to the trim tab control horn/ counterweight arm assembly with the hardware shown in Figure 181. Begin by threading an AN315-3R **jam nut** [261] onto the cable end, followed by the **rod end bearing** [254]. Thread the bearing onto the cable end about **1/2"**, stopping when the bolt hole in the bearing is aligned with the hole in the trim tab control horn. Tighten the jam nut against the bearing.

> **Warning** It's **imperative** that the rod end bearing be threaded onto the cable end **at least** beyond the small inspection hole drilled through the shank of the bearing. Test this by inserting a thin piece of wire into the hole. (A bent paper clip will do fine.) If the wire passes through, then the bearing needs to be threaded further onto the rod.

Connect the bearing to the trim tab horn with the hardware shown in the figure: from the left, the AN3-10 **drilled-shank bolt** [259] is inserted through an AN970-3 **large washer** [268], through an AN960-10 **washer** [266], through the bearing, through another AN960-10 washer, through the horn/counterweight arm assembly, and finally through a third AN960-10 washer. The bolt is then secured with an AN310-3 **castle nut** [260] and an AN380-2-2 **cotter pin** [262].

> **Note** You can go ahead and final-safety this bolt by bending the cotter pin ends at this time, because the cable throw will be adjusted at the gear box during "FINAL CONTROL SYSTEM RIGGING" in "SECTION X: FINAL ASSEMBLY."

Completed: [ ]

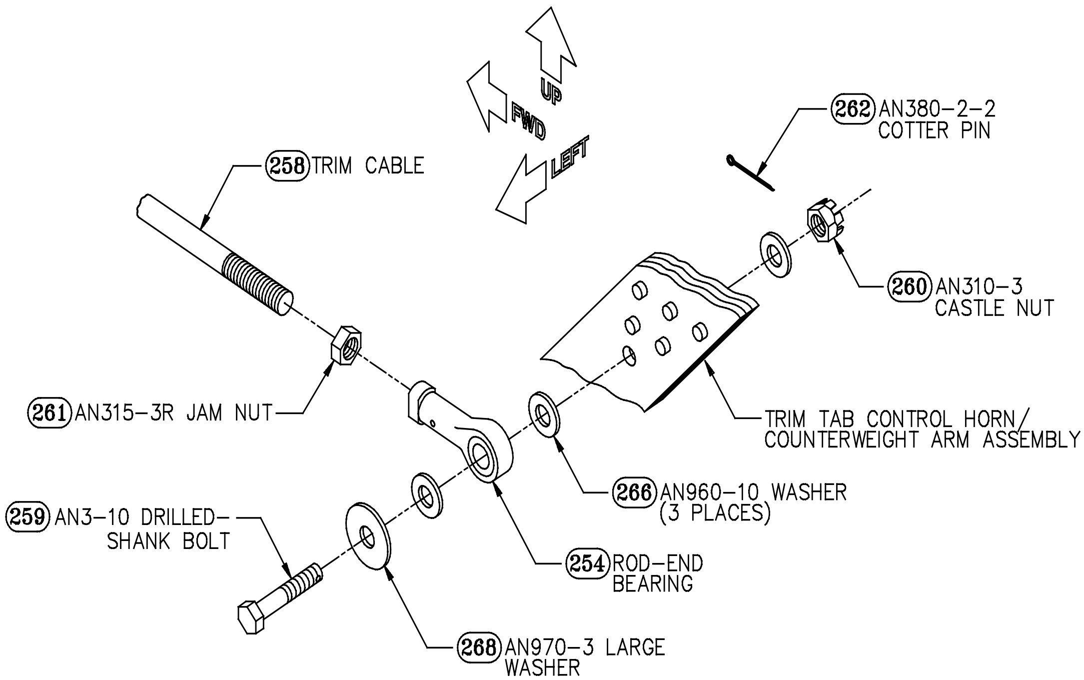


Figure 181: Installing the Terminal Hardware on the Trim Cable End

MISCELLANEOUS FUSELAGE PLUMBING AND WIRING

Step 115: Route the Fuselage Pitot Line

Pitot/Static System Options If you're installing either of Glasair Aviation, LLC's pitot/static system option kits, **turn to the option instructions now**. Return to the next step of this *Assembly Manual* when the specified option steps have been completed.

☞

The pitot line should be routed from the wing down the strut, and then forward under the door cutout or up the central cage truss to the pilot's side of the instrument panel. We recommend installing a disconnect fitting near the wing strut so that the wings can be removed without cutting the pitot line. Also, because moisture can enter the pitot system through the tube and cause failure or malfunction of the airspeed indicator, we recommend installing a low-point drain in the line somewhere between the wing and the panel.

Completed: [ ]

Step 116: Install the Static Ports and Lines

The Sportsman pitot/static option kits utilize two custom-designed static ports that are located on the waterline **10"** aft of the cowling joggle on each side of the fuselage. If you choose to install static ports from another source, be aware that this location may no longer be optimal, and inaccurate pressure readings may result.

In any case, since moisture can enter the static system through the ports, make sure that the static lines run only **uphill** from the ports to a common tee connector and then to the instruments.

Completed: [ ]

Note The next several steps all deal with wire routing. Because electrical systems will vary a great deal, no detailed instructions are given for these individual steps. However, keep in mind the following general principles:

1) All wiring should be secured to the fuselage structure at intervals of no more than about **8"**. Be sure to provide adequate chafe protection to wires wherever they might vibrate or rub on any part of the aircraft.

2) It's good practice to bundle wiring wherever practical. However, keep in mind that not all wires are compatible. In general, high-current wires such as the battery cable and the strobe power leads should be kept separate from antenna cables, and transmitting and receiving antennas should also be separated to the extent practical.

3) Insofar as possible, avoid routing wiring alongside fluid lines. Try also to avoid routing wiring under fluid lines; if the fluid line should leak, it could run down the underlying wiring, causing a short or a fire. Where it is unavoidable to run wiring under a fluid line, route it at right angles to the line. Wiring can always be bundled with pitot and static system lines.

4) It is imperative that ELT wires be kept as far away from COM antenna co-ax as possible. If located too close (less than 8-10"), the ELT will typically trigger when the transmit button is depressed.

Refer to AC43.13 or any aircraft maintenance handbook for elaboration on standard wire routing practices. See "RECOMMENDED READING" in "SECTION I: INTRODUCTION."

Step 117: Route the Fuselage Nav/Strobe Light Wiring

Nav/Strobe Light Option If you're installing Glasair Aviation, LLC's Nav/Strobe Light Option Kit, **turn to the *Option Instructions* now**. Return to the next step of this *Assembly Manual* when the specified option steps have been completed.
☞

Route the wiring harnesses for any wing lighting you're installing from the wing strut forward to the instrument panel area. We recommend the installation of quick-disconnect plugs near the fuselage strut attach so that the wings can be removed in the future without cutting any wiring. Also, if you're installing strobes, mount the power supply at this time. We recommend positioning the power supply on the fuselage sidewall aft of Bulkhead A.

Completed: [ ]

Step 118: Route the COM Antenna Cable Forward from the Vertical Fin *(Optional)*

If you installed a COM antenna inside the vertical fin, now's a good time to route the cable forward to the instrument panel area. (Keep separated from the ELT.)

Completed: [ ]

Step 119: Route the VOR Antenna Cable Forward from the Vertical Fin *(Optional)*

If you're installing an external V dipole VOR antenna on top of the vertical fin, route the cable forward to the instrument panel area now. The antenna itself can be installed later in "SECTION X: FINAL ASSEMBLY." We recommend the small, less expensive Bob Archer NAV antennas (Model 3), which will fit inside the Sportsman fiberglass wing tips.

Completed: [ ]

Step 120: Route the Battery Cables (Optional)

The precise placement of the battery is best left to the very end of the assembly process when the airplane has been weighed and you're ready to calculate your weight and balance figures. Retaining flexibility in battery location until the very end can be extremely useful in achieving the desired center of gravity.

On the 180-hp equipped Sportsman prototype, we mounted the battery on the firewall inside the cowl on the right side.

Completed: [ ]

Step 121: Install the ELT and Remote Switch Wiring

An emergency locator transmitter (ELT) with a remote, panel-mounted switch for emergency activation and testing is **required** by current FARs. We recommend installing the ELT on the fuselage side-wall aft of Bulkhead A opposite the side from the strobe power supply. After installing the unit, route the remote switch wiring forward to the panel area, keeping the wiring well clear of the COM cables or at least 4-5" clear of COM antennas.

Completed: [ ]

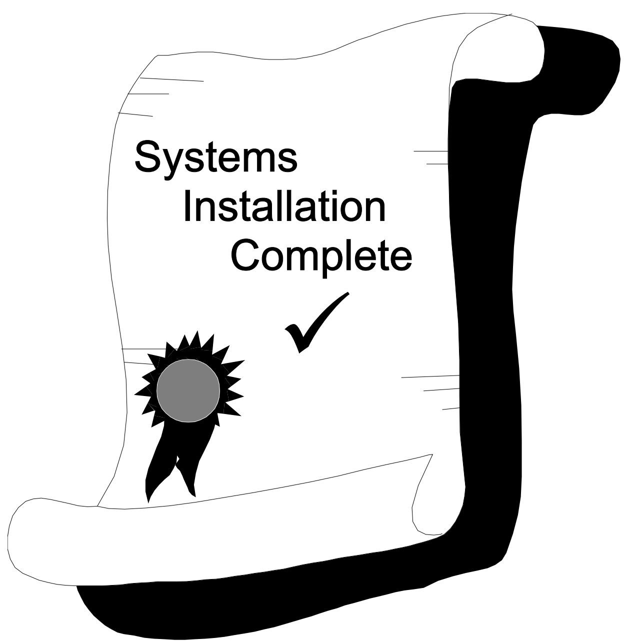
Step 122: Install the Transponder and/or DME Antennas and Cable(s) (Optional)

If you're installing a transponder and/or distance measuring equipment, now is a good time to mount the antenna(s). Hopefully, you already installed one or more aluminum ground planes between the cage and fuselage shell. Mount each antenna roughly in the center of a ground plane and route the cable forward to the panel area. Under the co-pilots seat (RH side) a 5" x 5" area of foam core is removed to provide a mounting point for the Transponder antenna.

Completed: [ ]

CONGRATULATIONS!

You've conquered systems installation! Now onward to that stage you've been waiting and working so long to reach—**final** assembly!



This section contains pictures and illustrations of various assembly steps that were not included in the written portion of the manual.

Figure A: Laser Jig for Locating the Tail Wheel Steering Cable

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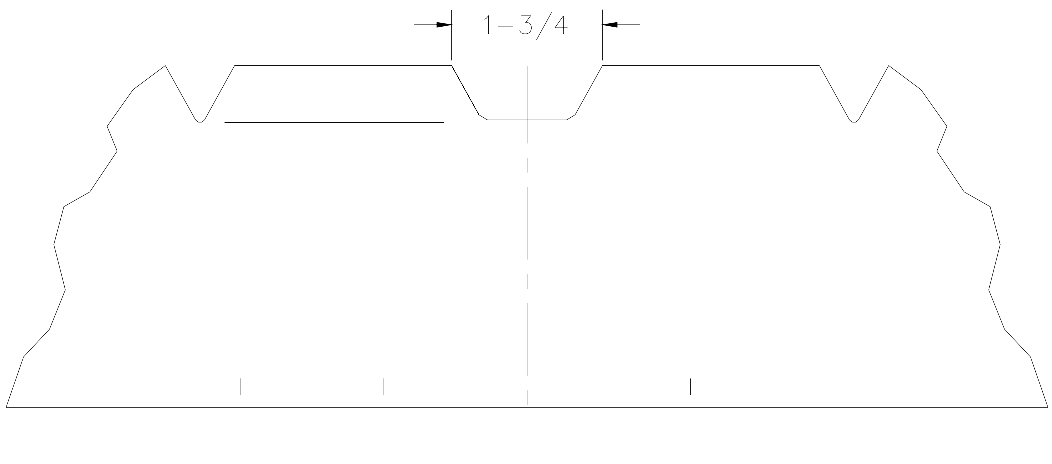
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1:

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33, the following options will be added/revised in the options table.:

Sportsman Option	**Part Number**
Induction System, O-360	**922-07050-01 ~~922-07000-01~~**
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

SECTION X: FINAL ASSEMBLY

MAIN PARTS LIST

Key No.:	Part Name:	Qty:	Part No.:
1	(removed)		
2	Lower left wing-fold hatch half	1	101-01053-01
3	Lower right wing-fold hatch half	1	101-01053-02
4	Upper left wing-fold hatch half	1	101-01053-03
5	Upper right wing-fold hatch half	1	101-01053-04
6	Baggage door	1	101-01054-01
7	Tailcone [from Sect. VIII]	1	101-01055-01
8	Rudder base fairing	1	101-01006-01
9	Lower left horizontal stabilizer strake half	1	101-01551-01
10	Lower right horizontal stabilizer strake half	1	101-01551-02
11	Upper left horizontal stabilizer strake half	1	101-01551-03
12	Upper right horizontal stabilizer strake half	1	101-01551-04
13	Left cabin door	1	101-10001-01
14	Right cabin door	1	101-10001-02
15	Aft lower door hinge half, left	1	101-10041-01
16	Aft lower door hinge half, right	1	101-10041-02
17	Aft upper door hinge half, left	1	101-10051-01
18	Aft upper door hinge half, right	1	101-10051-02
19	Forward left door hinge half	2	101-10052-01
20	Forward right door hinge half	2	101-10052-02
21	Windshield	1	101-14001-01
22	Left door window	1	101-14002-01
23	Right door window	1	101-14002-02
24	Left quarter window	1	101-14003-01
25	Right quarter window	1	101-14003-02
26	Skylight	2	101-14004-03
27	Forward upper door latch, left	1	101-16001-03
28	Forward upper door latch, right	1	101-16001-04
29	Center door latch, left	1	101-16003-13

30	Center door latch, right	1	101-16003-14
31	Exterior door handle	2	101-16008-01
32	Inboard/outboard flap cove skin	2	201-00020-01
33	Center flap cove skin	2	201-00020-03
34	Aileron cove skin	2	201-00023-01
35	Wing trailing edge doubler	8	201-00026-01
36	Left aileron counterweight	1	201-15015-01
37	Right aileron counterweight	1	201-15015-02
38	Lower left wingtip fairing half	1	201-20001-01
39	Lower right wingtip fairing half	1	201-20001-02
40	Upper left wingtip fairing half	1	201-20002-01
41	Upper right wingtip fairing half	1	201-20002-02
42	4.45" inspection hole cover [from Sect. IX]	4	201-33001-01
43	6.2" X 4.7" inspection hole cover [from Sect. IX]	2	201-34001-01
44	5.75" inspection hole cover [from Sect. IX]	4	201-35001-01
45	Fuel cap	2	201-40001-01
46	Fuel tank filler neck [from Sect. IX]	2	201-40002-01
47	Rudder tip fairing	1	301-00015-01/02
48	Horizontal stabilizer tip fairing	2	302-00014-01
49	Elevator tip fairing	2	303-00014-01
50	Control stick	2	601-01500-03
51	Left seat pan	1	802-00001-01
52	Right seat pan	1	802-00001-02
53	Seat back	2	802-02000-05
54	Seat base	2	802-03000-05
55	Inboard seat track	2	802-04000-01
56	Left outboard seat track	1	802-05000-01
57	Right outboard seat track	1	802-05000-02
58	Aft control cable cover angle	2	805-01003-03
59	Forward control cable cover angle	2	805-02003-01
60	Threaded steel rod, 1/4"-28	18 in.	015-02001-01
61	DBM cloth, 3" width [from Sect. VIII]	n/a	027-00002-01
62	Horizontal stabilizer tip fairing, closeout	2	302-00015-01
63	Instrument panel template	1	040-00125-01

64	Acorn nut	16	064-00001-01
65	Rivnut	2	064-00003-01
66	Nutclip	12	064-00004-01
67	Aluminum sheet, .020" X 27" X 30"	1	075-01025-01
68	Aluminum sheet, .020" X 12" X 36"	2	075-01022-01
69	Aluminum sheet, .032" X 16" X 16"	1	075-01031-01
70	Aluminum sheet, .063" X 12" X 43"	1	075-01060-03
71	Aluminum sheet, .12" X 3" X 10"	1	075-01253-01
72	Stainless steel sheet, .016" X 32" X 42"	1	075-03001-01
73	Stainless steel sheet, .016" X 4-1/8" X 32"	4	075-03002-01
74	Stainless steel sheet, .090" X 3/4" X 24"	1	075-03003-01
75	Door latch over-center spring, aft	2	077-00002-01
75.1	Door latch over-center spring, forward	2	077-00002-02
76	Seat-back adjustment locking pin spring	4	077-00003-01
77	Rubber hose, 5/8" [from Sect. IX]	approx. 30 in.	083-00001-01
78	Nylon washer, .032" [from Sect. VIII]	n/a	085-00003-01
79	Nylon washer, .064" [from Sect. VIII]	n/a	085-00004-01
80	Nylon washer, small	4	085-00005-01
81	Aluminum angle, .063" X 1/2" X 1/2"	120 in.	100-0640-002
82	Aluminum angle, .063" X 1" X 1" [from Sect. VIII]	approx. 14 in.	100-0640-003
83	Cable tie, 4" [from Sect. IX]	n/a	210-0018-001
84	Phenolic sheet, 3/16" X 3" X 4"	1	210-0495-008
85	MEKP catalyst [from Sect. VIII]	n/a	270-0105-001
86	Bi-directional cloth, 50" width [from Sect. VIII]	n/a	270-0110-002
88	Foam sheet, 5-lb., 1/2" X 12" X 12"	3	270-0123-407
89	Foam sheet, 40-lb., 1/2" X 3" X 4"	2	270-0126-408
90	Mill fiber [from Sect. VIII]	n/a	270-0130-001
91	Cabosil	100 g	270-0131-102
92	Cobalt promoter [from Sect. VIII]	n/a	270-0135-001
93	DMA accelerator [from Sect. VIII]	n/a	270-0135-002
94	Q-cell [from Sect. VIII]	n/a	270-0140-001
95	Vinyl ester resin [from Sect. VIII]	n/a	270-0155-001

96	Drain valve	2	320-0334-001
97	Finger screen	2	330-0340-001
98	Roll pin, 1/8" X 5/8"	2	450-0070-003
99	Hose clamp, 7/32"–5/8"	4	450-0190-004
100	Roll pin, 3/32" X 1/2"	4	450-0420-003
101	UHMW polyethylene, .125" X 2" X 2"	1	620-0420-001
102	Door seal	29 ft.	620-4100-316
103	Knob	2	622-1050-001
104	Aluminum blind rivet, 3/32"	92	700-0003-002
105	Aluminum blind rivet, 1/8"	4	700-0045-001
106	Stainless steel rod, 1/4"	18 in.	710-0420-001
107	Self-tapping screw, #6 X 3/8"	2	720-0420-004
108	Aluminum sheet, .125" X 6" X 12"	1	750-0280-004
109	Lead sheet, 12" width [from Sect. III]	n/a	750-0372-002
110	Aluminum tubing, 3/8 x .035", 6061-T6	12 ft.	820-0624-002
111	Bolt	4	AN3-10A
112	Bolt	4	AN3-13A
113	Bolt	46	AN3-4A
114	Bolt	9	AN3-5A
115	Bolt	6	AN3-6A
116	Bolt	4	AN3-7A
117	Jam nut	20	AN315-3R
118	High-temperature self-locking nut	2	AN363-1032
119	High-temperature self-locking nut	10	AN363-832
120	Nylon self-locking nut	99	AN364-1032A
121	Nylon self-locking nut	13	AN364-428A
122	Nylon self-locking nut	4	AN364-832A
123	Nylon self-locking nut	9	AN365-428A
124	Bolt	1	AN4-10A
124.1	Bolt, drilled-shank	2	AN4-11
125	Bolt	2	AN4-12A
126	Bolt	4	AN4-14A
127	Bolt	2	AN4-26A
128	Bolt	1	AN4-32A
129	Bolt	6	AN4-5A

130	Bolt	4	AN4-6A
131	Flush-head machine screw [from Sect. VIII]	n/a	AN507-10R16
132	Flush-head machine screw [from Sect. VIII]	n/a	AN507-10R20
133	Flush-head machine screw	2	AN507-8R8
134	N/A		
135	Flush-head machine screw	16	AN509-10R18
136	Flush-head machine screw	16	AN509-10R20
137	Flush-head machine screw	6	AN509-10R24
138	Round-head machine screw	2	AN515-8R10
139	Round-head machine screw	92	AN526-8R6
140	Round-head machine screw	76	AN526-8R7
141	Round-head machine screw	52	AN526-8R8
142	45° aluminum elbow	2	AN844-6D
143	Plug	2	AN913-1D
144	Lock washer	20	AN936A10
145	Washer	25	AN960-10
146	Thin washer	58	AN960-10L
147	Washer	14	AN960-416
148	Thin washer	13	AN960-416L
149	Washer	30	AN960-8
150	Thin washer	10	AN960-8L
151	Aluminum washer	50	AN960D10
152	Thin aluminum washer	48	AN960D10L
153	Aluminum washer	28	AN960D416
154	Thin aluminum washer	14	AN960D416L
155	Thin aluminum washer	15	AN960D8L
156	Large washer	7	AN970-3
157	Large washer	8	AN970-4
158	Nutplate	130	K1000-08
159	Nutplate	10	K1000-3
160	Nutplate	2	K1000-4
161	Nutplate	2	K2000-08
162	Floating nutplate	9	MF5000-08
163	Rolled hinge with pin	19 in.	MS20257P2
164	Rolled hinge with pin	72 in.	MS20257P2

165	Monel universal-head rivet, 1/8"	62	MS20615-4M3
166	Turnbuckle locking clip	11	MS21256-1
167	Steel spacer	6	NAS43HT4-12
168	Round-head machine screw	12	NAS603-7P
169	Plain steel bushing	8	NAS75-3-004

COMMON MAIN LANDING GEAR PARTS LIST

Note The instructions in this section cover final assembly procedures for the standard, 6.00 X 6 tricycle **and** taildragger landing gear options, and the following list includes parts that are common to these two installations. The 8.00 X 6 or larger taildragger options are covered in separate option instructions. Landing gear-related parts that are common to **all four** installations are included in the MAIN PARTS LIST above.

Key No.:	Part Name:	Qty:	Part No.:
170	Main wheel pant, fwd half	2	401-00025-01
171	Main wheel pant, aft left half	1	401-00026-01
172	Main wheel pant, aft right half	1	401-00026-02
173	Bulkhead, main wheel pant	2	401-00024-01
174	Main wheel attach bracket, outboard	2	401-00029-01
175	Flush-head machine screw	22	AN507-8R8
176	Bolt	2	AN4-3A
177	Floating nutplate	22	MF5000-08
178	1/2" 5 lb foam 18" x 30"	2	270-0123-611
179	(Reserved)		

STANDARD TRICYCLE LANDING GEAR PARTS LIST

Note The following list contains parts that are unique to the standard, 6.00 X 6 tricycle landing gear installation (5.00 x 5 nose tire).

Key No.:	Part Name:	Qty:	Part No.:
180	Left nose gear leg fairing half	1	302-5411-001
181	Right nose gear leg fairing half	1	302-5411-002
182	forward nose wheel pant half	1	401-00027-01
183	aft nose wheel pant half	1	401-00028-01
184	Towbar bracket assembly	1	371-5140-101
185	Bolt	4	AN4H3A
186	Flush-head machine screw	12	AN507-8R8
187	Flush-head machine screw	2	AN507-10R8
188	Flush-head machine screw	2	AN509-10R24
189	Floating nutplate	4	MF5000-3
190	Floating nutplate	12	MF5000-08
191	Rolled hinge with pin	18"	MS20257P4
192	(Reserved)		

MANUAL TRIM SYSTEM PARTS LIST

Note The following list contains parts that are unique to the manual trim installation. The electric trim installation has a separate parts list contained in the *Option Instructions*.

Key No.:	Part Name:	Qty:	Part No.:
193	Cable clamp [from Sect. IX]	2	045-02001-01
193.1	Nylon self-locking nut	2	AN364-1032A
193.2	Flush-head machine screws, #10 x 13/16	2	AN509-10R13
193.3	Large steel washer, #10	2	AN970-3

PARTS LIST ERRATUM

Note The following list contains a part that was inadvertently omitted from the MAIN PARTS LIST.

Key No.:	Part Name:	Qty:	Part No.:
194	Nylon loop clamp, 1/4"	2	450-0006-250
195	Nutplate, single lug	12	K2000-3
196	Hinge Assembly aft, Baggage door	2	101-01170-01
197	Hinge Assembly fwd, Baggage door	2	101-01175-01
198	Handle Assembly, Baggage door, int.	1	101-01180-01
199	Latch sleeve, baggage door	2	101-01181-01
200	Latch pin, baggage door	1	101-01182-01
201	Latch bar, baggage door	1	101-01184-01
202	Pivot shaft, baggage door	1	101-01186-01
203	Spring, latch pin, baggage door	1	101-01188-01
204	Handle, canopy latch ext.	1	202-1051-001
205	Housing, canopy latch pivot	1	202-1053-001
206	Dowel pin, 3/32 x 5/8	1	450-0420-004

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

Th233?sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point.

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

207	Snap ring 1/8 IDX	1	450-5133-018
208	Knob, canopy latch int.	1	622-1050-001
209	Spring, canopy latch housing	1	772-0002-020
210	Nut, self-locking shear	14	AN364-1032A
211	Cotter pin, 1/16 x 3/8	1	AN381-2-6
212	Clevis pin, 3/16 x 13/32	1	AN393-13
213	Screw, flush sink, #10 x 7/16	1	AN509-10R7
214	Screw, flush sink, #10 x 1/2	14	AN509-10R8
215	Washer, steel, #10	14	AN960-10
216	Washer, thin alum, #10	2	AN960D10L
217	Roll pin, 3/16 x 1-1/4	1	MS16562-239
218	Bushing, steel,	1	NAS75-7-.100
219	Bolt, 1/4	2	AN4-25
220	Nut, castle	2	AN310-4
221	Cotter pin	2	AN381-2-10
222	Washer, steel, thin	4	AN960-416L
223	Washer, steel	3	AN960-716
224	Retainer ring	1	450-5101-043
225	Bolt, 1/4"	1	AN3-16A
226	Bushing	1	NAS75-3-.100
227	Latch cover plate	1	101-01189-01
228	Screw, sheet metal	5	720-0420-004
229	Cap nut	1	064-00001-01
230	Strap, interior handle	1	101-01190-01
231	Washer, #10 beveled	6	850-3235-028
232	Shur-Lok nut	16	450-0607-037
233	Flap track recess cover	2	101-00040-01

TOOL LIST

1. Steel ruler, 12"
2. Fine-tipped marking pen
3. Band saw or hacksaw
4. Wrenches (sizes 3/8" to 3/4"), screwdrivers, hammers and other common hand tools
5. Center punch
6. Electric or pneumatic drill motor with the following bits: #40, #30, #19, #10, #1 (optional); 1/16", 3/32", 1/8", 11/64" (optional), 3/16", 15/64" (optional), 1/4", 5/16", 3/8"; and “A” (optional), “B” (optional) and “F”
7. Hole deburring tool
8. Assorted fine-toothed files
9. Edge deburring tool (optional)
10. Belt sander (recommended)
11. Scissors
12. Offset sheet-metal snips
13. Straightedges, 18" and 48"
14. Measuring tape
15. Hand seamer (recommended)
16. Bench brake (optional)
17. Bench vise
18. Cleco side-grip clamps or small C-clamps (10-12)
19. #30 extension bit or right-angle drill motor with #30 bit
20. Clecos, 3/32", 1/8" and 5/32", with pliers
21. Air compressor
22. Rivet gun with 1/8" and 3/32" universal sets and flush set
23. Bucking bars
24. Microstop countersink tool with #40, #30, #19, #10 and 1/4" piloted 100° cutters
25. Rivet squeezer with flush set (recommended)
26. Heavy-duty scissors or rotary cloth cutter
27. Resin brushes (one with 14" handle extension)
28. Die grinder with rotary file (recommended)
29. Right-angle drill motor or adapter with #19 and #10 bits
30. 3/32" dimple dies
31. Hole saws, 1/2", 3/4" and 1", or equivalent Unibit(s)
32. Single-ended hacksaw
33. Sheet metal edge rolling tool (optional)
34. Saber saw with carbide grit blade or rotary cutting tool on die-grinder (optional)
35. Bench grinder (optional)
36. Drill press (recommended)
37. Blind rivet puller
38. Digital level (optional)
39. Framing square
40. Large channel-lock pliers

41. Plumb bob
42. Utility knife
43. Scroll saw (optional)
44. Q-cell fillet "radius tool" (see description in Step 33)
45. Heat gun (optional)
46. Rivnut installation tool
47. Sanding blocks, long and short
48. Portable work light and/or flashlight
49. Hot-melt glue gun (optional)
50. Small sanding drum for drill motor or drill press (recommended)
51. 100° countersink bit (uncaged)
52. Spirit level
53. Narrow rat-tail file (optional)
54. Large C-clamps
55. Try square
56. Rubber mallet or lead body hammer
57. Duck bill pliers or safety wire twisters
58. Vise-grip pliers
59. Scriber
60. Non-metallic abrasive wheel in a bench grinder or drill motor (optional)
61. Hole saws, 2-1/4" and 3-1/8", or equivalent fly-cutter or instrument panel cutout dies
62. Vise-grip style locking C-clamps
63. Tubing cutter (recommended)
64. Cable tensiometer
65. Scale accurate to the nearest ounce
66. Articulated inspection mirror
67. 3/32" Allen wrench
68. 1/4"-28 die and handle
69. Aircraft scales

ADDITIONAL MATERIALS

1. Sandpaper, assorted sheet sizes and grits, 220–60
2. Anti-corrosion protection materials
3. Scrap cardboard
4. Rubber cement or artist's spray glue
5. Five 3/8"-diameter, 1/2"-long bolts and nuts (hardware-store quality)
6. Miscellaneous scrap wood blocks, 1 X 4, 2 X 4, 2 X 8, etc.
7. Shop stool or sawhorse
8. CP-25 fire barrier caulk (recommended; available from S-H — P/N 270-0132-001)
9. UHMW polyethylene anti-chafe tape
10. Wide masking tape or duct tape

11. Mold release wax or non-silicon paste wax
12. Acetone
13. Unwaxed resin mixing cups
14. Resin mixing sticks
15. Latex surgical gloves
16. Two pieces of 1/4" X 24" X 15" marine plywood
17. Polyurethane varnish, epoxy paint or equivalent
18. Small amount of household paint, any type or color
19. Light axle grease
20. Push pins or thumb tacks
21. Lightweight body filler (e.g., Bondo)
22. Hot-melt glue
23. Sand or shot bags
24. 20" length of broom stick, wooden dowel or 1" pipe
25. 20" length of 1 X 4
26. 38" length of 1/4" dowel or 1/4"-thick scrap wood strip
27. WD-40, LPS or equivalent spray lubricant
28. Household epoxy (either 5-minute or long-curing is fine)
29. Modeling clay
30. Small scrap lengths of hardware-store 1" X 1" aluminum angle stock
31. Short length of 1"-diameter pipe or dowel
32. .032" stainless steel safety wire
33. Permatex High Tack Adhesive Sealant or equivalent
34. Wire marking materials
35. Nylon cable ties
36. Black vinyl striping tape, 1/2" width
37. Masking tape, 3/4" width
38. Masking paper
39. Black pigment for window bonding (order P/N 027-01000-01 or use used copier toner)
40. Witness paint (order Torque Seal from S-H; P/N 620-0642-501)

WORKSPACE

A good bit of work remains to be accomplished before the wings are mated to the fuselage for the final time, and therefore, there's no immediate need to abandon the friendly confines of your shop for the airport. Keep in mind, however, that when you mount your engine, the fuselage length will suddenly grow by close to 4', not including whatever space you take up while working. Also bear in mind that you'll need either a portable engine hoist and room to maneuver it or an overhead beam in the right place for a come-along or chain hoist.

Ultimately, of course, you'll have to mount the wings permanently, and there's a considerable amount of work that's best done after this has been accomplished. If you have a hangar lined up at the airport, you might prefer to move your Sportsman to its new home before mounting the wings. Alternatively, you can move the airplane outside your shop to mount the wings and finish the remaining work, either covering it with tarps or folding the wings and pulling it back inside at the end of the day. That's Sportsman versatility!

ASSEMBLY SEQUENCE

Details, details, details! This is the part of aircraft construction that many builders find frustrating—their project looks like an airplane and they want to go flying! But of course, there's still a lot of work to be done—some have said that 90% of the work of building an airplane is in the last 10% of the job. Don't let this get you down! Just strive to make steady progress through the pages of this final section of the *Manual*, keeping in mind that while there are a lot of tasks left, they're almost all little ones. **At the end of the Final Assembly Section are photos showing various assembly aids which were left out of the main written section of the manual**

This section of the *Manual* presents the remaining tasks in an order that we find most logical, but there is a lot more flexibility here than in earlier sections. Although you will generally be more productive if you follow a specific plan and finish one task before beginning the next, you should divide this work up in whatever way keeps you most motivated, and if that entails skipping around, just make sure that you don't leave any steps out before calling in the FAA!

The suggested order of major tasks is as follows:

1) **Firewall Installation**: cutting and joining the firewall and the mounting flanges, and installing the completed firewall assembly in the fuselage shell.
2) **Firewall Forward**: installing the engine, propeller, spinner, cowling and related systems.
3) **Interior Installation**: installing the baggage bulkhead close-out, control cable covers, floorboards, seat pans and seats, and optional cabin air vents.
4) **Fuselage Fairing Installation**: installing the horizontal stabilizer strakes, rudder base fairing, tailcone and rudder tip fairing.
5) **Gear Fairing Installation**: installing the wheel pants and gear leg fairings.
6) **Final Wing Assembly**: riveting the upper and cove skins; installing the fuel tanks and finalizing the details of the wing fuel system; riveting the root ribs; fabricating the delta wings; installing the wingtip fairings; and final-mounting the wings on the fuselage.
7) **Door Installation**: fitting and installing the cabin and baggage doors, as well as the latch and optional lock mechanisms.
8) **Top Deck Installation**: finishing the cabin roof and the wing-fold hatches.
9) **Instrument Panel Installation**: installing and wiring the instrument panel and installing the glare shield.
10) **Window Installation**: installing the skylights, quarter windows, door windows and windshield.
11) **Control Surface Balancing and Fairing Installation**: installing the aileron counterweights; calculating and installing the elevator and trim tab counterweights; and installing the horizontal stabilizer and elevator tip fairings.
12) **Final Control System Rigging**: adjusting control surface travel, and tensioning and safetying the control cables.
13) **Miscellaneous Final Assembly Details**: installing the fuel gauges, delta wings, optional antennas, seat belts and shoulder harnesses, manual trim system travel stops, etc.
14) **Weight and Balance**: weighing the completed aircraft, calculating weight and balance figures, and fabricating and installing the battery tray.

15) **Systems Check-Out**: final testing of aircraft systems prior to taxi and flight testing.

16) **Fastener Inspection and Safetying**: inspecting and safetying all flight-critical fasteners, and installing all inspection covers, interior components, fairings, etc.

17) **Go Flying!**

FIREWALL INSTALLATION

Step 1: Fabricate and Install the Instrument Panel Angle Brackets

The first step in the firewall installation doesn't really have anything to do with the firewall, but it needs to be accomplished now because there will be no access for this task after the firewall is in place. The instrument panel is braced along its upper edge by two lengths of aluminum angle that run forward from the panel to the front of the cage. At the forward end, these braces are bolted to angle brackets, which in turn are bolted to the inboard pair of triangular forward shell attach fittings. As you may recall, you laminated and riveted these fittings to the fuselage shell and bolted them to the cage in "SECTION VIII: FUSELAGE ASSEMBLY." You used AN3-4A bolts with the heads forward. These bolts will also be used to secure the panel brace angle brackets, and it is their heads that are inaccessible once the firewall is installed.

As shown in Figure 1a, the angle brackets are cut from the length of **.063" X 1" X 1" aluminum angle** [82] left over from "SECTION VIII: FUSELAGE ASSEMBLY." Cut two brackets, each **3/4"** long. Then mark and drill a hole approximately in the center of each flange—a **#19** hole in one flange and a **#10** hole in the other. The locations of these holes aren't critical—just eyeball them. Sand or file the cut edges smooth and deburr the holes. Corrosion-proof both brackets if you wish.

Figure 1b shows how the brackets should be installed on the inboard forward shell attach fittings. First, remove the AN364-1032A nylon self-locking nut and AN960D10 aluminum washer from the AN3-4A bolt securing the fitting to the cage tab. Slide the #10 hole in the angle bracket over the end of the bolt, orient the bracket as shown with its other flange **inboard**, and then replace the washer and nut.

You will return to these brackets in the "INSTRUMENT PANEL INSTALLATION" sub-section below.

Completed: [ ]

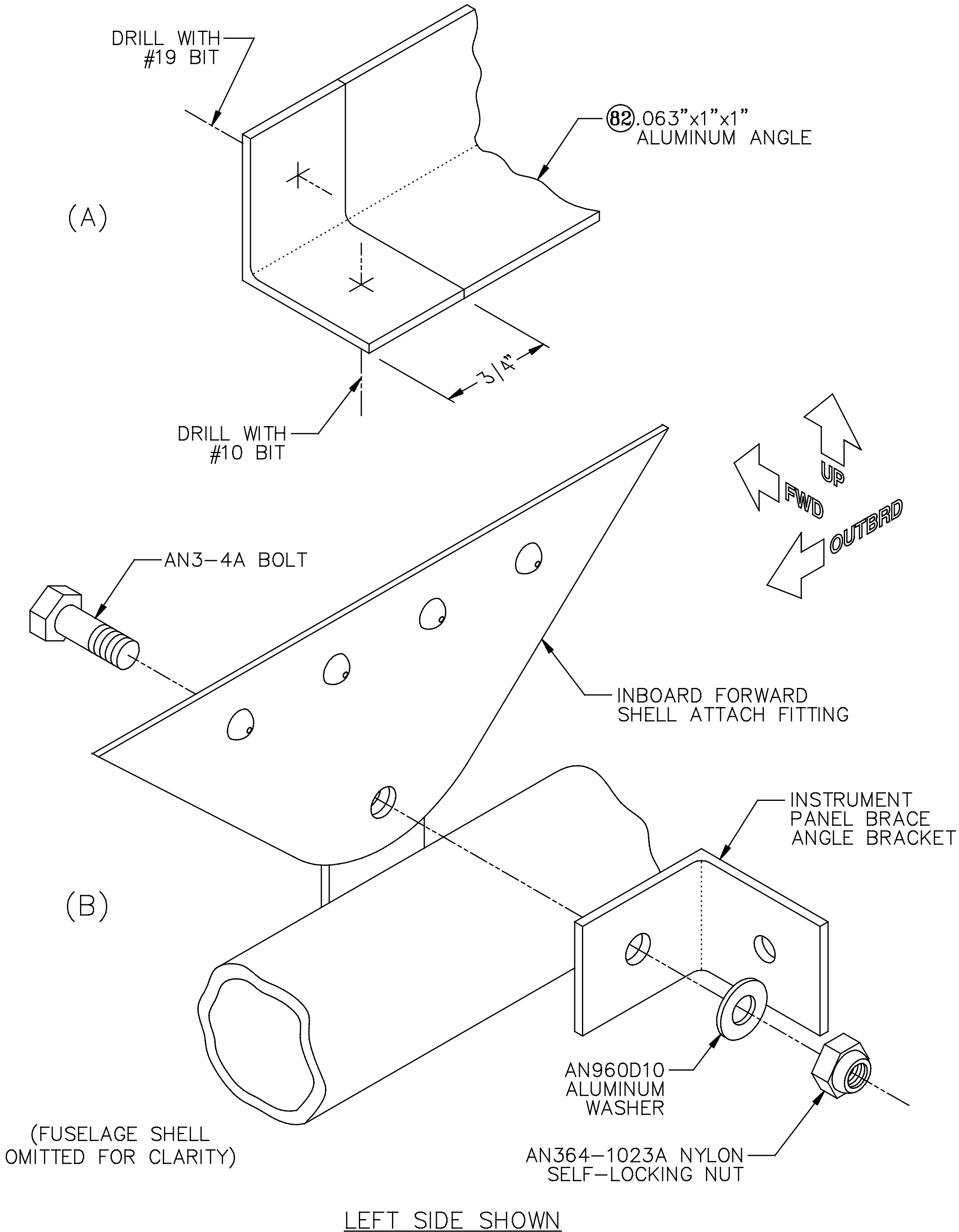


Figure 1: Fabricating and Installing the Instrument Panel Brace Angle Brackets

Hint A final checklist of fastener safetying procedures is included in the "FASTENER INSPECTION AND SAFETYING" sub-section later in this *Manual*, but there's nothing that says you can't get in there now while the getting's good to do most of the cotter pinning and witness painting in the forward part of the cage. If you wait until after the firewall is installed, you'll be doing these on your back with a flashlight, a mirror and a long pair of tweezers!

Step 2: Fabricate the Firewall Components

As Figure 2 shows, the firewall assembly consists of a flat firewall and four formed flanges. The small leg of the flanges are riveted to the **aft** of the firewall, and then the entire assembly is slid into the fuselage from the front until the firewall contacts the cage structure. The flanges are then flush-riveted to the cowling mounting flange on the fuselage shells. In this step, you will cut out the firewall and form the flanges and in subsequent steps you will join them and install the completed assembly. Mounting the flanges to the aft side of the firewall sheet makes for a cleaner installation, but it takes more time to drill up.

Begin by making a firewall template by tracing the outside of the fuselage shell opening on a large sheet of cardboard. Trim the cardboard blank until it just fits between the fuselage shells. You'll notice that, because of the taper of the shells, a tight fit at the forward edge of the cowling flange translates into a slight gap all the way around the blank when it is pushed back against the cage structure. Don't worry about this—it's no problem at all.

In addition to these steps, refer to the cowling instructions at this time as well.

Tricycle Landing Gear Option: Obviously, before you can fit the firewall template the engine mount and nose gear must be removed. Support the nose of the aircraft on a sawhorse under the forward part of the cage. As you trial fit your cardboard firewall template, you'll notice immediately that the nose gear mounting brackets are in the way. Cut around these brackets leaving a gap of approximately 1/16".

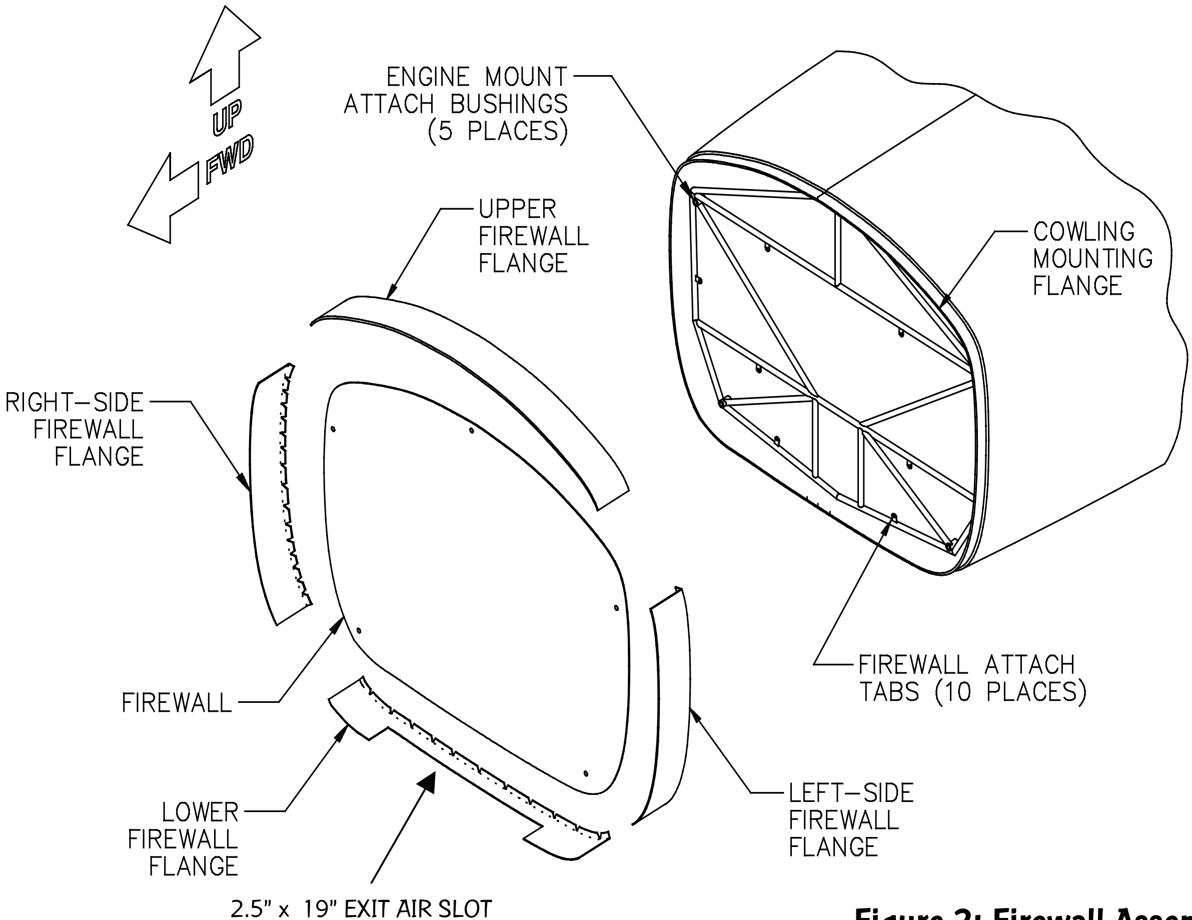


Figure 2: Firewall Assembly

When you're satisfied with the fit of your cardboard template, use it to cut the actual firewall from the supplied **.016" X 32" X 42" stainless steel sheet** [72]. Thoroughly deburr the cut edges. Save the scrap material for use later in Step 108.

> **Caution** Shearing stainless steel leaves an especially sharp burr that can inflict some nasty cuts, so be careful handling the firewall and the firewall flanges until they have been deburred.

Figure 3 shows the dimensions for cutting out the flanges; Figure 3a covers the upper and lower flanges, and Figure 3b shows the dimensions of the side flanges. Each flange is cut from one of the supplied **.016" X 4-1/8" X 32" stainless steel sheets** [73]. To cut the flanges, begin by laying out the locations of the crack-stop holes on a line **5/8"** from the aft edges of all four of the flanges in the locations shown in Figures 3a and b. Use a **#30** or a **1/8"** bit to drill these holes, and then deburr them. These holes will form a smooth radius at the “bottom” of each of the

60° notches shown in the figure, preventing the formation or propagation of cracks in the stainless steel. The notches in turn allow easy bending of the tabs through which the flanges will be riveted to the firewall. Use your sheet metal snips to cut the notches, carefully deburr the cut edges.

Note As indicated in Figure 3, omit the holes at **both** ends of the **lower** flange and at the **upper** end of **both side** flanges.

Figure 2 shows the 2.5" x 19" dimensions for the cooling air exit cutout. Trace this on the lower firewall flange after it has been positioned and drilled on the firewall.

Note As indicated in Figure 3a, these forward-edge hole locations can be omitted for **10"** on either side of the centerline on the **lower** flange only. The flange will ultimately be relieved in this area to provide a cooling air exit from the cowling (see Figure 2).

Note Do **not drill** any of the rivet holes through the forward edges of the firewall flanges at this time. These holes will be drilled later, after the firewall assembly has been trimmed and fitted to the fuselage shell.

Use a hand seamer, a small bench brake or a form block in a vise to bend up the tabs on all of the firewall flanges. Use a tight bend radius. The bend line should go right through the middle of the crack-stop radii at the "bottom" of the notches. Be careful to bend the tabs on the **side** flanges in the proper direction to make mirror-image parts (since both the upper and lower flanges are completely symmetrical, they will work no matter which direction the tabs are bent).

Completed: [ ]

Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: [redacted]

Page 33, the following options will be added/revised in the options table.:

Sportsman Option	**Part Number**
Induction System, O-360	**922-07050-01 ~~922-07000-01~~**
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

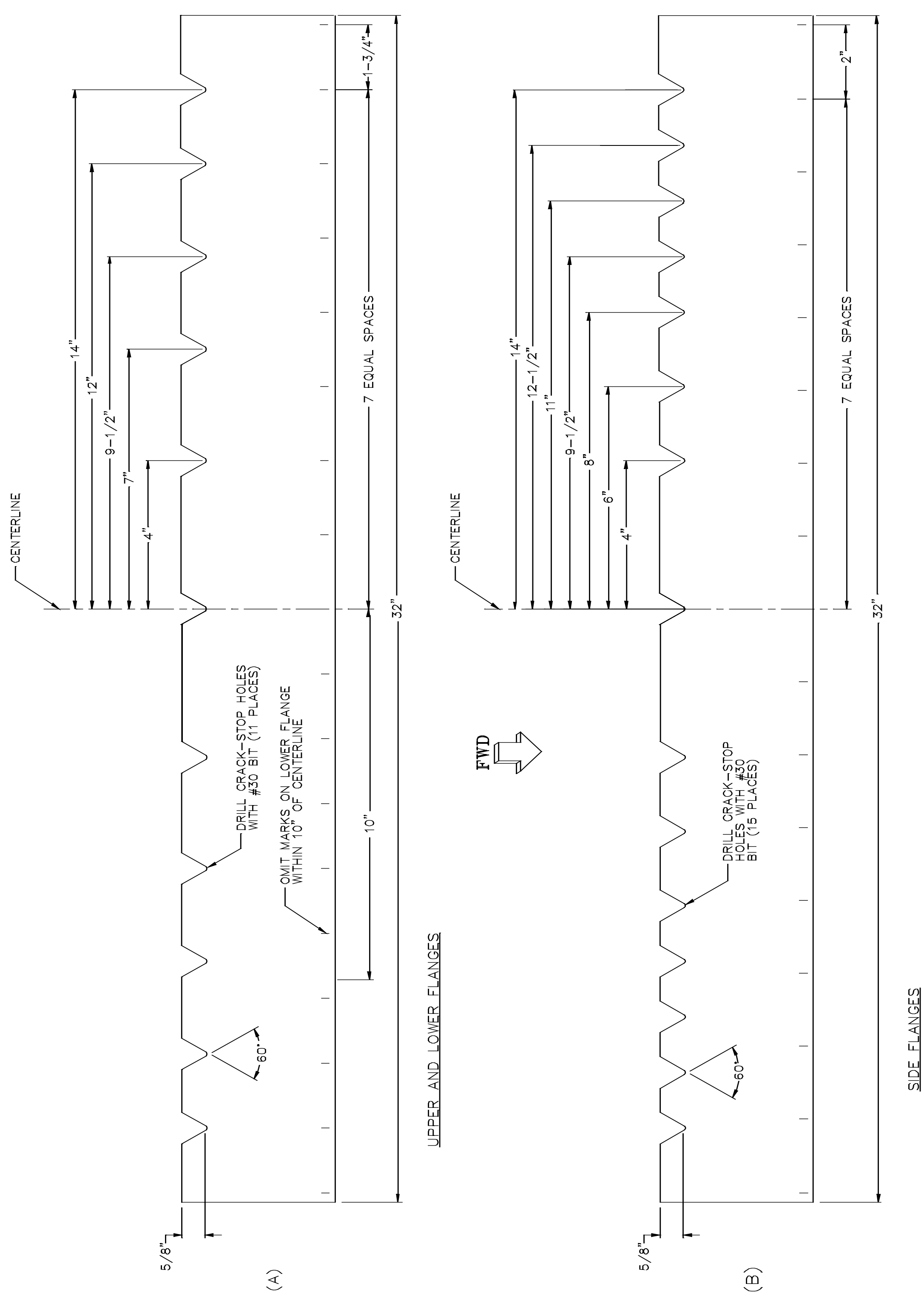


Figure 3: Firewall Flange Layout

Step 3: Fit the Firewall to the Fuselage and Drill the Engine Mount Bolt and Attach Tab Holes

Note Refer to your cowling instructions at this time for Camloc locations. This will determine the rivet spacing on the fuselage/cowl flange.

Fit the firewall sheet into the front of the fuselage and position it so that the gap between the firewall and the inside of the shell is as equal as possible all the way around, as shown in Figure 4. Have a helper hold the firewall sheet in position from the forward side while you mark the positions of the five **3/8"** engine mount bolt holes from the aft side.

Note If you have a very compact drill motor, you might be able to drill the holes right through the cage engine mount bushings with the firewall in place. Otherwise, mark each hole location by inserting a 3/8" drill bit through each bushing until it contacts the firewall and then spinning it with your fingers. Alternatively, use a felt-tip pen to mark the hole locations; a "Pilot RAZOR POINT II" fits the cage bushings very well. Then remove the firewall and drill a **3/8"** hole at each of the five marked locations. Begin by drilling a hole 1/4" in diameter or smaller, and then finish up either with a Unibit or by step drilling up to final size in 1/16" increments

After the five **3/8"** engine mount bolt holes have been drilled, pin the firewall in place temporarily with hardware-store 3/8" nuts and bolts. Then, crawl back inside the cage and drill through each of the ten cage attach tabs and the firewall with a **#19** bit, while your helper supports the firewall in position from the front. Pressing a scrap wood block against the forward side of the firewall opposite the bushing being drilled will help.

Note Don't sweat it too much if you have trouble keeping all these holes aligned; they can easily be filed to fit later.

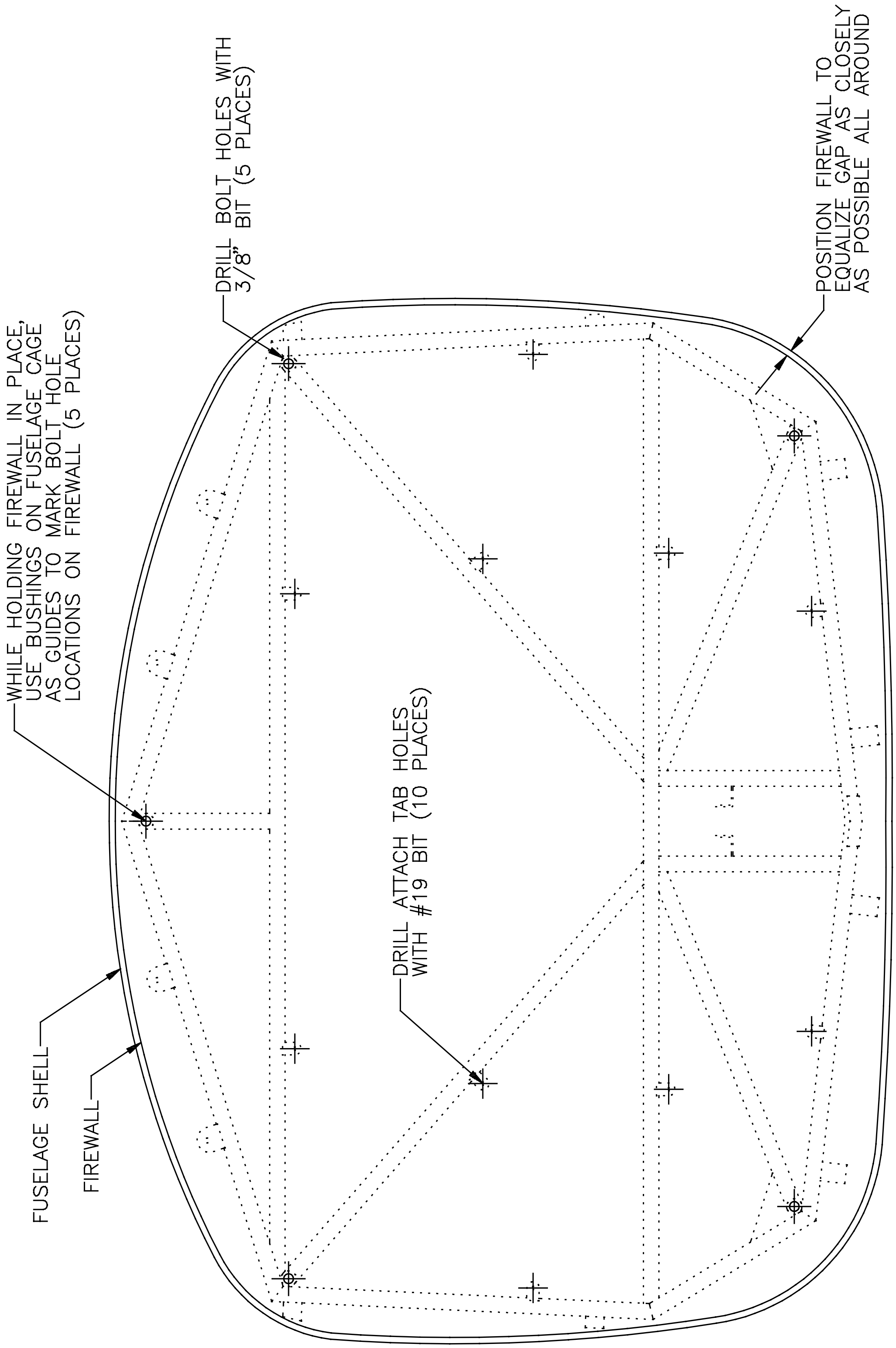


Figure 4: Drilling the Engine Mount Bolt and Attach Tab Holes

Remove the firewall and deburr all the holes. Also, deburr the cage attach tabs. In order to place the flanges behind the firewall, you will have to position the flanges first and then place the firewall over them. You may need to trim a little more off the firewall in order to get it to fit inside the flange bend radius. Then replace the firewall, again temporarily securing it to the cage with the 3/8" bolts.

Fit the **lower** firewall flange inside the fuselage shell, bending it to match the contour of the shell. Center the flange laterally on the firewall and butt the bent tabs on the aft edge of the flange against the firewall sheet. Use several small C-clamps or Cleco side-grip clamps to secure the forward edge of the firewall flange to the cowling flange of the fuselage shell. Repeat for the two side flanges and then the upper flange. Adjust the positions of the side flanges vertically so that the overlap between the flanges is equal at all four corners.

When satisfied with the fit of the flanges, begin drilling the rivet holes that secure the flange tabs to the firewall sheet with a **#30** drill bit, as shown in Figure 5. You'll need to use either an extension bit or a right-angle drill motor to gain access to these holes from the aft side where possible. When drilling from the front side make a mark where the flange tabs are located. Also, have an assistant hold a block of scrap wood against the firewall from behind to back-up the drilling; this will prevent the pressure of the drill from bending the firewall and flanges. Cleco the holes as you go.

When all the holes have been drilled, mark the forward edge of the cowling flange onto the outside of the firewall flange all the way around, as shown in Figure 5. **Mark the camloc locations both on the fuselage flange and the firewall flange as shown in the cowling instructions. Then mark the position of two rivets on the firewall flange between each camloc spaced 6" apart and three rivets between the camlocs spaced 7" apart. It is best to keep these 1/4" from the edge of the flange, as this will keep the sheet down tight to the composite joggle flange.**

Remove the firewall flanges from the firewall and trim them to the marked lines. Deburr the trimmed edges of the flanges and all the holes in both the flanges and the firewall. Finally, as shown in Figure 5, mark and center punch rivet hole locations **1/4"** in from the trimmed edges of the flanges at each of the lengthwise locations you marked in Step 2 (see Figure 3). These will get drilled later in step 5.

Completed: [ ]

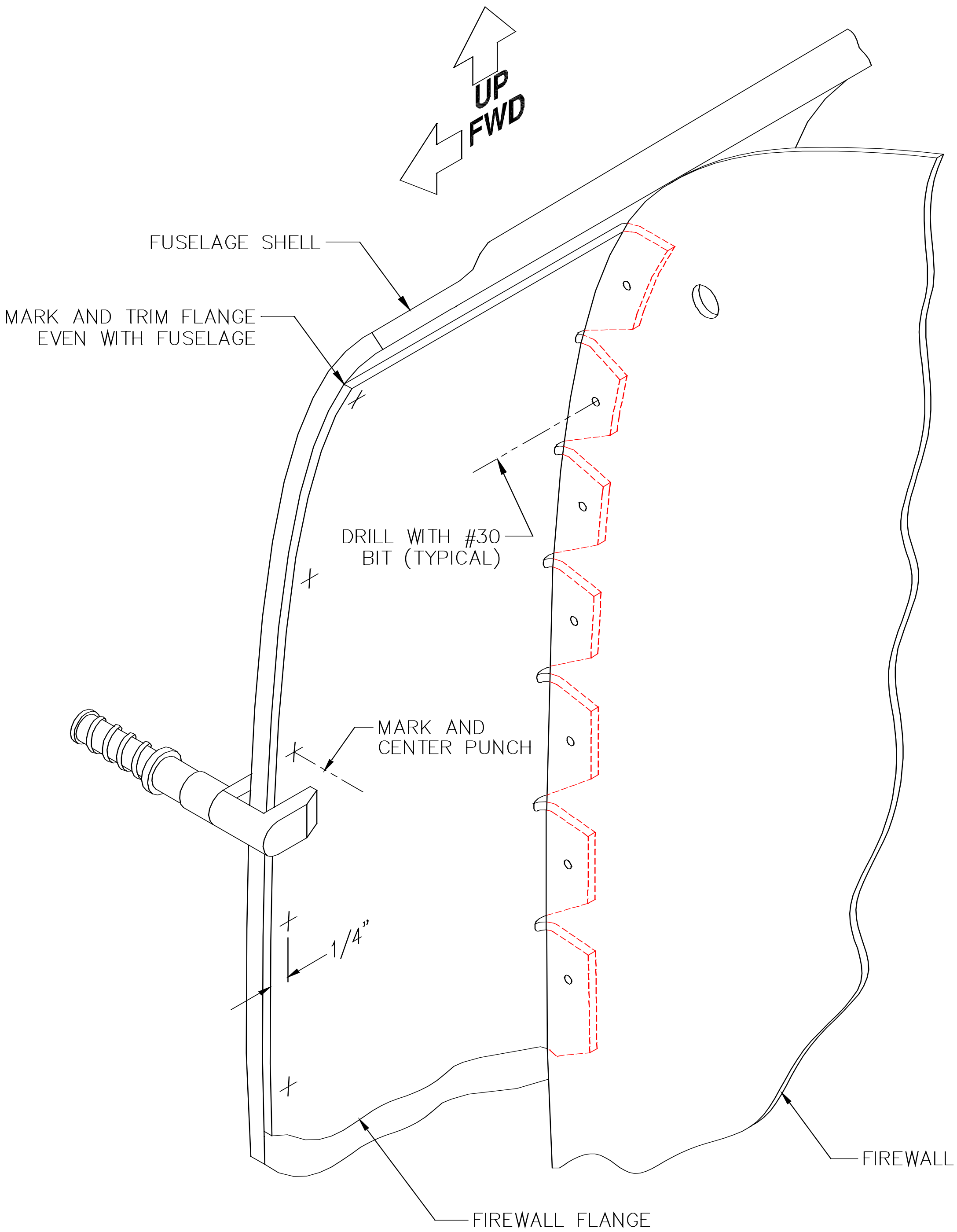


Figure 5: Drilling and Trimming the Firewall Flanges

Step 4: Rivet the Firewall Assembly Together

Now, use **1/8" monel universal-head rivets** [165] to rivet the firewall flanges to the front of the firewall sheet. When riveting on the flanges, be careful to preserve their relationship so that you maintain the shingle effect described in the last step.

Standard riveting practice would have you install the rivet head on the tab side of the firewall flange. From a practical standpoint, it will be easier to wipe down the engine/firewall compartment if the rivet heads are on the forward side of the firewall.

> **Note** We recommend sealing the gaps between the firewall and the flanges with a fire-resistant caulk to isolate the cabin from hot gases in the event of an engine compartment fire. New GlaStar offers an excellent material for this purpose: CP-25 Fire Barrier Caulk (P/N 270-0132-001). Apply a 1/4"-radius fillet all the way around the inside corner of the firewall assembly to fill any gaps. Reference also the cooling air cutout in the following step at this time.

Completed: [ ]

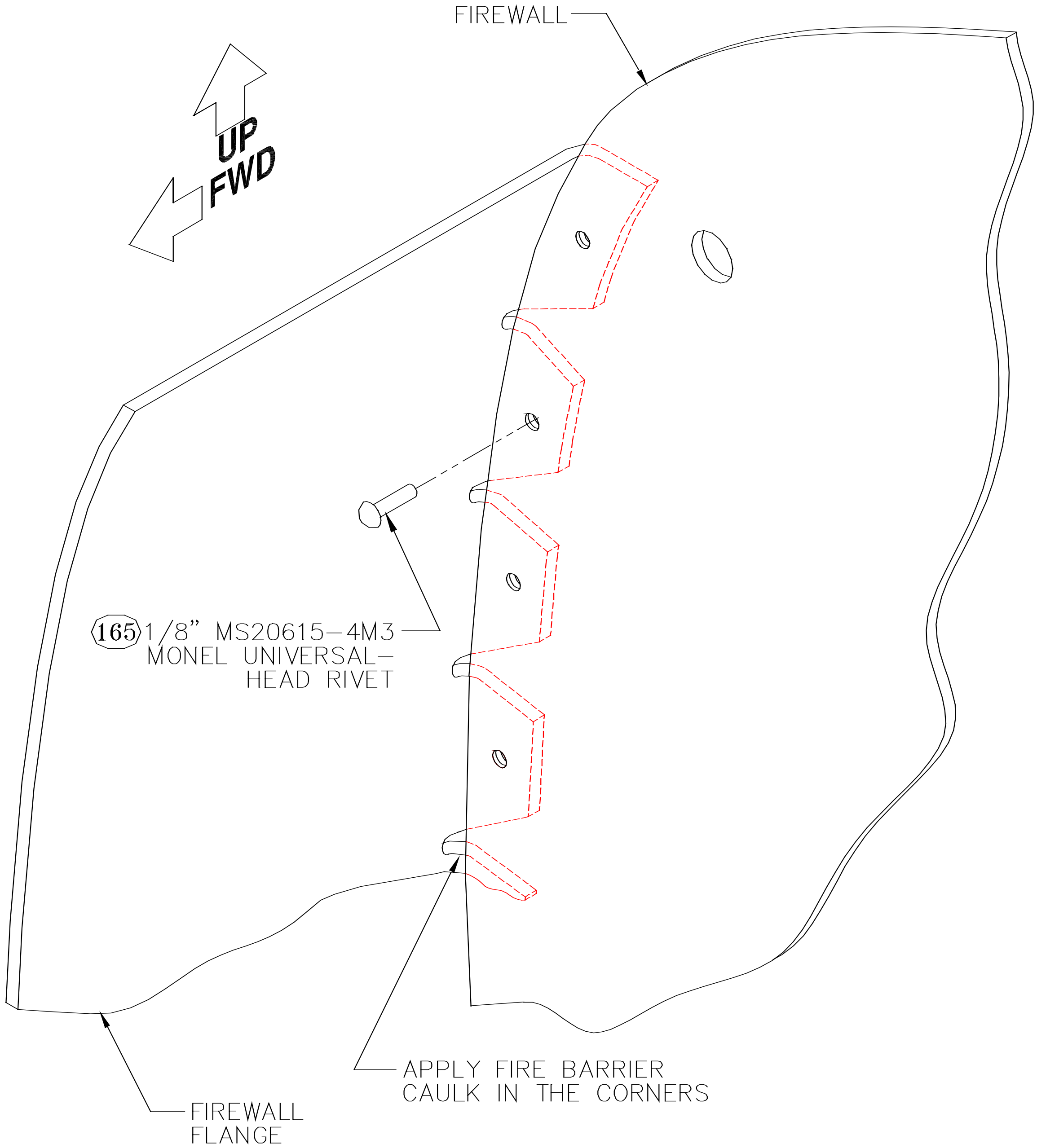


Figure 6: Riveting the Firewall Flanges to the Firewall

Step 5: Fasten the Firewall Assembly to the Fuselage

Note Before installing the firewall assembly, we recommend applying some kind of protective tape to the cage tubes at the front of the fuselage cage. This will help prevent wear on the tubes when the firewall vibrates against it, as well as reducing cabin noise. You can use the same 3/4"-wide anti-chafe tape that you used on the hat sections in the fuel-tank bays of the wings.

Slide the firewall assembly into the front of the fuselage shell until the firewall contacts the front of the fuselage cage. Again pin the firewall assembly to the cage with the 3/8" hardware-store bolts; clamp the firewall flanges to the cowling attach flanges with small C-clamps or Cleco side-grip clamps. As shown in Figure 7, use a **#30** drill bit to drill the rivet holes through the firewall flanges and the cowling joggle at all the marked locations.

Trace the exit air cutout onto the fuselage flange and cut or grind away the composite material until flush with the edges of the lower stainless firewall flange. You may wish to review the baffling installation (Step 13) at this time where it refers to the installation of the exit air cooling ramp.

Remove the firewall assembly once again and deburr all the rivet holes in the firewall flanges. Use your microstop countersink tool with a #30-piloted cutter to countersink the rivet holes on the **outside** of the fuselage shell. Reinstall the firewall assembly for the final time (whew!), only this time, secure the firewall to the cage at each of the ten attach tabs with AN526-8R7 **round-head machine screws** [140], AN960-8L **thin washers** [150] and AN363-832 **high-temperature self-locking nuts** [119]. The screw heads should be on the firewall, the washers and nuts on the tabs.

Note Wherever practical, the firewall should be pulled back tight against the cage tabs. In a few places, however, most likely including those tabs nearest to the engine bushings, there may be a gap between the cage tab and the firewall. Use AN960-8 washers [149] as spacers between such tabs, as necessary, to avoid kinking or excessively bending the firewall.

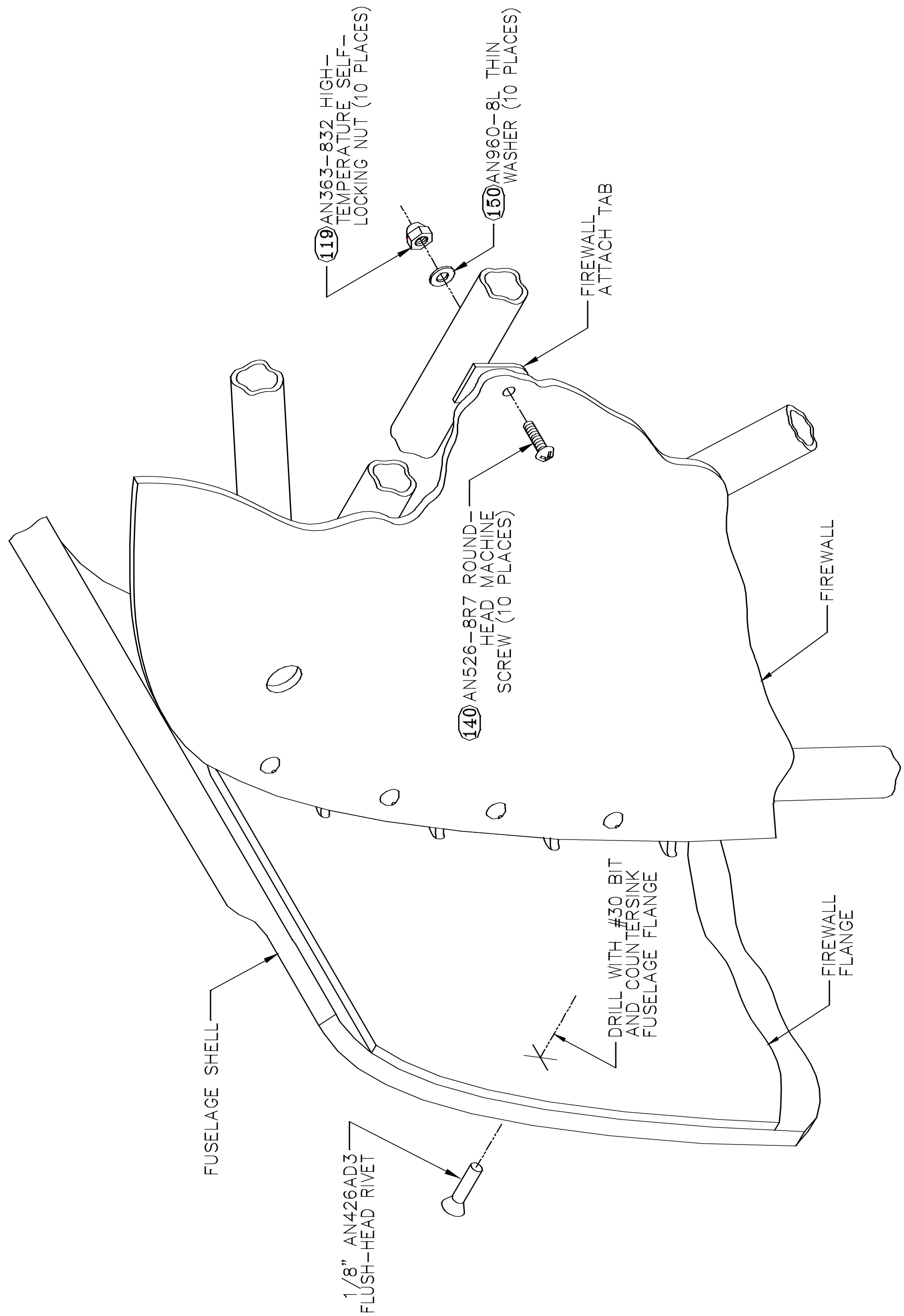


Figure 7: Fastening the Firewall Assembly to the Fuselage Cowl Flange

Finally, rivet the firewall flanges to the cowling attach flange with 1/8" AN426AD4 flush-head rivets. Use a rivet squeezer if you have one. It would be a good idea to keep the 3/8" bolts in the engine mount holes temporarily to guarantee that they stay properly aligned.

Caulk the exposed surfaces of the composite flange on the exit air cutout with the same CP-25 fire barrier caulk.

Tricycle Landing Gear Option At this time you can reinstall your nose gear leg.

Completed: [ ]

Step 6: Install the Brake Reservoir

The brake reservoir can now be permanently installed on the aft side of the firewall. As shown in Figure 8, hold the reservoir mounting bracket against the firewall such that the bottom of the reservoir is approximately **19"** above the fuselage shell floor. The reservoir can be positioned anywhere from side-to-side, but we recommend a location near one of the cage attach tabs on the top cross-tube of the firewall truss. This provides a little more stiffness to the reservoir mounting.

With the reservoir positioned where you want it, drill through the firewall with a **#10** bit, using the two holes in the mounting bracket as guides. Then cut a **2"-square** doubler out of the **.016"**-thick stainless steel scrap left over from the firewall and drill matching #10 holes in it. Deburr the holes in the firewall and the doubler, and then secure the reservoir with NAS603-7P **round-head machine screws** [168], AN960-10L **thin washers** [146] and AN363-1032 **high-temperature self-locking nuts** [118]. As the figure shows, the doubler and the screw heads should be on the forward side of the firewall.

Completed: [ ]

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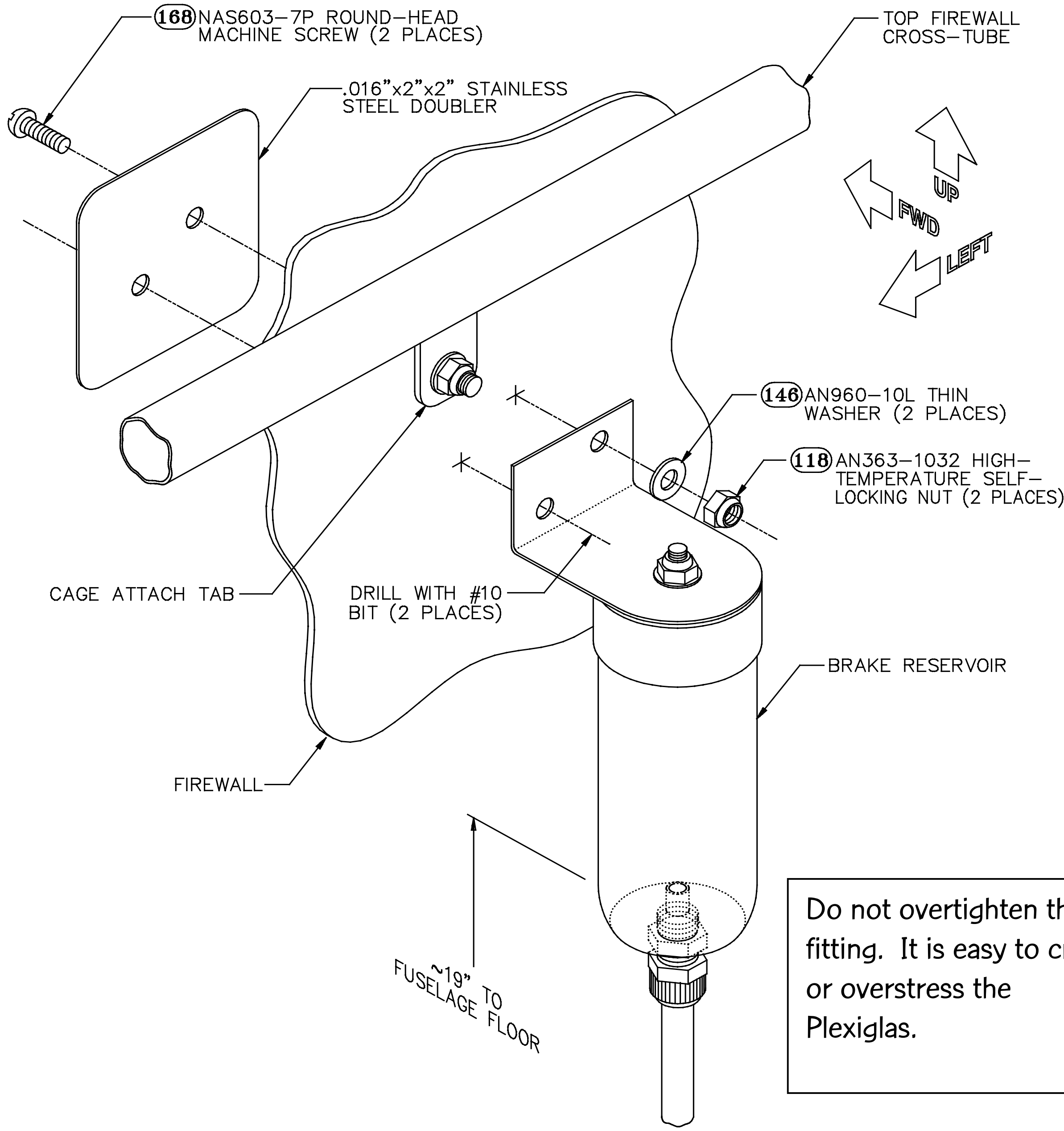


Do not overtighten this fitting. It is easy to crack or overstress the Plexiglas.

Figure 8: Installing the Brake Reservoir

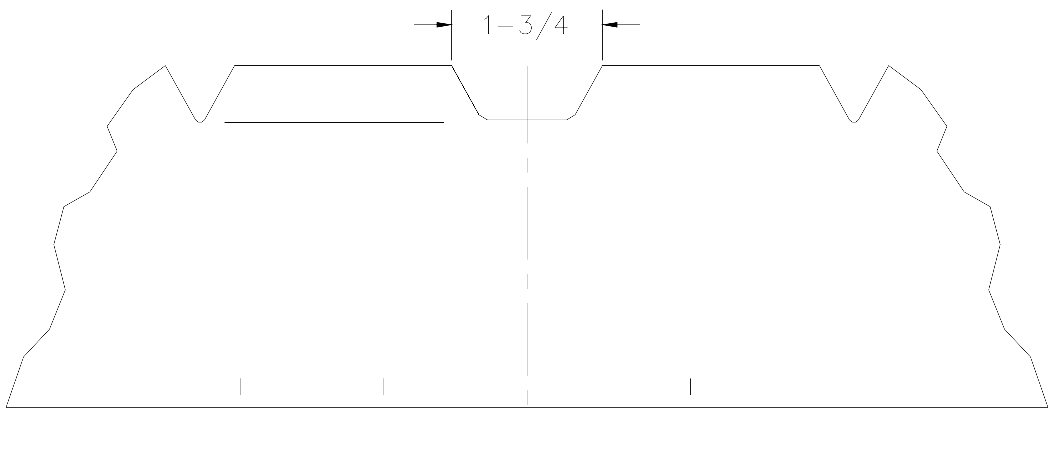
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33[redacted]

FIREWALL FORWARD

Step 7: Install Everything Forward of the Firewall

Obviously, the "firewall forward" portion of any airplane project is a tremendous amount of work consisting of many, many steps, and these steps can vary widely depending on the specific combination of engine, propeller and accessories you choose to install. The Sportsman is developed around the Lycoming O-360 180HP engine and Glasair Aviation supports most of the firewall forward parts and system components that you will need. Contact the Options Order Desk for more information.

Sportsman Option	**Part Number**
Exhaust System	925-03000-01
Oil Cooler Installation	922-06000-01
Baffling Installation Alternator Recess	505-03001-01
Baffling Installation O-360	922-05000-01
Vacuum System	912-03000-01
Induction System O-360	922-07000-01
Shock Bushings	222-4011-501
A-750 Vernier Control Cable-Prop if required rear Governor	05-07948
A-750 Vernier Control Cable-Mixture	05-07848
A-800 Friction Lock Control Cable-Throttle	05-09248
A-740 Control Cable-Cabin Heat	05-14072
A-740 Control Cable-Carb Heat	05-14072
Engine Controls Bracket Installation O-360	922-08000-01
Prop Governor Jihostroj Installation	681-0210-682
Prop Governor Bracket Installation	922-09000-01
Usher Gascolator	332-0341-102
Gascolator Bracket	05-25971
Cabin Heat System Installation	938-03000-01
Fuel Pump Cooling Shroud Installation	331-0165-501
Starter Solenoid	210-0024-059
Lycoming Engine O-360-A1F6	501-04000-02
Propeller Hartzell CS for O-360 80" w/o damper	502-04000-03

Interior Installation

In this sub-section, you will fit the baggage bulkhead close-out, the control cable covers, floorboards, seat pans and seats. All of these installations could be put off until near the very end of the assembly process if you wished, and in some ways, this would make the most sense, because once fitted, all these items will have to be removed to complete other work in later sub-sections. The reason we have chosen to put these steps here is to maximize the amount of work that can be accomplished before the wings have to be mounted to the fuselage for the final time. In other words, if space is at a premium, you'd be wise to get as much of this sort of thing out of the way as you can while the airplane's still skinny enough to fit in your shop! If you've got plenty of room, you might prefer to move this whole sub-section to "Miscellaneous Final Assembly Details." It's your call.

Step 8: Cut Out the Bulkhead A Close-Out

Bulkhead A needs a close-out to keep cargo from getting beyond the cargo area.

Glasair Aviation has a very nice composite close-out for Bulkhead A available. Contact the order desk for part number 101-01060-06.

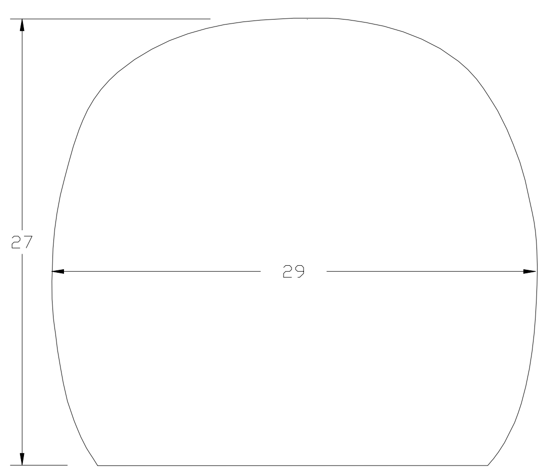


Figure 9: Bulkhead A Close-Out

Figure 9 shows the dimensions of the close-out. Lay out this pattern on cardboard and trial fit until you are satisfied, then transfer it to the **.020" x 27 x 30" aluminum sheet** [67]. It should not ride up on the Q-Cell radius on the forward side of the bulkhead. Trim as necessary, and then deburr the edges.

Completed: [ ]

Step 9: Drill the Close-Out and Install the Mounting Nutplates

Mark **sixteen** screw holes around the perimeter of the close-out. Each location should be **3/4"** in from the edge and approximately 6" apart. The spacing of the holes isn't critical—we suggest five holes evenly spaced across the bottom and the remaining eleven holes evenly spaced around the circular perimeter.

Figure 10: Baggage Shelf

When all the holes have been marked, position the close-out against the bulkhead and tack it in place with several pieces of tape. Then drill through the close-out and the bulkhead at each mark with a **#19** bit. Cleco as you go. Remove the close-out and deburr all the holes.

Next, drill **#40** rivet holes for K1000-08 **nutplates** [158] at each of the holes in Bulkhead A. Countersink the holes on the forward face of the bulkhead and install the nutplates on the aft face using 3/32" AN426AD3 flush-head rivets.

> **Note** The close-out is now ready for installation with AN526-8R6 **round-head machine screws** [139], but you will access this back area again later.

Completed: [ ]

Step 10: Install the Baggage Shelf or Back Seat (Optional)

For the purpose of calculating weight and balance, the Sportsman baggage compartment is divided into two zones—a forward and an aft. As in any airplane, the forward zone can carry more weight than the aft without exceeding the center of gravity envelope. If the pilot carefully monitors the distribution of weight in the baggage compartment, there's no need to provide any physical separation of these compartment zones. However, in our Sportsman prototype, we installed a raised shelf in the aft part of the baggage compartment that serves to physically define the two zones and also serves as the bench seat for the two back occupants.

Our prototype shelf consists of a composite core panel and front bulkhead supported on DBM flanges laminated to the fuselage. Aluminum angles on Bulkhead-A support the aft end of the panel. This panel is screwed down around the perimeter to the flanges and angles.

All Sportsman fuselage halves come with foam core recesses for the installation of the aft seat belt restraints and the back rest pivot and support points. Because the hard points are already in, the rear seat installation can always be done at a later date.

Glasair Aviation is working on the details for this rear seat installation and it will be available soon. Contact the order desk for more information.

If you choose not to install a shelf, just remember that this doesn't mean you can load up the aft zone of the compartment (or the forward one, for that matter) with anything that will fit! In fact, we strongly recommend that you install a placard defining the baggage zones and the weight limit for each, regardless of whether you install the shelf.

Note Detailed information on weight and balance calculations can be found in the "WEIGHT AND BALANCE" sub-section at the end of this *Manual*, as well as in the *Sportsman Owner's Manual*

Completed: [ ]

Step 11: Fit the Aft Control Cable Cover

The kit includes two "L"-shaped pieces of **aft control cable cover angle** [58]. Trimmed to fit the contour of the fuselage floor, these pieces form a protective cover over the control cables and wiring that run along the aircraft centerline from the aft end of the cage to Bulkhead A.

The first step in fitting the covers is to cut them to length. Use a tape measure to find the distance from the main cross-tube between the tricycle gear sockets to the forward face of Bulkhead A and cut both pieces of angle stock to this dimension with a pair of snips. Sand the cut edges smooth.

Baggage Shelf Option If you have installed the optional baggage shelf, cut the angle stock to extend from the tricycle gear socket cross-tube to the partial bulkhead at the forward end of the shelf. Adjust the number of rivets specified below according to the reduced cover length.

If you are not installing the baggage shelf , you will need approximately (2) 52" pieces of the cable cover. Early kits will have to splice two pieces of cable cover (-01 which is 48" long and the –05 which is 8" long) in order to get the full length from the aft gear truss to the A bulkhead.

Next, as shown in Figure 11, lap the two "L"-shapes over one another to form an inverted "U," with the wider flanges vertical and the narrower flanges horizontal; clamp the two parts together with spring clamps at each end. Then lay out and drill a series of twelve **#40** rivet holes along each edge of the upper cover half. Observe proper edge-margin standards by keeping the hole centers at least **3/16"** from the edges. Drill the holes, Clecoing as you go.

Note The precise width of the overlap between the two pieces can be varied to suit as long as you leave adequate clearance for the control cables and any wiring and as long as you position your rivet lines so as to preserve adequate edge margin on both halves.

Hint When drilling the holes, place the overlapped covers over a scrap length of 2 X 8 set on edge in a bench vise.

Place the Clecoed cover in position in the fuselage and trim the lower edges of each side to fit the slight curvature of the fuselage floor. Trial and error may be about the best method for this, but you might prefer to make a cardboard template first. In either case, the height of the cover sidewalls can be varied to suit, as long as adequate clearance is maintained around the cables and wiring. Sand the trimmed edges smooth.

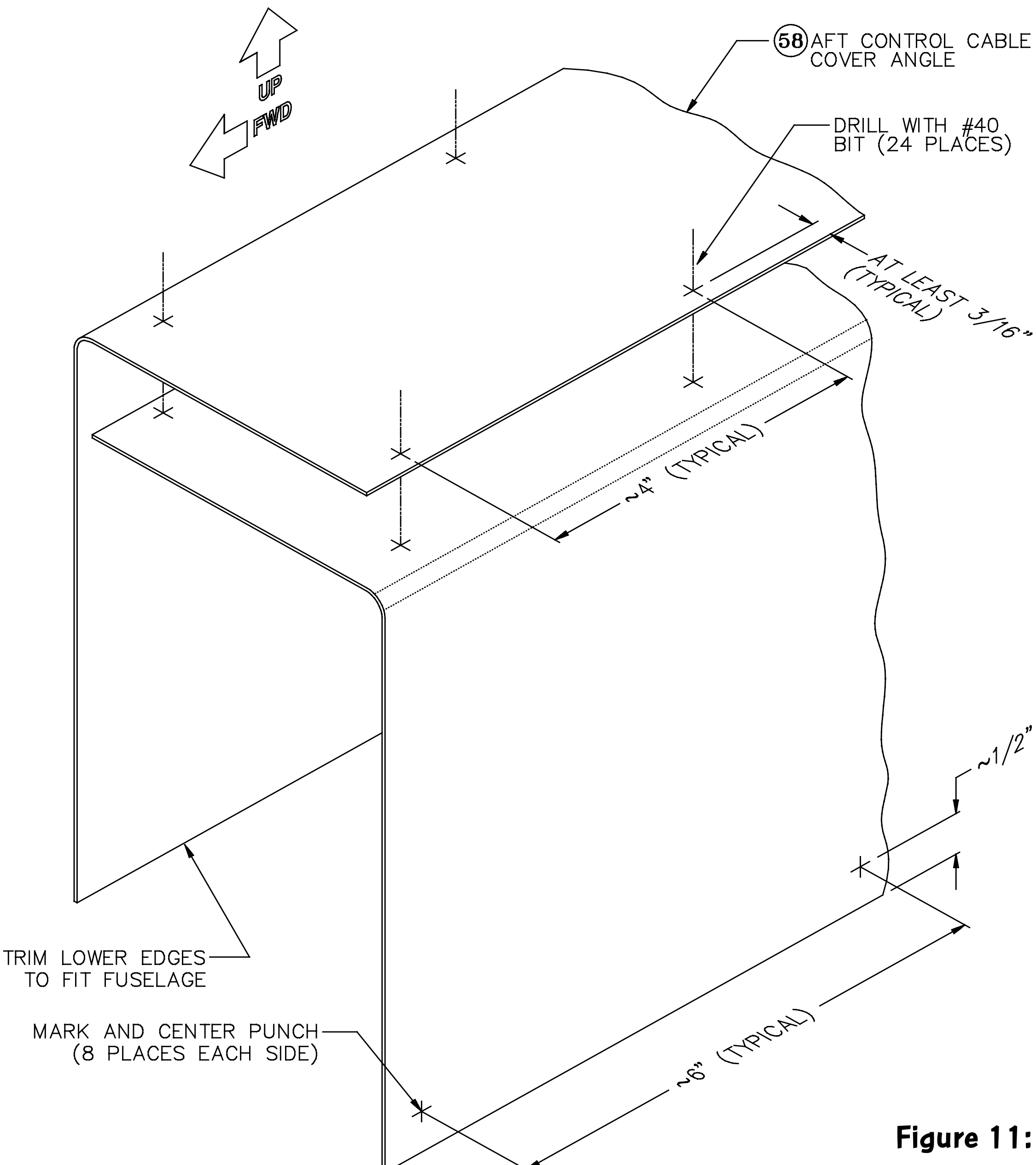


Figure 11: Assembling and Trimming the Aft Control Cable Cover

Finally, after the edges are trimmed to your satisfaction, lay out and center punch a row of hole locations along the lower edge. Space **eight** of these locations evenly along each edge, and mark them about **1/2"** above the lower edge, as shown.

Completed: [ ]

Step 12: Fabricate and Drill Aft Attach Angles for the Aft Control Cable Cover

The aft control cable cover will be attached to the fuselage floor with sixteen mounting tabs that you'll install in the next step. However, it's also desirable to anchor it to Bulkhead A at its aft end in order to stabilize it side-to-side.

Baggage Shelf Option If you have installed the optional baggage shelf, interpret every reference in this step to Bulkhead A as referring to the baggage shelf partial bulkhead instead. All the procedures are otherwise the same.

You will fabricate these aft attach angles from the scraps you cut off the two lengths of aft control cable cover angle in the last step. As shown in Figure 12, each angle should be about **1"** tall, and each flange should be about **1"** wide. These dimensions are not critical. Use snips to cut the angle from the scrap and sand the edges smooth. You can also make these parts from a 1 x 1 x .06 angle. The parts can also be installed internally in the tunnel so they are hidden from view.

Then position the angles as shown in Figure 12, with one flange tight against Bulkhead A and the other flange tight against the side of the cable cover. The vertical positions of the angles isn't critical—simply place one near the top of the cover and one near the bottom. Tape the angles to the cover, and then drill through the center of each Bulkhead A flange with a **#19** bit. Finally, remove the entire cover and, with the angles still taped in place, drill through each taped angle in two places with a **#40** bit, as shown in the figure.

Separate the cover halves, remove the tape, and then use Clecos to re-attach the four attach angles to the cover halves.

Finally, use standard procedures to position, drill and install four K1000-08 nutplates on the aft side of Bulkhead A—one behind each of the #19 aft attach angle holes. Use 3/32" AN426AD3 flush-head rivets to secure the nutplates.

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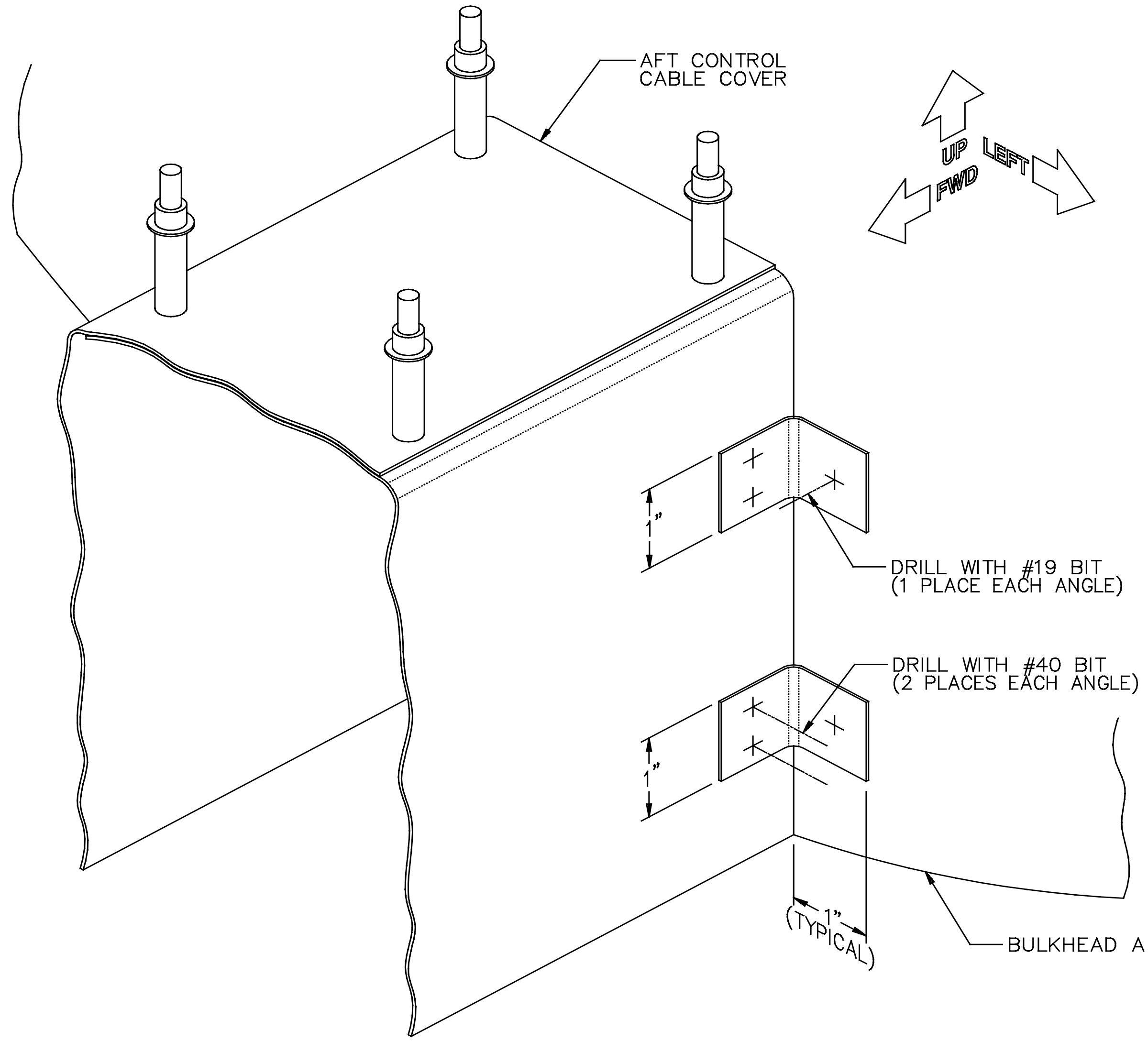

Figure 12: Positioning and Drilling the Aft Attach Angles for the Aft Control Cable Cover

Step 13: Install Mounting Tabs for the Aft Control Cable Cover

The sixteen aft control cable cover mounting tabs will be laminated in place on the fuselage floor using **3"-wide DBM cloth** [61]. The cover halves themselves will be used as forms for laminating the tabs. Prepare them for this role by, first, marking reference lines on the **inboard** side of the cover halves' sidewalls just opposite the hole locations you marked along the lower edges in Step 11. Each line should extend about **2"** above the lower edge of the cover half, as shown in Figure 13a. Second, apply a liberal coating of mold release wax or the equivalent to an area at least **2"** high by **3"** long centered on each reference line you just marked. Clean the fuselage floor very well and do not get any wax on the composite surface.

Next, position one of the cover halves in the fuselage. At its aft end, secure it to Bulkhead A with a pair of AN526-8R8 **round-head machine screws** [141] through the aft attach angles, as shown in Figure 13a. At the forward end, check to see that the sidewall of the cover half is vertical, and then temporarily secure the half to the cage structure with tape. Apply more tape along the lower edge of the cover half on the **outboard** side to secure it to the fuselage floor. Use a straightedge to ensure that the lower edge doesn't have bends or waves in it.

Next, as shown in Figure 13b, cut **thirty-two** small, **2" X 3"** patches of DBM cloth. Laminate two of these pieces against the fuselage floor and the cover half sidewall at each of the reference marks.

After the tabs have cured, sand or grind the rough edges smooth and round the corners. Then, as shown in Figure 13c, drill through the cover and the tab at each of the hole locations marked on the **outboard** side of the cover half. Use a **#19** bit in a right-angle drill motor or adapter. Deburr the holes and set the cover aside.

Finally, as shown in Figure 13d, drill and countersink **#40** holes in each tab for K1000-08 nutplates. Rivet these nutplates in place on the **inboard** face of each tab with 3/32" AN426AD3 flush-head rivets.

Repeat the above procedures for the opposite cover half.

Completed: Left [ ] Right [ ]

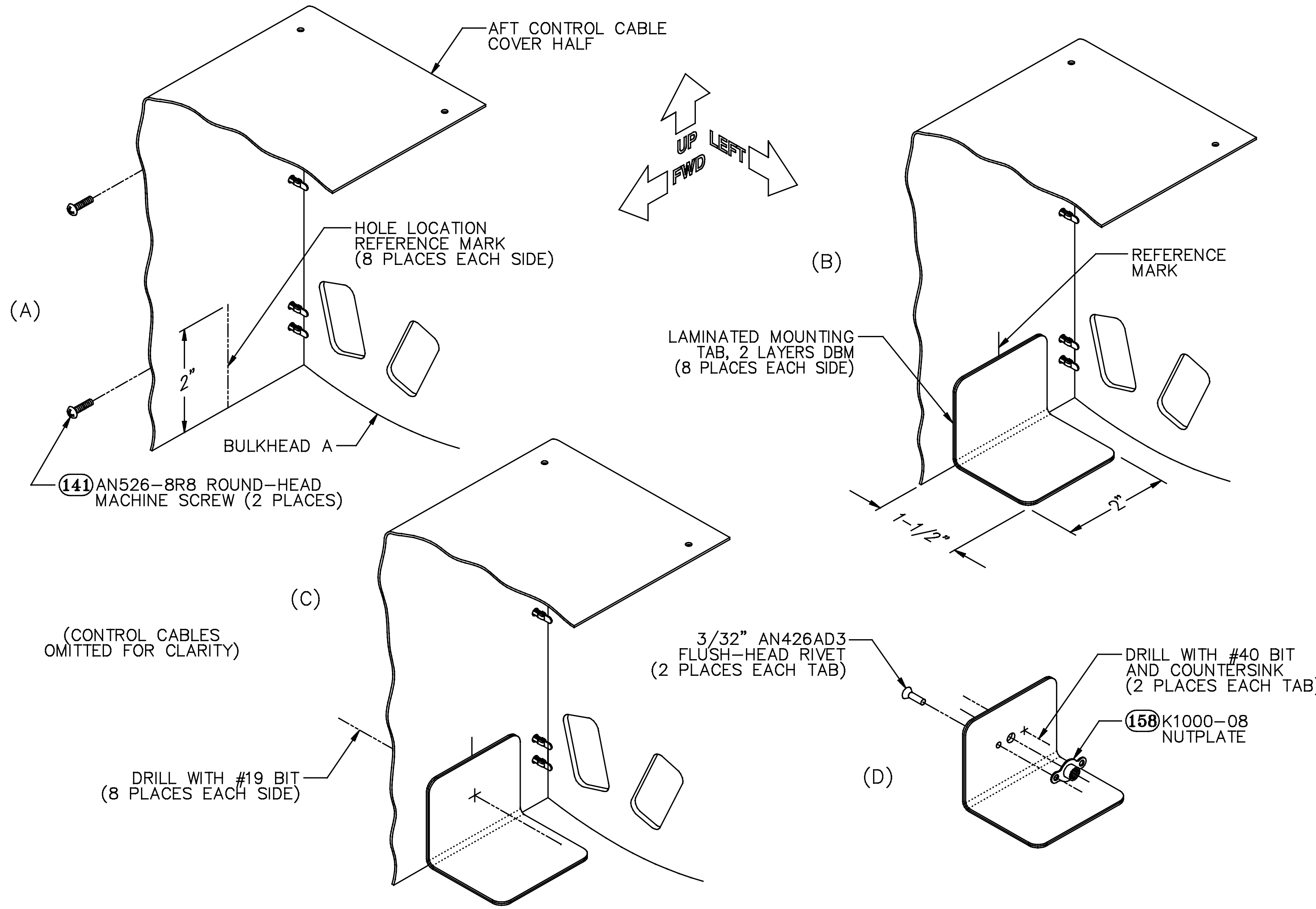

Figure 13: Installing the Aft Control Cable Cover Mounting Tabs

Step 14: Assemble the Aft Control Cable Cover

Deburr all the holes in both cover halves and all four aft attach angles. Apply the anti-corrosion protection of your choice. Then use 3/32" AN470AD3 universal-head rivets to join the two halves and to rivet the attach angles to the assembly.

> **Note** Alternatively, you can certainly dimple the cover halves and attach angles to accommodate AN426AD3 flush-head rivets if you wish.

You can now install the cover with AN526-8R6 round-head machine screws through the mounting tabs and -8R8s through the aft attach angles, but you may prefer to wait, as the cover will have to be removed for final inspection.

Completed: [ ]

Step 15: Fit the Forward Control Cable Cover Halves

The two **forward control cable cover angles** [59] cover the central cage truss from the main cross-tube between the taildragger gear sockets to the firewall. As you will notice the two trusses are not parallel with each other so some trimming will be required. First, a cutout must be made near the forward end of each piece to allow it to clear the rudder control weldments and another cutout must be made in the top of each half to accommodate the fuel shut-off valve as well as trimming each to a width of 4-3/8", if necessary. **Before you trim to any of the dimensions in the next few figures, make sure you measure your actual dimensions on your installation.**

Figure 14 shows the approximate dimensions of the rudder control weldment cutout that must be made in each half. Use snips to cut a bit inside the indicated line; you can use trial and error shortly to trim to final size.

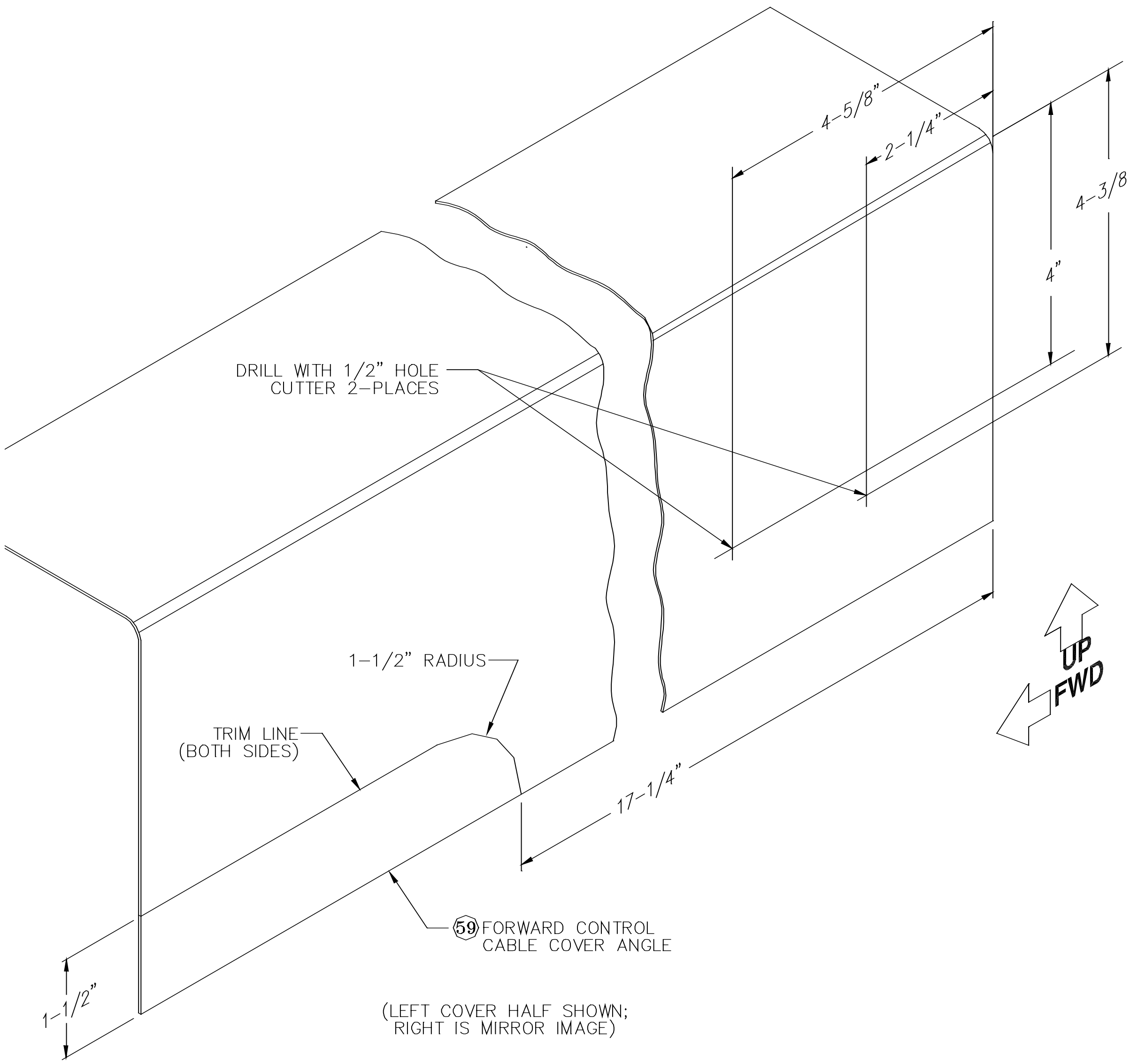

Figure 14: Trimming the Forward Control Cable Cover Halves to Clear the Rudder Control Weldments

Next, you need to make the cutout for the fuel shut-off valve. Begin by overlapping the two halves and clamping them together with spring clamps as you did with the aft pair. The width of the forward cover is not flexible like the aft width was; it is set by the width of the central cage truss. Adjust your clamps until the vertical sidewalls of the two cover pieces are tight against the truss.

Mark the location of your fuel shut-off valve on the temporarily joined cover, either by measuring the location of the valve relative to the cage structure and transferring this location to the outside of the cover or by using the modeling clay method you used in locating the fuel gauge flange on the wing root ribs to mark the valve location on the inside of the cover (see "SECTION IX: SYSTEMS INSTALLATION," Step 54). The cutout can be shaped to suit, but be sure to leave ample room for your fingers between the edges of the cutout and the valve handle. Figure 15 gives a suggested size and shape for the cutout.

Start the cutout using hole cutters and finish it up with a single-ended hacksaw, snips and/or a rotary cutting tool. At a minimum, sand the cut edges very smooth, but you may also want to consider rolling the edges under slightly.

Warning Ultimately, you will need to provide some sort of close-out under the shut-off valve cutout to prevent the possibility of foreign objects falling through the cutout and jamming the control cables below. This can consist of nothing more than a flap of carpeting or upholstery, or it could be a more elaborate sheet-metal or composite close-out.

With the fuel valve cutout complete, you can now position the cover to check the fit over the rudder control weldments. Enlarge those cutouts as necessary to provide at least **1/16"** of clearance around all parts of the rudder control mechanism when the top of the cover is flat against the truss.

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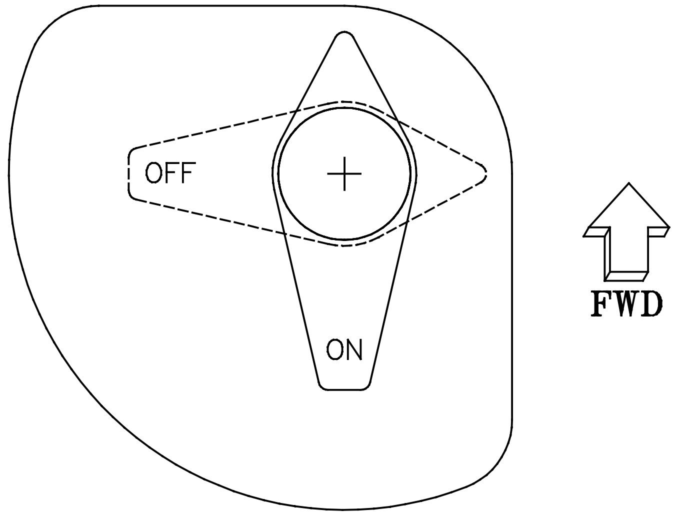

Figure 15: Template for Suggested Fuel Shut-Off Valve Cutout (Full Size)

Step 16: Join the Forward Control Cable Cover Halves

Now you're ready to join the cover halves. The recommended method for doing so varies depending on whether you're installing a manual or electric trim system. Follow the instructions appropriate to your system; instructions common to both systems begin again with Step 17.

MANUAL TRIM OPTION

The trim gear box and its mounting brackets dictate that the forward cover halves be joined with screws and nutplates rather than rivets. This allows the cover halves to be slid into place individually from the side rather than as a unit from above, which in turn minimizes the size of the holes that must be cut in the cover to accommodate the trim system.

With the cover halves still clamped together to the width of the cage truss, lay out and drill a series of **six #19** screw holes on a line **5/16"** from the edge of the **upper** cover half, which should be the **left-hand** half. As shown in Figure 16, these holes should be spaced roughly on **4-1/2"** centers, with each end hole **5/8"** from the end of the cover. Because the cover is supported from below by the truss, you only need holes along this one edge.

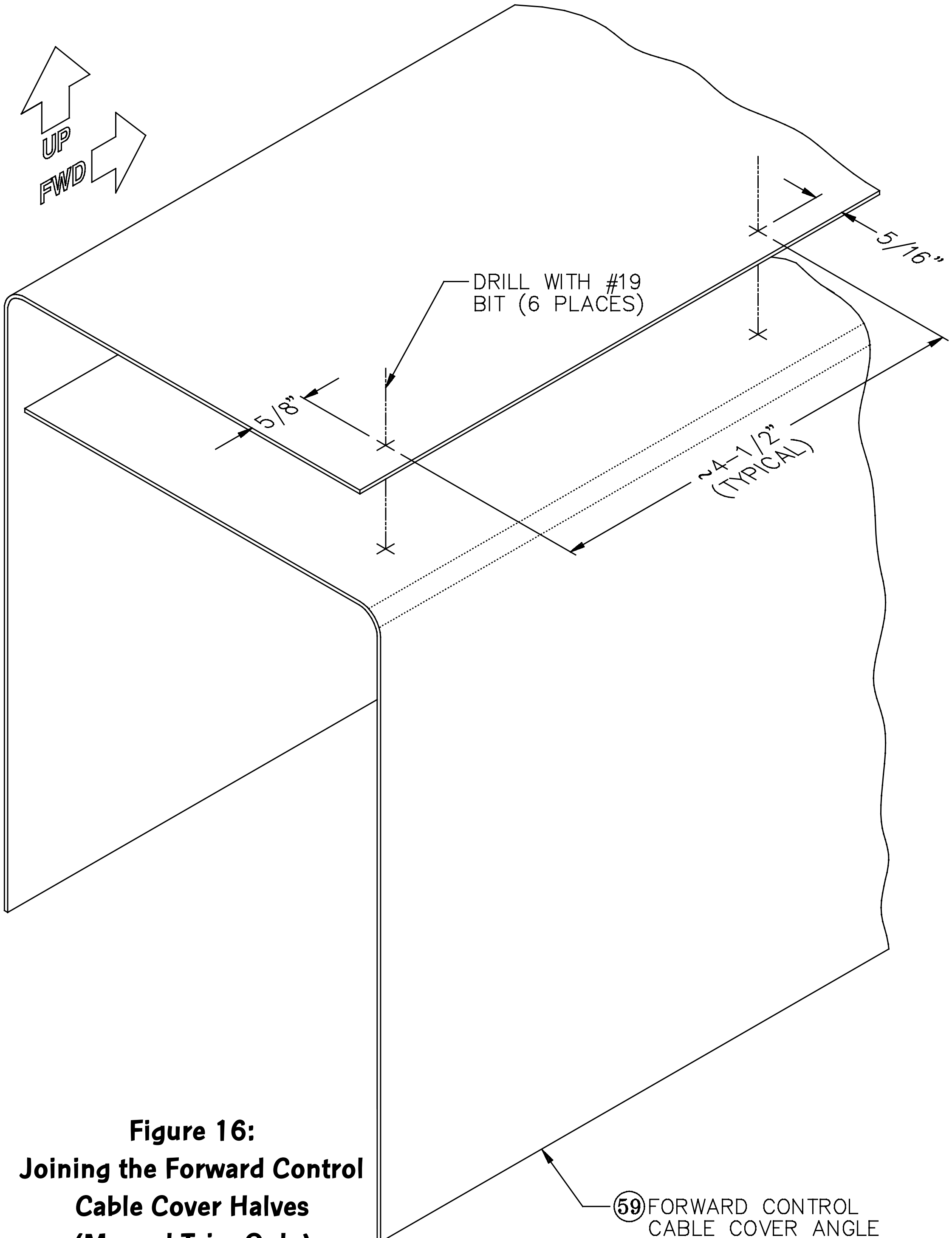

Figure 16:
Joining the Forward Control Cable Cover Halves (Manual Trim Only)

The next step is to cut slots in the cover halves to accommodate the trim cable. The cover will eventually be installed **between** the trim gear box brackets and the cage truss, so there's no need to provide cutouts in the cover for the brackets themselves, but the cable does have to come through the cover.

With the gear box temporarily mounted on the cage truss (as described in Step 116 of "SECTION IX: SYSTEMS INSTALLATION"), measure the **longitudinal** distance between the center of the trim cable where it emerges from beneath the top of the truss and the **forward** side of the main cross-tube between the taildragger gear sockets. This dimension is labeled "**X**" in Figure 18a. Next, measure the **lateral** distance between the center of the trim cable where it emerges from beneath the top of the truss and the **left** side of the left-hand truss tube. This dimension is labeled "**Y**" in Figure 18b.

Join the two cover halves with Clecos, as shown in Figure 18c, and then mark the "X" and "Y" dimensions you just measured on top of the left-hand cover half. Use a Unibit or a hole saw to drill a **3/4"** hole at the intersection point.

After the hole has been cut, disassemble the two halves and, using snips, cut slots from the hole to the edge of each half, as shown in Figure 17. Smooth the cut edges of the slot with a fine-toothed file or sandpaper.

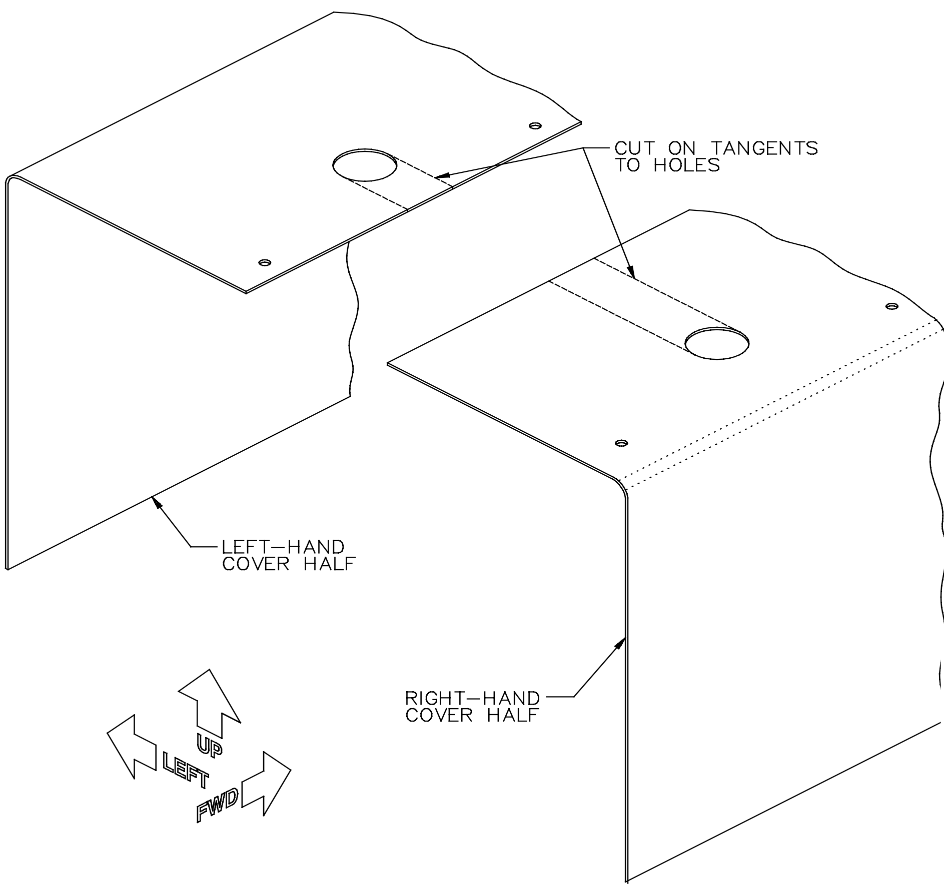

Figure 17: Cutting the Trim Cable Slots (Manual Trim Only)

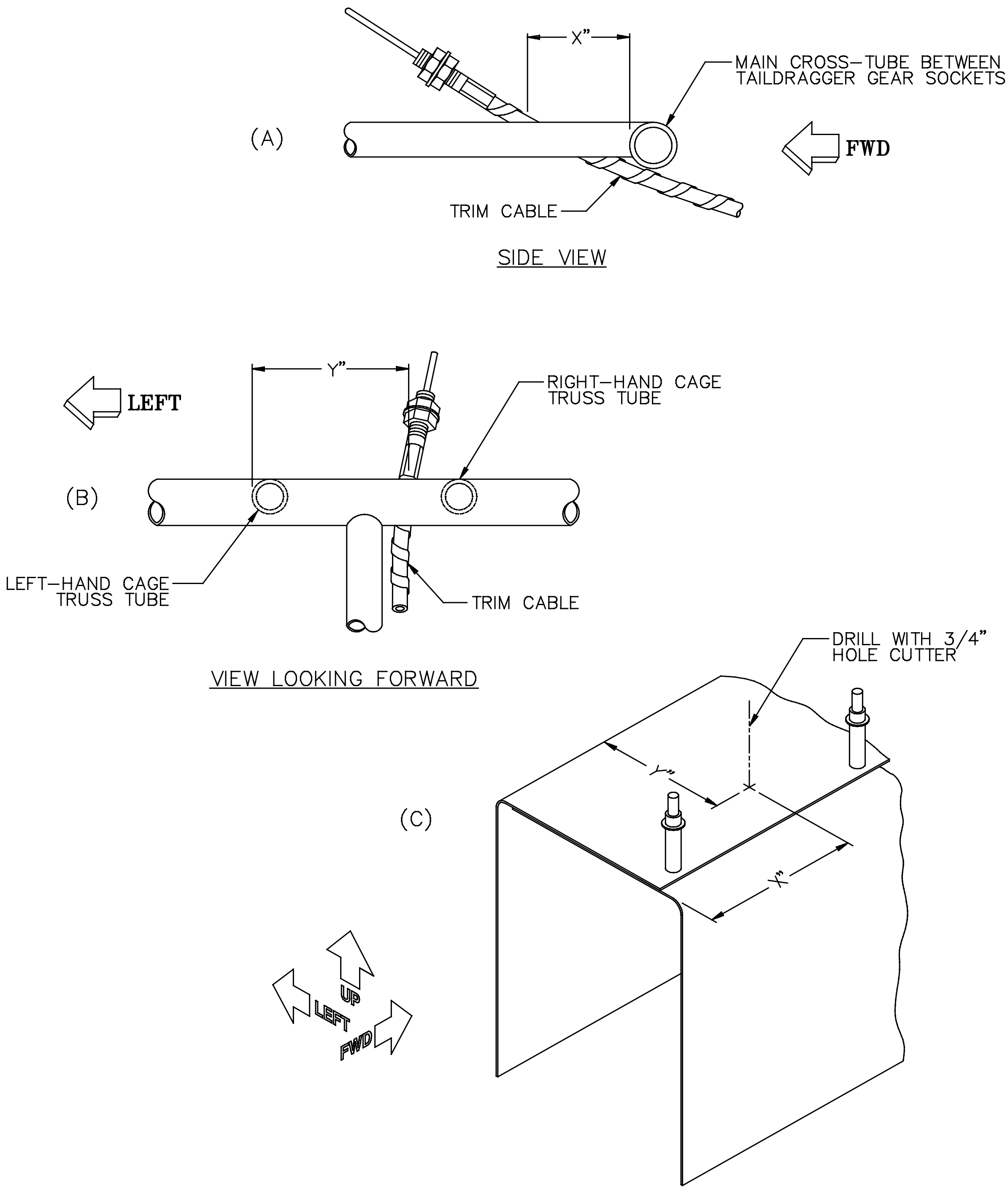

Figure 18: Marking and Cutting the Trim Cable Hole (Manual Trim Only)

Now you need to mark and drill holes through the cover for the screws that hold the trim gear box brackets to the loop clamps. Remove the gear box and brackets from the cage truss, but leave the clamps and nutclips in position. Beginning with the left-hand cover half, slide it into position over the cage truss, with its aft end up against the cross-tube between the taildragger gear sockets. From the right-hand side of the cage truss, reach underneath and use a marking pen to mark the locations of the holes in the two horizontal loop clamps on the underside of the cover half. Repeat the process for the right-hand cover half to mark the locations of the holes in the two vertical loop clamps.

After both halves have been marked, drill at the marked locations in the **left-hand** half with a **#40** bit and in the **right-hand** half with a **#19** bit. Then re-Cleco the two cover halves together and, using the #40 holes in the left-hand half as guides, drill through both halves at those locations with a **#19** bit.

Note It's quite likely that these holes won't line up perfectly with the loop clamp nutclips when it comes time for final installation of the trim gear box, but don't worry about this for now; they can easily be enlarged as necessary when the trim gear box is re-installed in Step 195 of the later sub-section, "SYSTEMS CHECK-OUT."

Next, use standard procedures to position and drill a K1000-08 nutplate at each #19 screw hole along the right-hand edge of the right-hand cover half. Dimple the rivet holes and then corrosion-proof both cover halves as you see fit. Finally, use 3/32" AN426AD3 flush-head rivets to rivet the nutplates to the underside of the right-hand cover half. Assemble the cover with AN526-8R6s and position it over the cage truss. Don't worry about repositioning the trim gear box for now.

ELECTRIC TRIM OPTION

The forward covers can be riveted together just like the aft ones were, although you only need to rivet one edge since the cover is supported from below by the cage truss and thus needs no great strength. As with the aft covers, lay out rivet hole locations on a line at least **3/16"** in from the edge of the upper cover half (which should be the **left-hand** half, as shown in Figure 19). **Six** holes on roughly **4-1/2"** centers are ample.

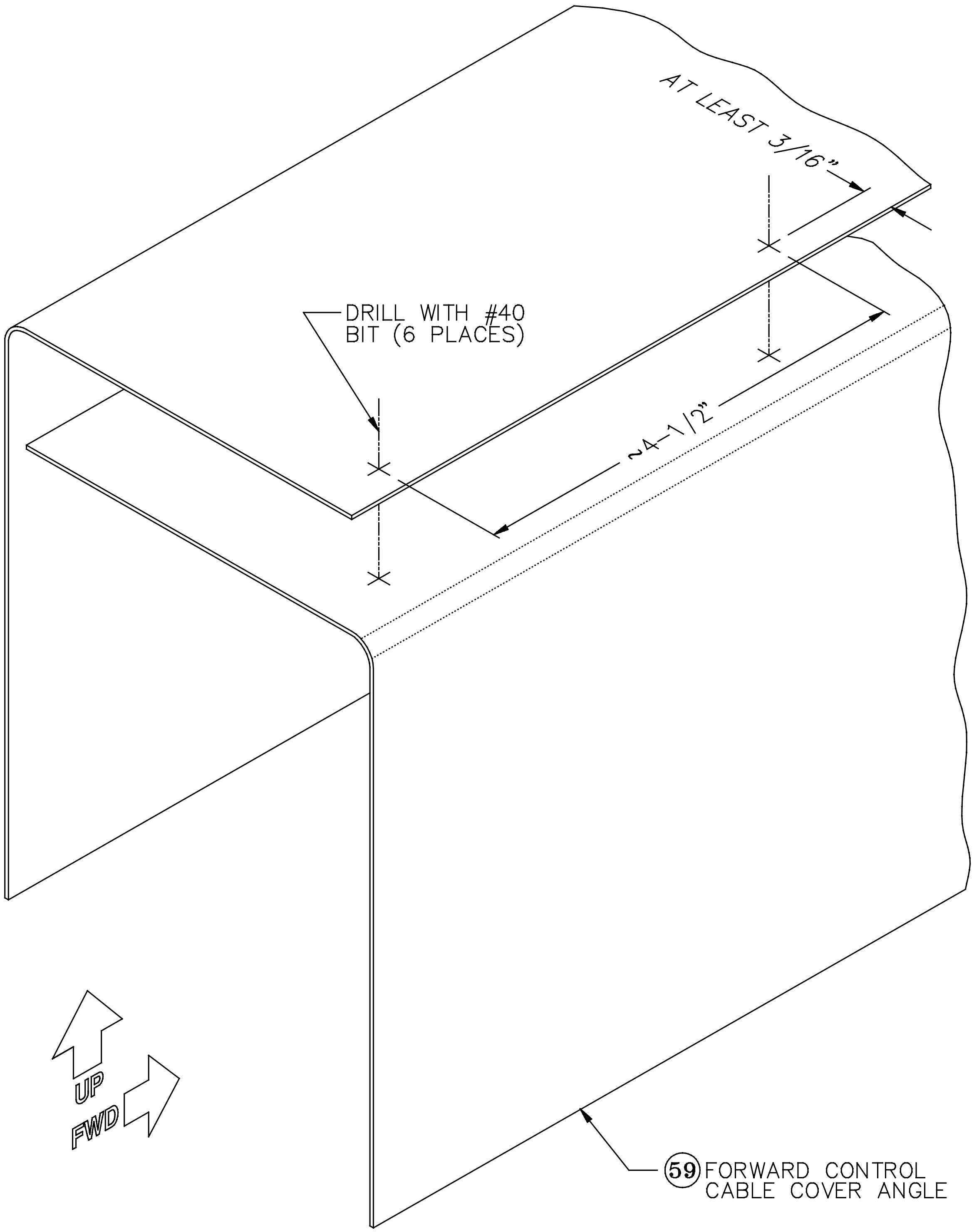

Figure 19: Joining the Forward Control Cable Cover Halves (Electric Trim Only)

Clamp the cover halves together again to the width of the cage truss (if they aren't already), and then drill through both halves at each marked location with a **#40** bit. Deburr all the holes, corrosion-proof the halves as you see fit, and finally use 3/32" AN470AD3 universal-head rivets to join the halves.

Note If you prefer, you can dimple the cover halves and use AN426AD3 flush-head rivets.

Completed: [ ]

Step 17: Fit the Floorboards

As indicated by the shaded areas in Figure 20, the floorboards cover the area between the rudder control weldments and the seat pans in a fore-and-aft direction, and between the fuselage sidewall and the forward control cable cover in a lateral direction. They are held in place at twelve attach tabs welded to the cage; the locations of these tabs are shown in the figure.

Cut the floorboards out of **1/4"** marine-grade plywood, available at any building supply store. You can also use lightweight composite panels for this if you have a local source for them, but this is definitely more expensive. Because of small but significant variations in the Sportsman cages, we are unable to provide templates for the floorboards, so make a pair out of cardboard for your own cage. Note that each floorboard must be relieved in three locations: at its forward end (Point A in Figure 20) to fit around the rudder control weldments; along its outboard edge (Point B) to accommodate one of the small, vertical tubes in the truss at the lower edge of the cage sidewall; and at its aft, outboard corner (Point C) to fit around the taildragger gear socket. Also note that the Point A cutouts are **not** the same left and right. Finally, take special care to get a **tight** fit on the inboard edges of both floorboards. This is where they contact the sides of the forward control cable cover, and to prevent the cover from rattling around, the floorboards should fit snugly.

Note The gaps all the way around the floorboards in Figure 20 are exaggerated for clarity; strive for a good, tight fit all around.

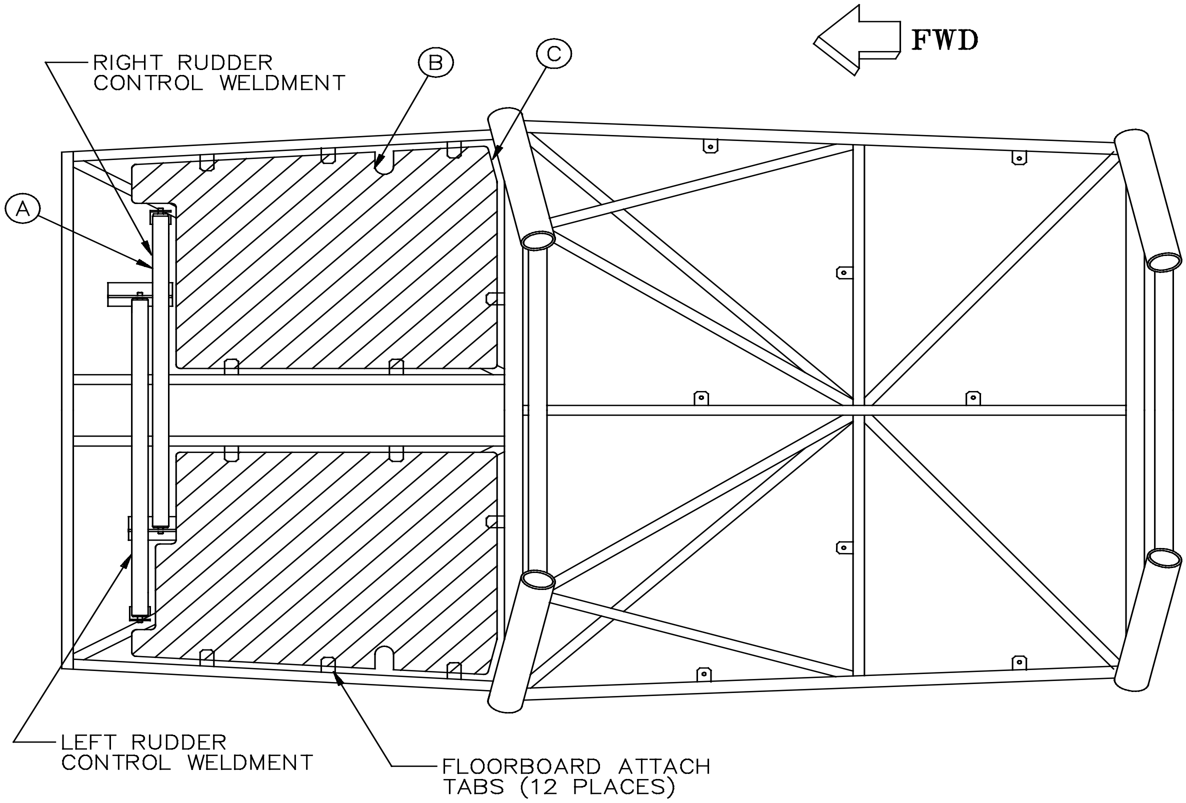

Figure 20: Fitting the Floorboards

Once you have the floorboards fitted to your satisfaction, it's time to address the mounting holes. The locations of the twelve attach tabs will vary slightly from cage to cage, so you'll have to mark the actual locations of the attach tabs on each floorboard.

If you have any tabs with holes, start with those. The task is to mark and drill a hole in the floorboard that matches the underlying one in the tab. One approach is to dab a small amount of paint onto the upper surface of the attach tabs, and then to carefully lower the floorboard into position. The tab locations will be marked on the bottom of the floorboard, with the hole showing up unpainted. Matching holes can then be drilled through the floorboard. The paint can be wiped off the tab before it dries.

For the tabs without holes, simply position the floorboard, eyeball the location of the underlying tab and drill through both board and tab in a single pass from above. In all cases, use a **#19** bit. Once all the holes have been drilled through both the floorboard and the tabs, remove the board and ream all the attach tab holes up to final size with a **#10** bit. This mismatch in hole size between the floorboard and the tabs simply makes it easier to align the screws when the board is installed.

Sand the floorboards to your satisfaction and finish them with polyurethane varnish, epoxy paint or any other durable surface finish you choose.

Caution Even if you intend to carpet your plywood floorboards, you should apply a moisture-resistant finish to prevent dry rot.

The boards are secured to the attach tabs with **nutclips** [66] and AN526-8R8 round-head machine screws. At this time, slide the clips over the attach tabs (with the nut body **down**) until they're centered on the screw holes in the tabs. You may find it helpful to use the blade of a small, standard screwdriver to hold the clips open for easier installation. You can use the AN526-8R8 screws to secure the floorboards now if you wish, but it would probably be smarter to wait until after final inspections of the aircraft systems have been completed.

Warning As with the fuel shut-off valve cutout mentioned earlier, it's important that the gaps between the floorboards and the fuselage shell be closed out—especially at the forward end near the rudder control weldments—in order to prevent loose objects in the cabin from jamming the controls. Thin aluminum sheet, rubber molding and/or carpeting and upholstery can all be adapted for this purpose.

Completed: [ ]

Step 18: Fit the Seat Pans

The **left** [51] and **right seat pans** [52] must be trimmed to fit around a variety of cage tubes and attach tabs, as well as the control sticks. The pans come with pre-molded scribe lines all the way around their perimeters to guide this trimming. Use files, sandpaper, a saber saw with a carbide grit blade and/or a rotary file in a die grinder to trim the excess fiberglass up to the line.

Note The scribe lines represent **minimal** trimming. In all likelihood, you'll need to take off a bit more than indicated. You need to decide how precise a fit you need. If you're striving for show-plane quality, you'll want to keep the tolerances tight, but count on this being quite a painstaking process. On the other hand, if you're motivated by more practical concerns, trim the pans to fit more loosely—even the most minimal upholstery will hide the gaps.

There is also a scribe line for an oblong cutout at the front of each pan to accommodate the control stick. Once again, this scribe line represents an **absolutely minimum**-sized cutout. In fact, we recommend that you continue the oblong all the way to the bottom of the pan, creating a slot for the control stick rather than a closed hole. This will allow you to install and remove the pans without having to unbolt the control stick, which is an extremely difficult task with the seat pans in place. However, if you insist on the smallest possible cutouts, the oblong shape will permit the sticks to be unbolted.

Note This would be a great time to include a couple of inspection covers in your seat pans to gain access to the to some systems without having to remove seats and pans!

Warning Regardless of the size or shape of your control stick cutouts, you must ultimately provide some sort of flexible close-out over the cutouts to prevents loose objects from jamming the controls. Either a rubber boot or simply a slit in your upholstery fabric will work fine.

Completed: [ ]

Step 19: Fabricate the Seat Track Slider Angles

Cut and drill **four** seat track slider angles from the supplied **.063" X 1/2" X 1/2" aluminum angle** [81], according to the dimensions you measure on your seat bases. Use standard procedures to position and drill K1000-3 **nutplates** [159] on each angle, as shown in Figure 21b. Do not paint the angles as it causes too much friction. Rather grease it during installation. Rivet the nutplates to them with 3/32" AN426AD3 flush-head rivets.

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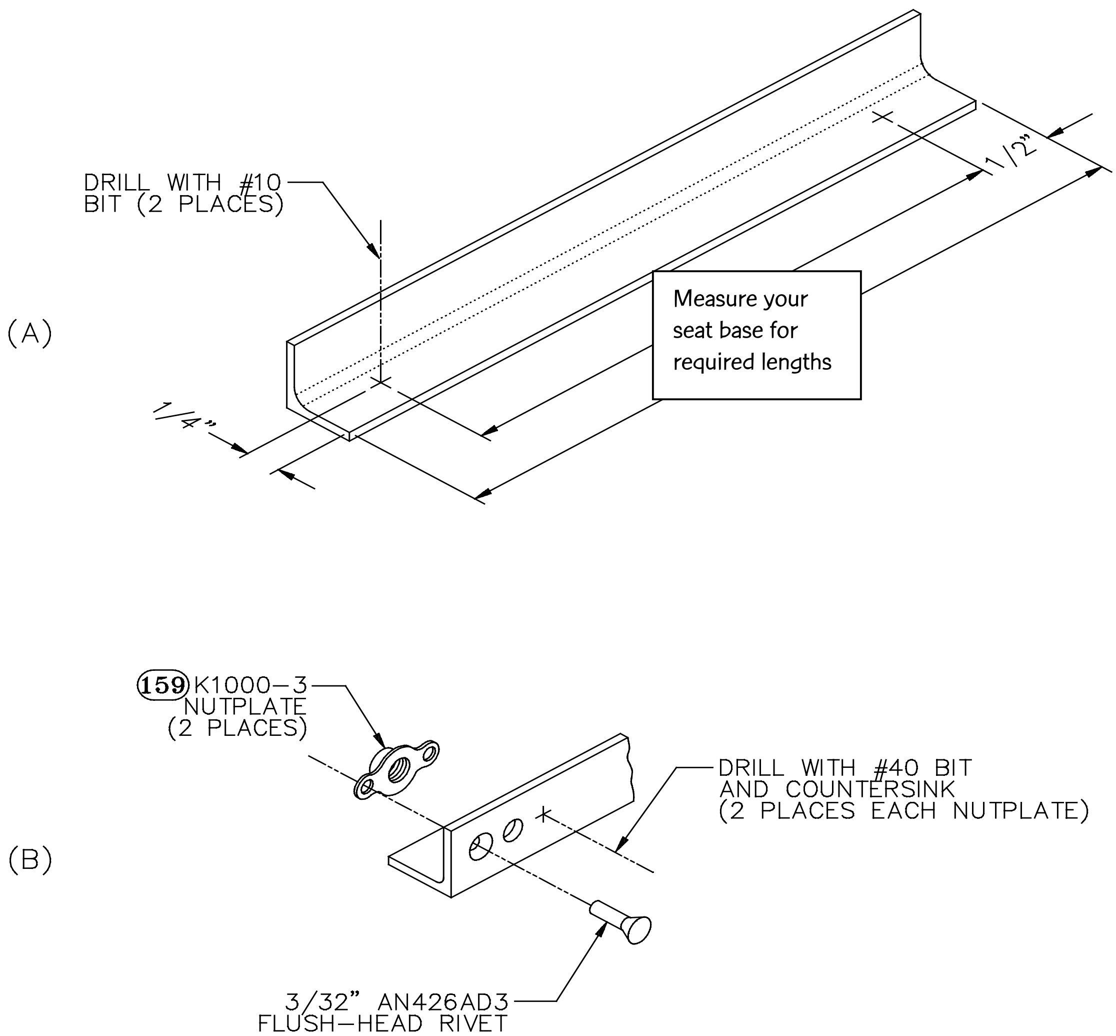


Figure 21: Seat Track Slider Angles

Step 20: Fabricate the Seat-Back Adjustment Locking Pins

Use the supplied length of **1/4" stainless-steel rod** [106] to fabricate **four** seat-back adjustment locking pins, as shown in Figure 22. To make the bend, clamp the rod in a vise and use a hammer to bend the rod over to 90°. Make the bend as tight as possible; the annealed stainless steel is quite malleable and can be bent rather sharply without cracking. Then use a grinding wheel or a file to taper the long end of each pin. Finally, drill a **#40"** hole through the rod **11/16"** from the bottom, as shown in the figure. This hole should be approximately perpendicular to the short, bent end of the rod, but this isn't critical. Keep the hole centered on the rod as closely as you can; using a drill press and a V-block vise will make this much easier.

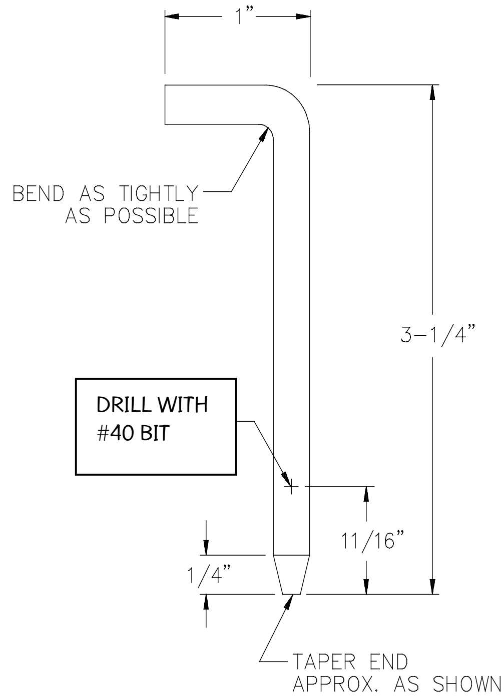


Figure 22: Seat Locking Pin

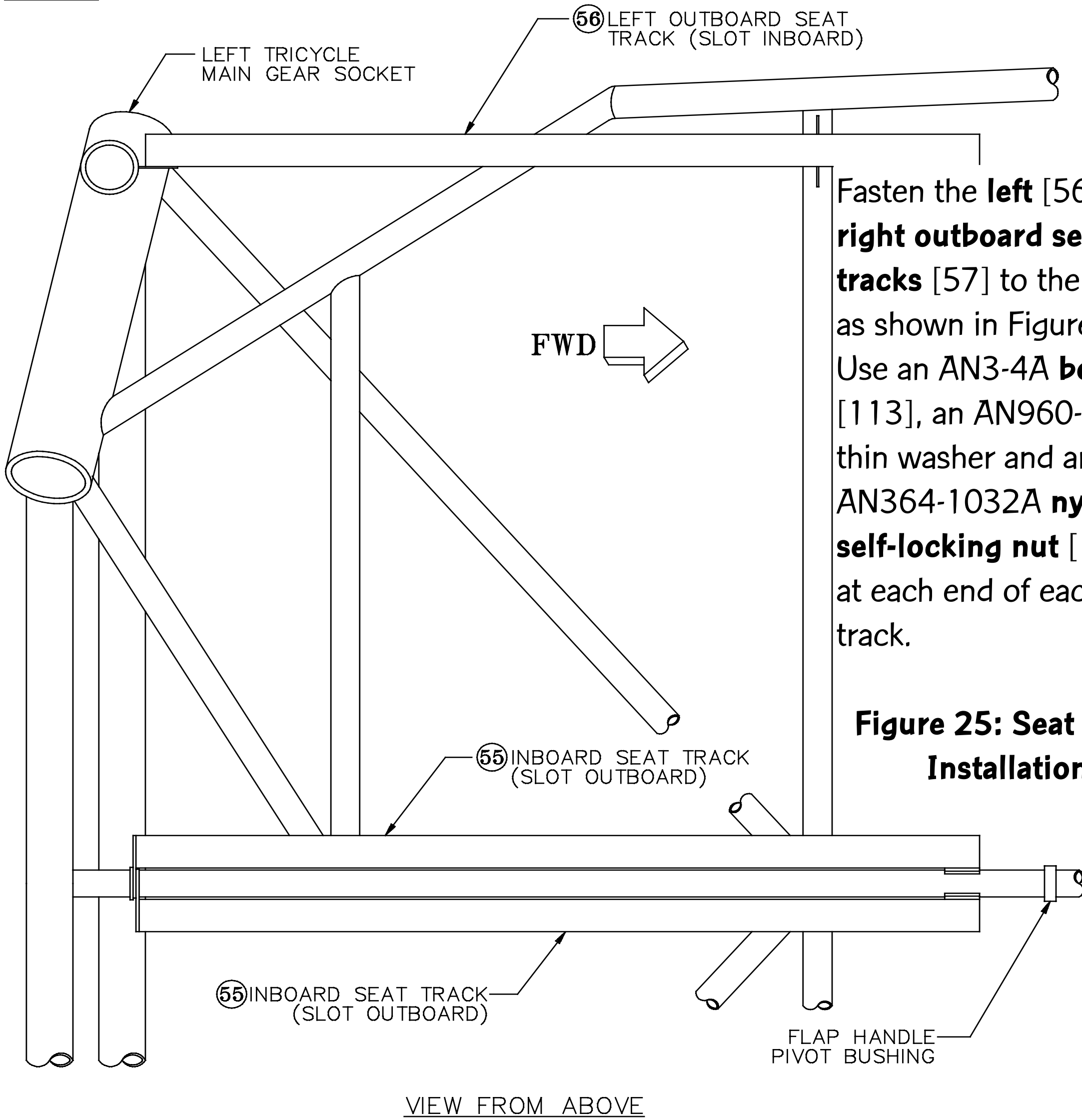
Completed: [ ]

Before going on to Step 21, read step 24 first. It is much easier to drill the seat tracks before mounting them on the cage.

Note: Figures 23 and 24 have been omitted.

Step 21: Mount the Seat Tracks on the Cage

Note **Read Step 24 first**. The seat pans should be in place during this step.



Fasten the **left** [56] and **right outboard seat tracks** [57] to the cage, as shown in Figure 26. Use an AN3-4A **bolt** [113], an AN960-10L thin washer and an AN364-1032A **nylon self-locking nut** [120] at each end of each track.

Figure 25: Seat Track Installation

Note The tabs on the **aft** ends of the outboard seat tracks go on the **inboard** sides of the tabs on the cage, while the tabs on the **forward** ends of the tracks go on the **aft** sides of the tabs on the cage. The slots in both tracks should be **inboard**.

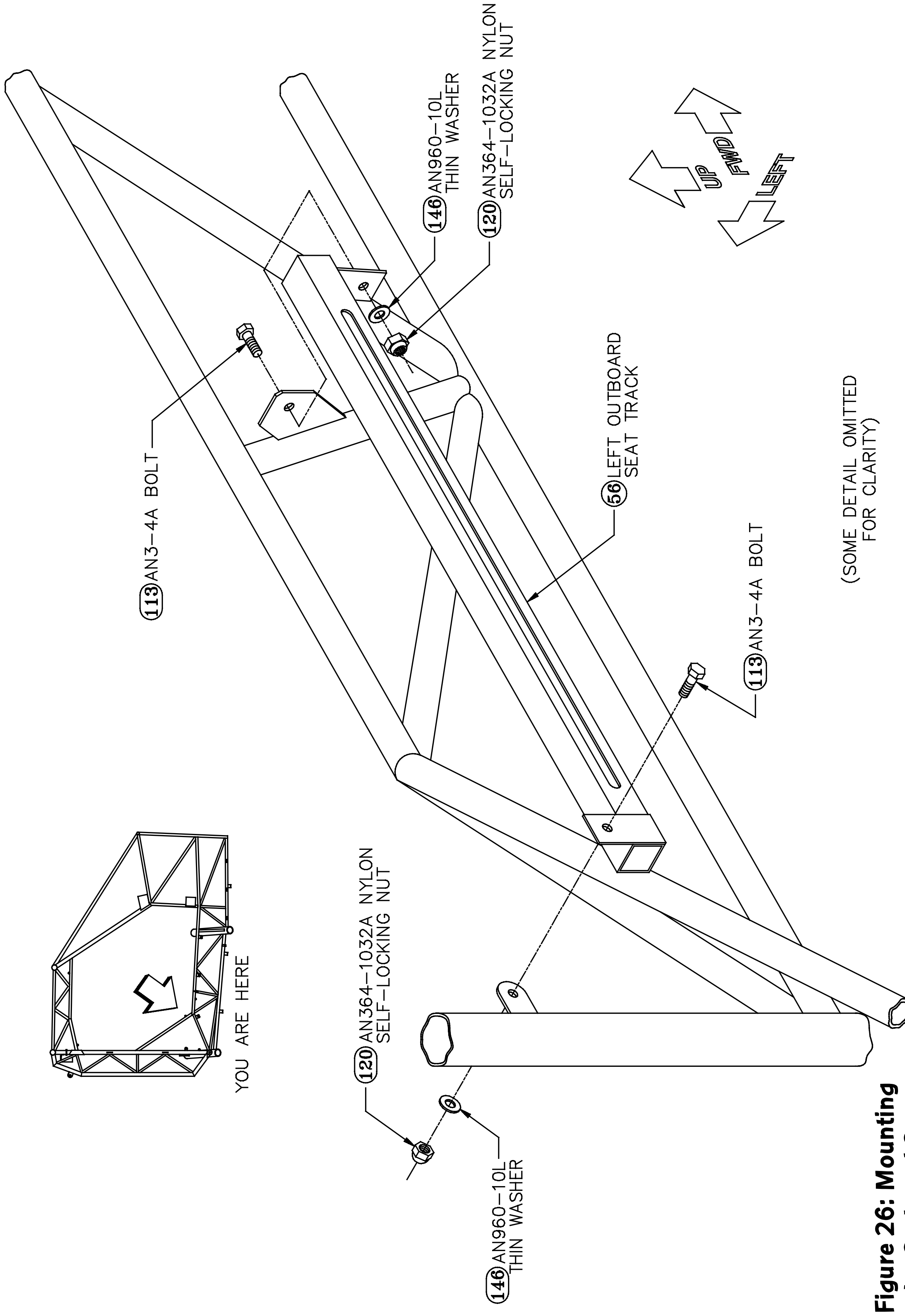


Figure 26: Mounting the Outboard Seat Tracks

Next, butt the **aft** end of the left **inboard seat track** [55] up against its attach tab, which is located on the center tube of the cage between the tricycle main gear sockets. Pin this track in place temporarily by inserting an AN3-5A **bolt** [114] through the holes in the track and cage tabs (see Figure 27). Then use a small C-clamp to clamp the **forward** end of the track to the **outboard** side of its mounting tab. From the right side of the airplane, sight across the left inboard and left outboard seat tracks and adjust the inboard track up or down until the two tracks are parallel. (Alternatively, use a digital level placed across the two tracks to check them. Move the forward end of the inboard track up or down until the inboard track is at the same angle relative to the outboard track at both ends.) When satisfied that the inboard track is parallel to the outboard track, use the holes in the two forward mounting tabs on the cage as a guide to drill a **1/4"** hole through both sides of the inboard track. Remove the inboard track and deburr the just-drilled hole.

Repeat these procedures for the right-side inboard track.

Note The tabs at the aft ends of the inboard tracks overlap, as shown in Figure 27, so the left track must be in place when fitting the right track; otherwise, the forward hole in the right track will be drilled too far forward. Thus, when you drill the forward hole through the right track your drill bit will pass through the entire assembly—left track, cage tabs and right track.

When all the mounting holes have been drilled and deburred, bolt the tracks in place, using the hardware shown in Figure 27: at the **aft** ends, an AN3-5A bolt, AN960-10 **washer** [145] and AN364-1032A nylon self-locking nut; and at the **forward** ends, an AN4-32A **bolt** [128], two AN970-4 **large washers** [157], two NAS43HT4-12 **steel spacers** [167] and an AN365-428A **nylon self-locking nut** [123]. The head of the aft bolt should be forward; the head of the forward bolt can be on either side.

Note The large washers and steel spacers will be used later to accommodate the inboard seat belt attach tabs. For now, the seat tracks must be securely bolted for a subsequent step in which the seat-back adjustment holes will be drilled in the tracks.

Completed: [ ]

Page 62: [redacted]

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

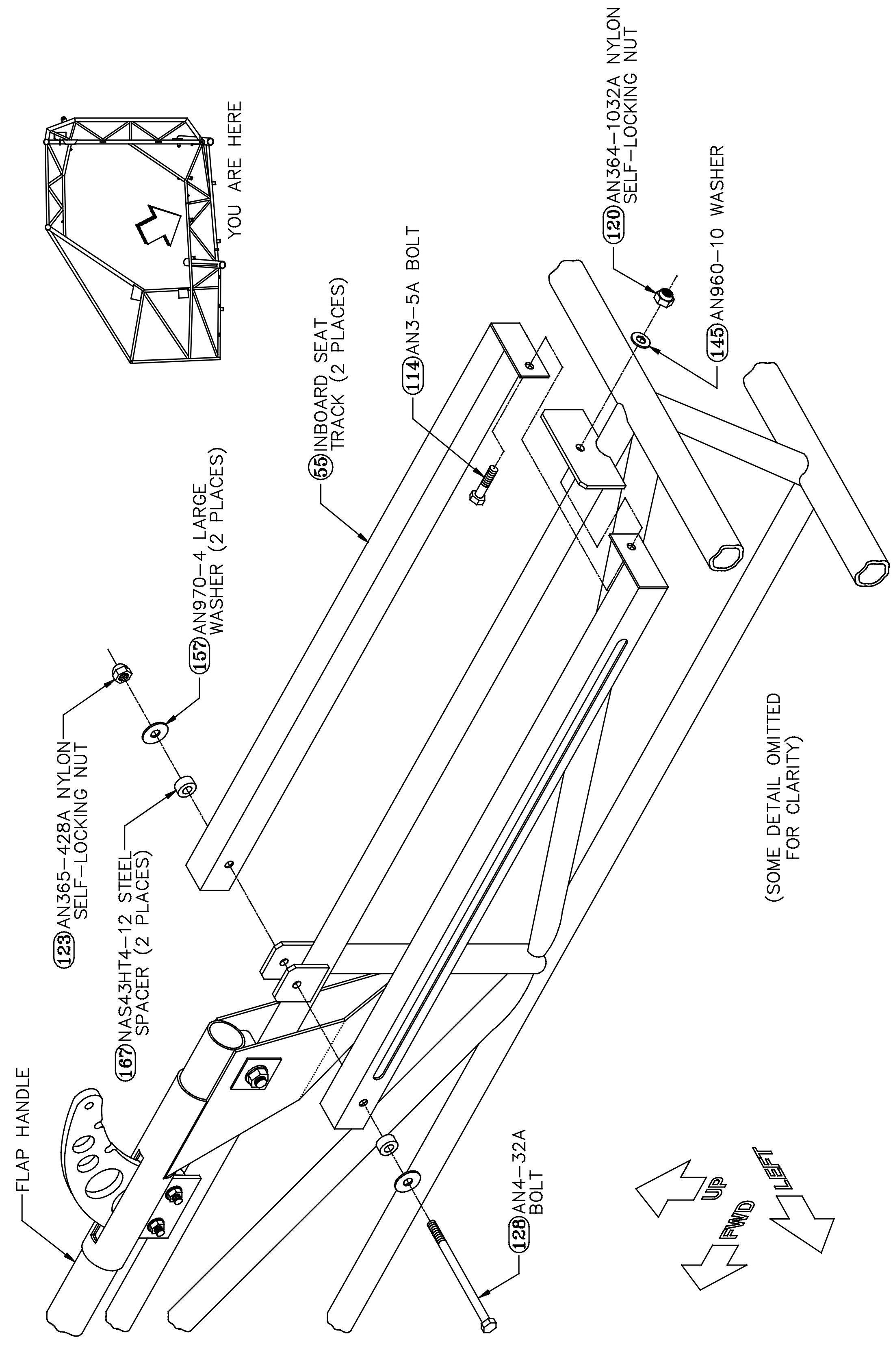


Figure 27: Mounting the Inboard Seat Tracks

Note Steps 22–25 all deal with installation of the **seat bases** [54]. Sportsman seat bases (P/N 802-03000-05) have been reinforced to include a gusset and a thicker walled tube, which will withstand the loads from the higher **seat back** [55] (P/N 802-02000-05). Any modifications to the seat back height from its current 18" dimension could overload the seat base structure resulting in a potential failure of components.

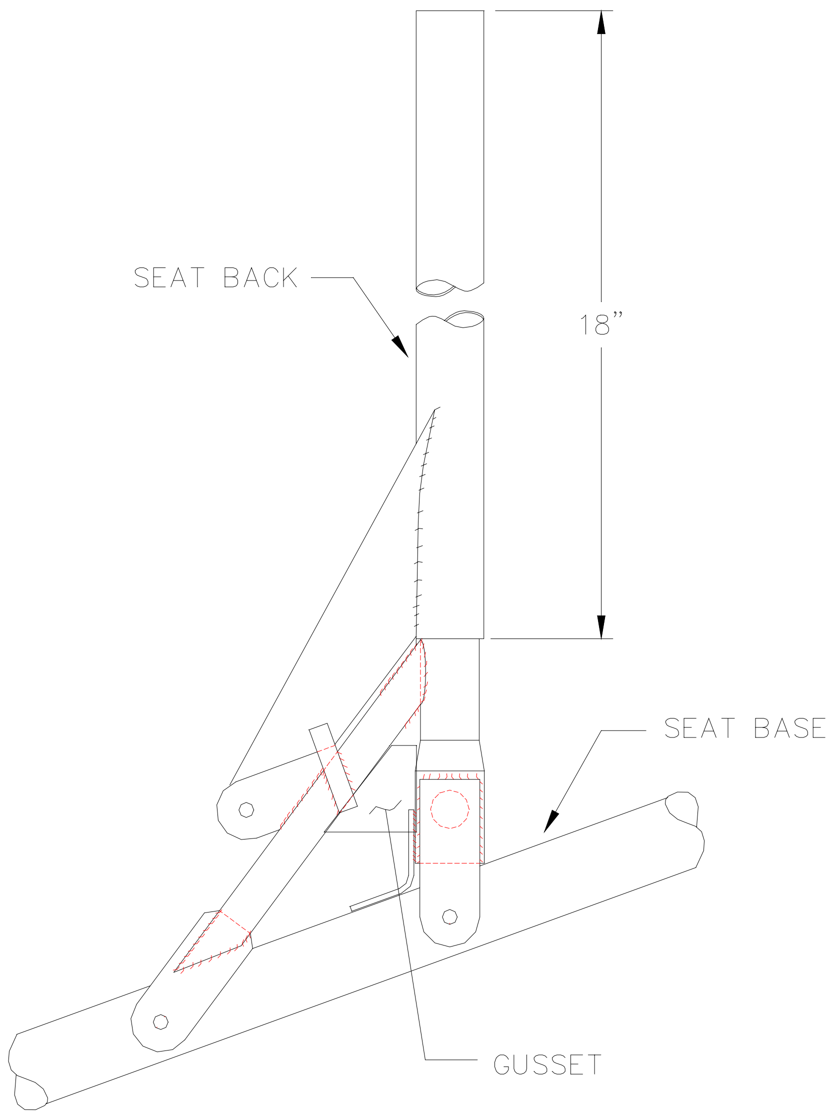


Figure 28: Sportsman Seat Base and Seat Back

Step 22: Bolt the Seat Back to the Seat Base

Use AN4-5A **bolts** [129], **.032" nylon washers** [78], AN960-416L **thin washers** [148] and AN364-428A **nylon self-locking nuts** [121] to fasten each seat back to a seat base, as shown in Figure 29. Tighten the nuts until a fair bit of friction exists between the back and the base.

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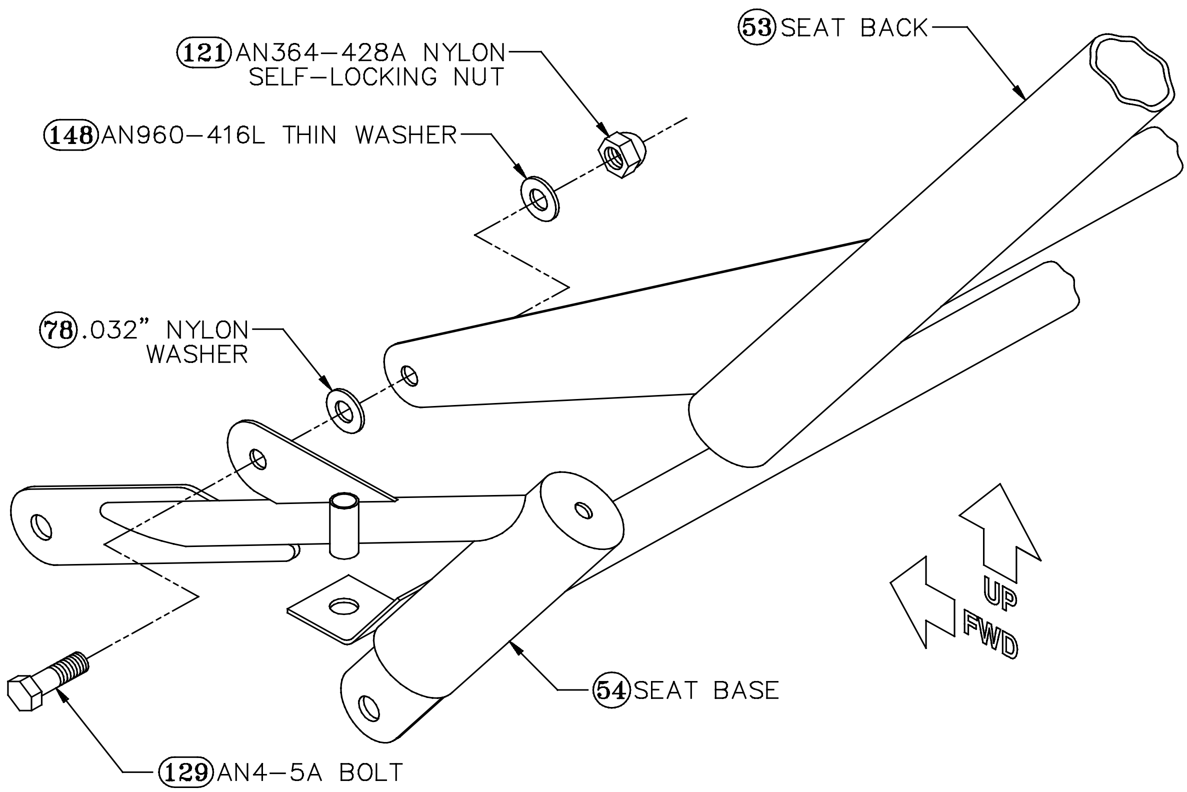

Figure 29: Bolting the Seat Back to the Seat Base

Step 23: Fasten the Seat Assemblies to the Tracks

Insert the seat track sliders into the seat tracks with the undrilled flanges up and the nutplates adjacent to the slots in the tracks, as shown in Figure 30. (Figure 30 shows the right outboard seat track and the corresponding corner of the right seat assembly, but the installation is identical in all cases.) Position the seat base between the seat tracks and thread AN3-5A bolts into the nutplates on the slider angles to secure it, as shown. Insert .032" and/or **.064" nylon washers** [79] between the tracks and the tabs on the seat base as necessary to take up slack and reduce friction. Tighten the bolts just until the heads contact the seat base tabs; over-tightening will clamp the seat base in place, making it difficult to slide.

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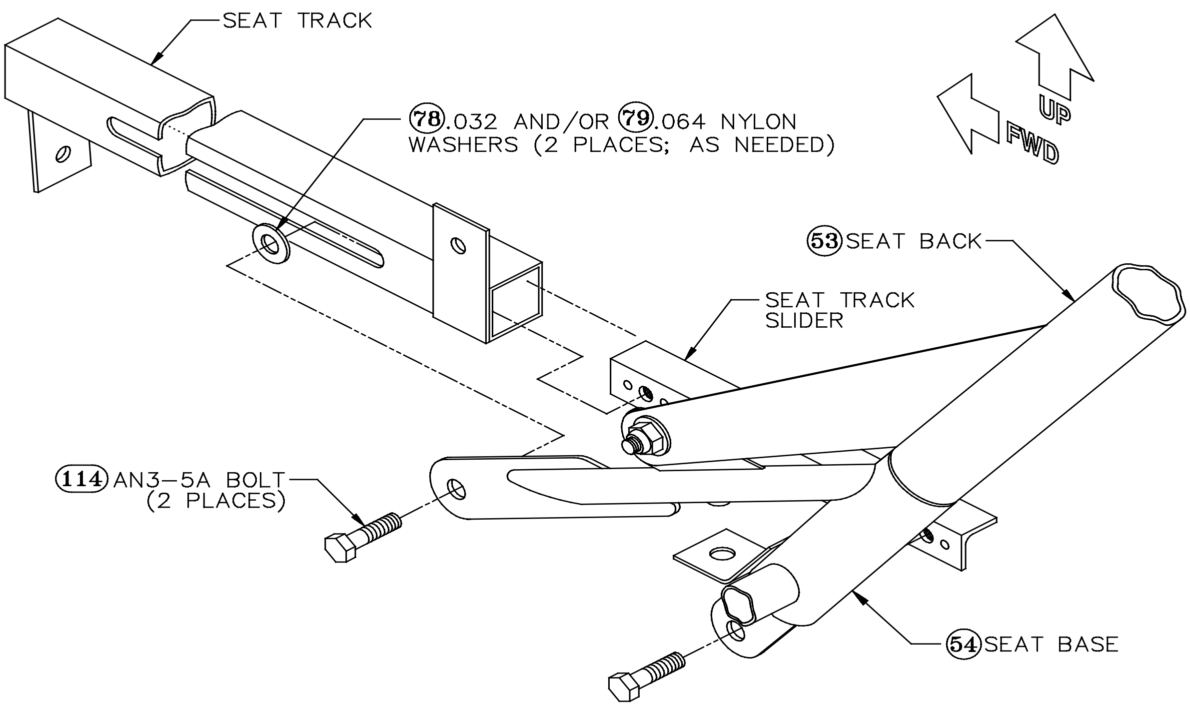

Figure 30: Mounting the Seat Assembly on the Tracks

Step 24: Drill the Seat-Back Adjustment Holes

Seat tract now come pre-drilled. If your seat tracks have not been drilled by the factory, then you may find it easier to drill the **outboard** track first before you install them. Starting 2.75" from the aft end of the track, drill eight #F holes through the center of the track spacing them 1.5" apart. Drill through both walls of the square tube. The forward most hole should also end up 2.75" from the forward end of the tube. Deburr them very well, especially the inside of the tube. The outboard locking pins would then position the seat base and the inboard track can be drilled as defined below. Now you can install the seat tracks as described in Step 21.

With the seat assembly bolted to the tracks, you will now use the locking pin bushings on the seat base as guides to drill locking pin holes through the **tops** of the seat tracks on both sides, as shown in Figure 31. Begin by sliding the seat as far forward in the seat-track slots as it will go. With a letter "**F**" bit, drill the forward-most adjustment holes with the seat in this position. Then, using the same procedures, drill additional pairs of holes at equal intervals as you slide the seat aft; intervals of about **1-1/2"** will allow good flexibility in seat-back positioning. **Open the track holes up to "G" or 17/64" diameter to keep the pin from binding.**

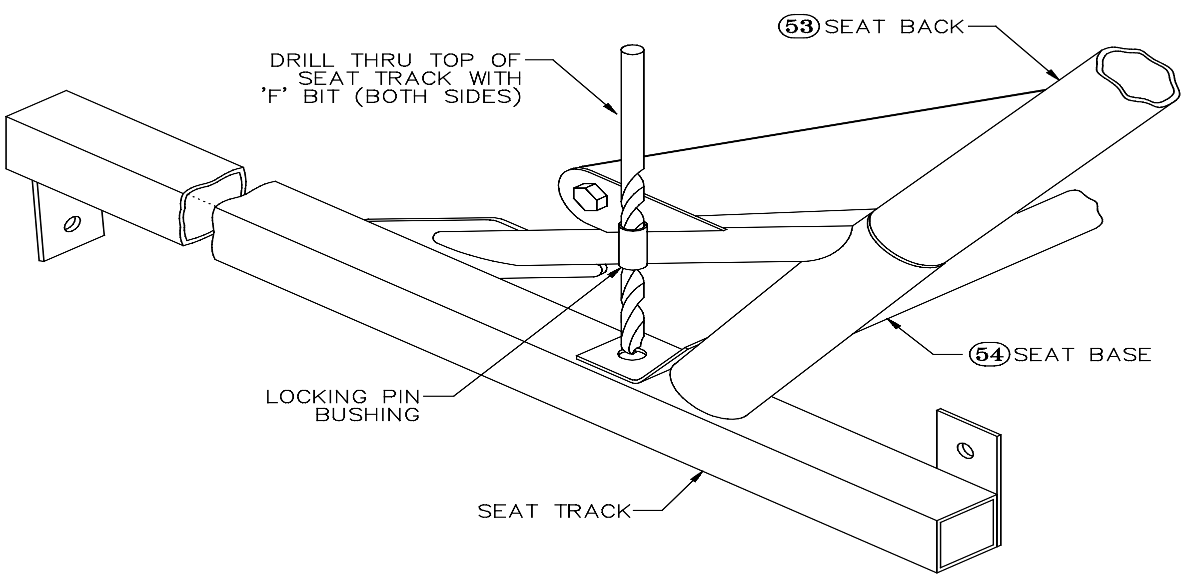

Figure 31: Drilling the Seat-Back Adjustment Holes

Make sure the seat is square to the tracks before drilling each pair of holes (a framing square may be useful to check this) and pin the first hole of each pair with one of the 1/4" stainless steel locking pins to maintain alignment while drilling the second hole. When finished drilling, deburr all the holes and use an air hose to blow all the loose chips and shavings out of the tracks.

Completed: Left [ ] Right [ ]

Step 25: Assemble the Locking Pins

Insert a locking pin through each bushing on each seat base, as shown in Figure 32. On the lower end of each pin, install an AN960-416 **washer** [147], a **seat-back adjustment locking pin spring** [76] and another AN960-416 washer, in that order. Compressing the spring out of the way, drive a **3/32" X 1/2" roll pin** [100] through the hole you drilled earlier to retain the spring. Use a light hammer or a large pair of channel-lock pliers to drive the roll pin. Repeat at all four locking pin locations.

> **Hint** It will probably be worthwhile to remove the seat assemblies from the tracks temporarily in order to assemble the locking pins more easily. While you have them out, apply a light coat of grease to the bearing surfaces of all the sliders.

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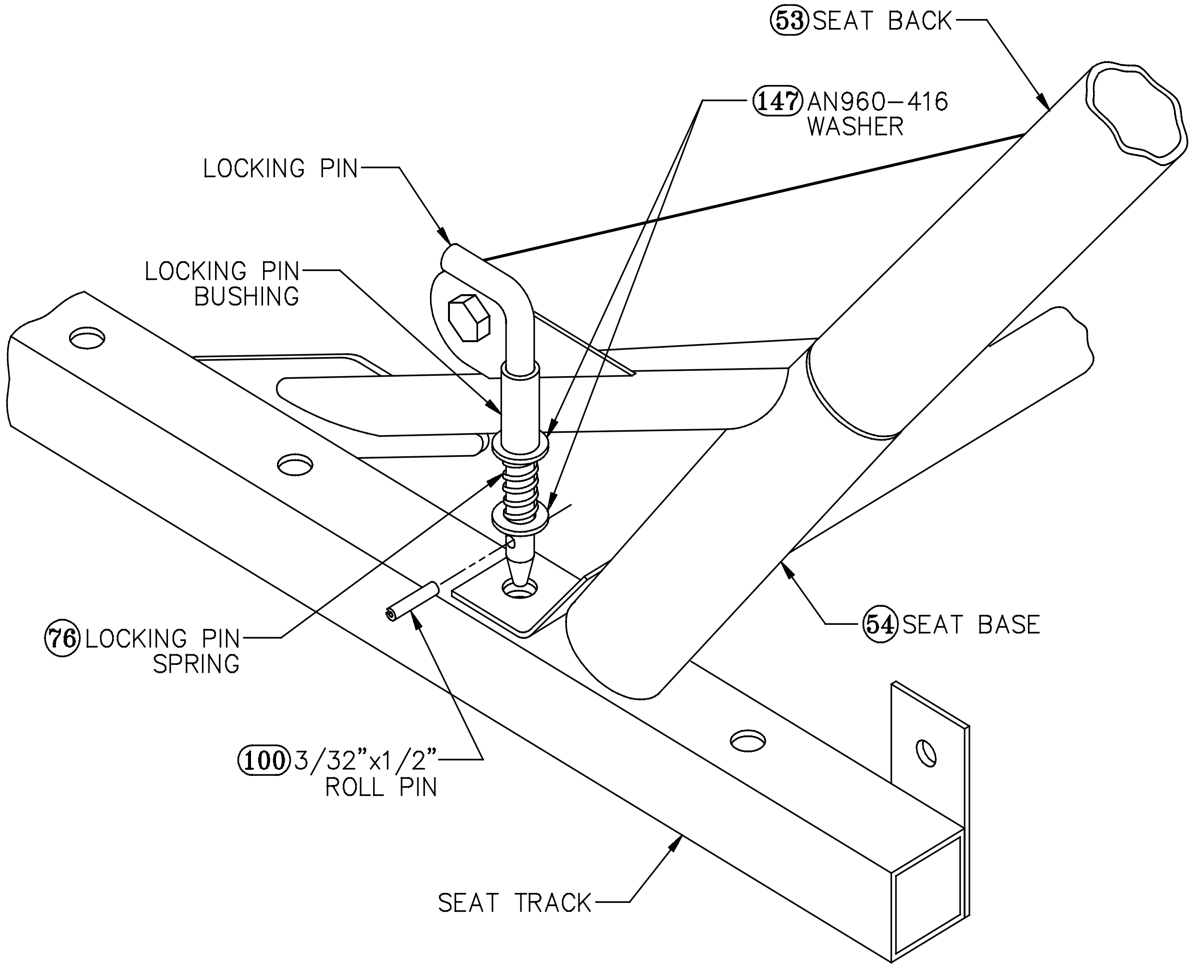

Figure 32: Assembling the Seat-Back Adjustment Locking Pins

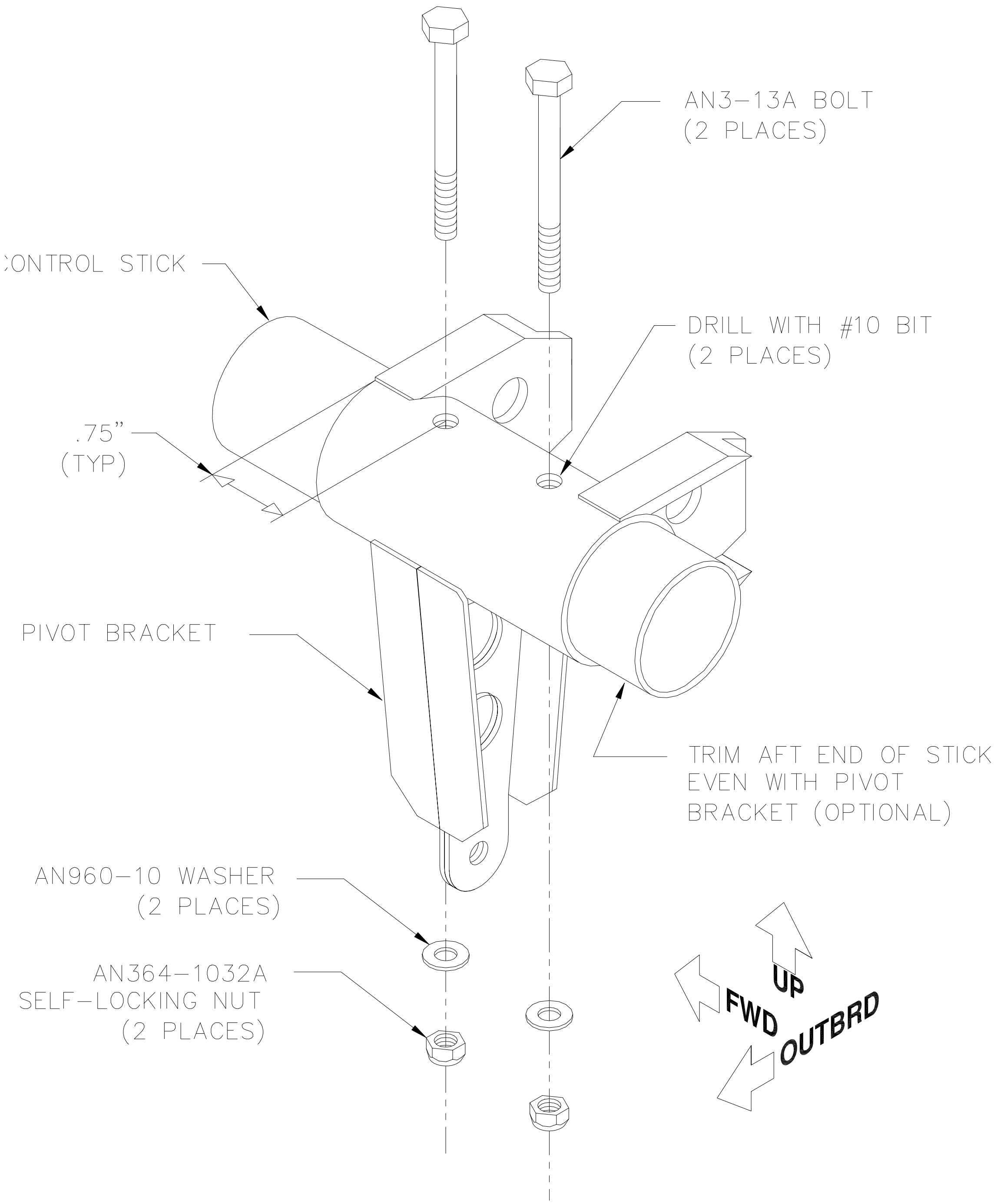

Figure 33: Installing the Control Stick

Step 25A: Install the Control Sticks

Now that can sit in your Sportsman and make airplane noises, it is time to position the **control sticks** [50] to your liking and drill the mounting holes!

> **Note** In most airplanes, the left and right stick are positioned identically, but if you have a taller or shorter co-pilot to please, there's no reason you can't position them separately and take separate measurements for each.
>
> If, for any reason, your wings are installed and control cables connected at this point, then neutralize the pivot brackets by setting the ailerons to their neutral positions—with their trailing edges even with the flap trailing edges—rather than by reference to the interconnect rod.
>
> Is your horizontal still installed? You may wish to work this step at the same time as step 181: Fabricate and Install the Elevator Control Stop.
>
> **If you wish, this step can be delayed until your airplane is more fully rigged with wings and horizontal tail installed.**

The Sportsman control sticks are made from a 1" x .058 wall tube and will slide directly into the control yoke pivot brackets, unless powder coat paint is on the surfaces. Slide the control sticks into the tubes on the control stick pivot brackets. Pad the seat pan and the seat back to the approximate thickness of the upholstery you'll be using and try out the seating position.

A simple jig can be fashioned from a piece of 1x4 with two 1" diameter holes spaced 19-7/8 apart. Slip this jig over the tops of the two control sticks to hold them stationary and parallel with each other during the drilling operation.

Adjust the seat back forward or aft to enable you to actuate the rudder pedals and brakes comfortably. Adjust the seat pads to position yourself at your preferred height, typically with your eyes about 2" below the upper door joggle. Slide the control stick forward or aft in the pivot bracket tube to the position you prefer. When you're happy with the stick position in a fore-and-aft direction, measure the straight-line distance from the top of the stick to the cage cross-tube along the bottom of the instrument panel area. Make a note of this distance, and then remove the stick from the pivot bracket.

Now remove the seat assemblies and seat pans. Set the control stick pivot brackets in their neutral positions—i.e., such that the interconnect rod is centered on the control yoke. (Refer back to Step 45 in "SECTION IX: SYSTEMS INSTALLATION.") Slide the two sticks back into the pivot brackets and re-establish their positions relative to the cage cross-tube using the measurement(s) you took earlier. Use a plumb bob to position the sticks vertical relative to the fuselage and parallel with each other. Drill two **#10** holes through each pivot bracket/control stick assembly, as shown in Figure 33. Position the holes **3/8"** from the ends of the pivot bracket tubes and at approximately **90°** to each other, as shown.

As an optional (but recommended) weight-saving measure, you may want to trim the lower aft ends of the control sticks where they emerge from the pivot bracket tubes. Mark the aft ends of the pivot bracket tubes onto the sticks, as shown in Figure 33; remove the sticks and trim them to the marks with a hacksaw. Smooth the cut edges with a fine-toothed file.

Regardless of whether you trim the sticks, remove them from the pivot brackets and deburr all the holes in both the sticks and brackets. Touch up any anti-corrosion protection as necessary. Then bolt the sticks to the pivot brackets with the hardware shown in Figure 33: AN3-13A **bolts** [112], AN960-10 washers and AN364-1032A nylon self-locking nuts.

Hint If you are installing any switches on your sticks such as push-to-talk or electric trim switches, don't forget to run the wires through the sticks before you bolt them in place. Also, be careful when inserting the bolts not to abrade or pinch any wiring that runs there.

Completed: [ ]

Step 26: Install the Cabin Air Vents (Optional)

Cabin Air Vent Option Glasair Aviation, LLC's Cabin Air Vent Kit includes pre-molded air boxes with integral NACA scoops and fully adjustable eyeball vents for both sides of the cabin, as well as all necessary installation hardware and detailed instructions. These vents provide ample air flow for comfortable operations in extremely hot conditions. Order P/N 938-02000-01.

If you're installing the Cabin Air Vent Option, **turn to the option instructions now**. Return to Step 28 in this *Assembly Manual* when the specified option steps have been completed.

☞

Note Figure 34 has been omitted.

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Fuselage Fairing Installation

In this sub-section, you will install the horizontal stabilizer strakes, the rudder base fairing, the tailcone and the rudder tip fairing; the wheel pants and gear leg fairings will be installed in the next sub-section, and the horizontal stabilizer and elevator tip fairings will be installed in the "Control Surface Balancing and Fairing Installation" sub-section toward the end of the *Manual*. Before installing any of the fuselage fairings, be sure your horizontal stabilizer and elevator are in place on the fuselage.

Step 27: Mark the Centerlines of the Horizontal Stabilizer Strakes on the Fuselage

The horizontal stabilizer strakes—which enhance the slow-speed handling and stall-recovery characteristics of the Sportsman by preventing the stabilizer from stalling at high angles of attack—extend forward from the horizontal stabilizer along the fuselage sides. **In order to work properly, the centerline of each strake must be aligned with the chord line of the stabilizer.** In this step, you will mark an extension of this chord line onto the sides of the fuselage.

Begin by marking the leading edge point on the fuselage. Draw a 24" line parallel to waterline from that point. Measure down 9/16" from this point on the waterline and then draw a line back to the leading edge of the horizontal stabilizer. This line represents the centerline of the stabilizer at a 1.4 degree down incidence angle. This is just using simple trigonometry to draw a line at an angle. There are several other ways to do this as well.

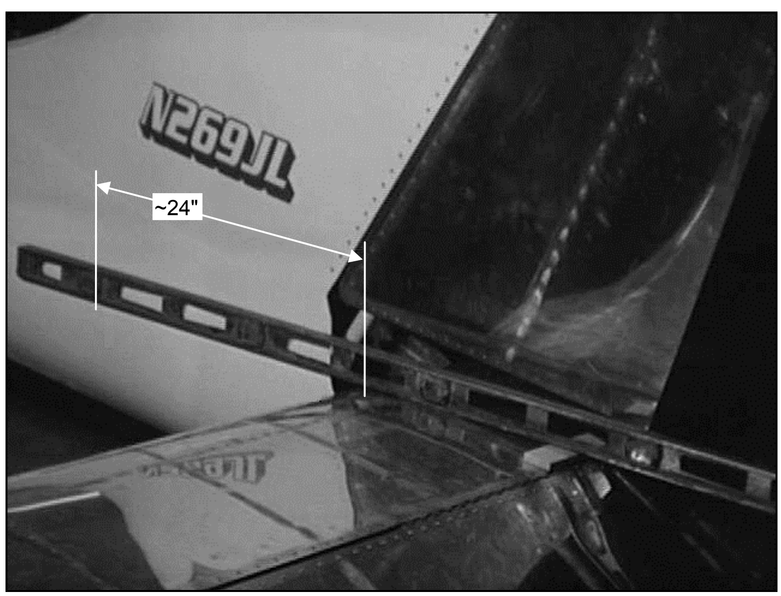

Figure 35: Marking the Stabilizer Chord Reference Lines

Check the two chord lines you just marked with a smart level. Don't get hung up trying to split hairs here. If you are within 0.2 degrees, that is acceptable. Using the distance measurement is very accurate as 1/16" represents approximately 0.15 degrees.

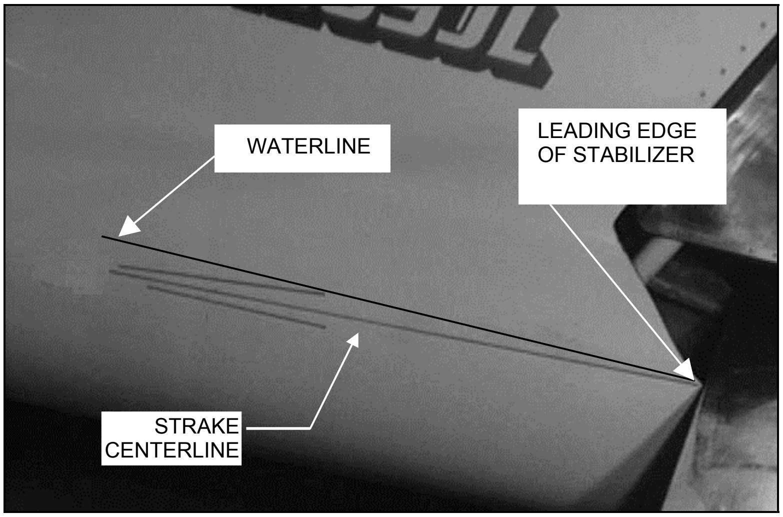

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Figure 36: Marking the Strake Centerline

Step 28: Fit the Strake Halves to the Fuselage and Stabilizer and Tape Them Together

Each strake consists of an upper and a lower half that you will bond together. Now that the strake centerlines have been established, you can use the contours of the fuselage and stabilizer to help align the halves and then temporarily tape them together for bonding. As a preparatory step, apply **eight–ten** layers of wide masking tape to the leading edge of the stabilizer on each side from the fuselage shell outboard about **14"**. The tape should wrap aft from the leading edge at least **2"** on both the top and bottom surfaces. This tape serves to simulate the thickness of the protective plastic tape you will apply later between the strakes and the stabilizer.

Next, pair the strake halves off in left-hand and right-hand sets—the **upper left half** [11] with the **lower left half** [9] and the **upper right half** [12] with the **lower right half** [10]. Each of the four halves is different; to help distinguish them, keep in mind that the "fuselage flange" (that is, the longer flange that goes against the fuselage shell) of each **upper** half is at an **obtuse** angle to the surface of the strake, while the fuselage flange of each **lower** half is at an **acute** angle to the surface of the strake. Figure 37 illustrates this.

The strakes form a symmetric section and differ only in their attachment to the fuselage.

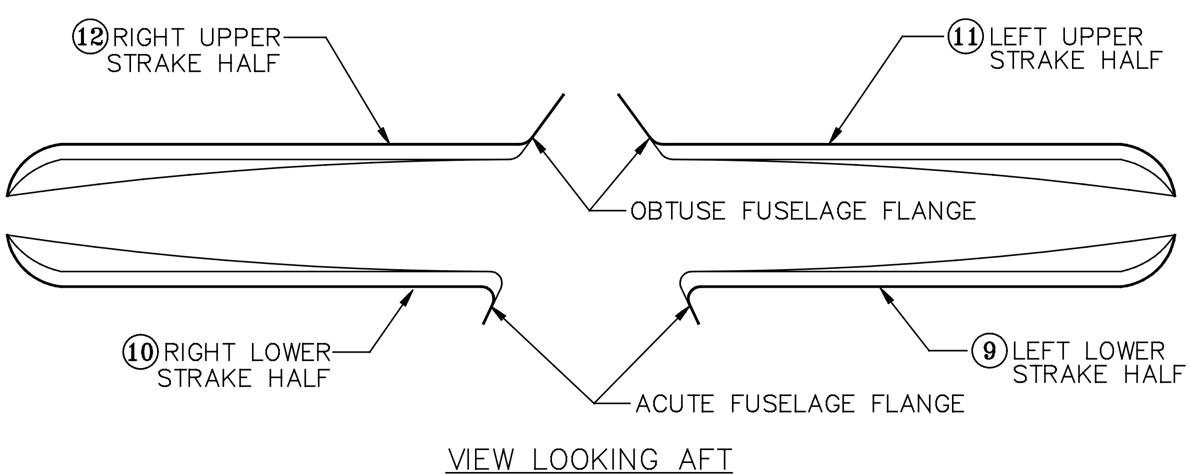
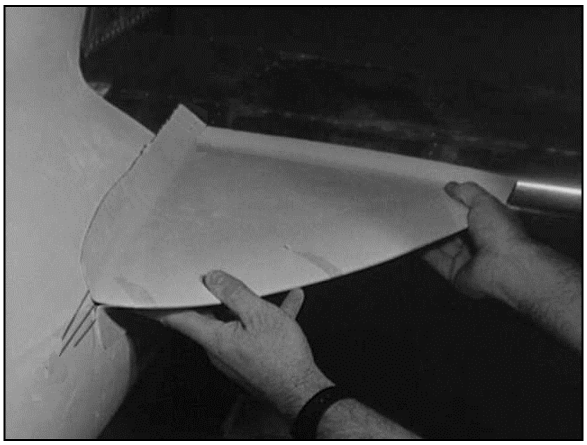
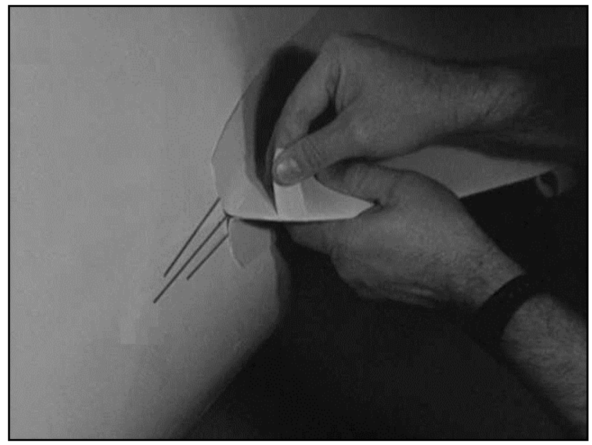


Figure 37: Identifying the Strake Halves

With the strake halves paired off, use a few strips of masking to tape to bind each pair together, aligning the leading edges of each half reasonably well. Then position each pair against the fuselage shell and the horizontal stabilizer, as shown in Figure 38a, aligning the seam between the halves with the marked strake centerline. If necessary, readjust the tape strips, as shown in Figure 38b, in order to get the fuselage flanges of each half to lie flat against the shell and the "stabilizer flanges" (that is, the shorter flanges that lie against the stabilizer) to fit snugly against the taped stabilizer leading edge.



(a)



(b)

Figure 38: Fitting the Strakes to the Fuselage and Stabilizer

Step 29: Seam the Strake Halves Together

The strake halves are joined with two layers of **bi-directional cloth** [86]. Cut four strips of this cloth on the 45° bias, each **1"** wide by **24"** long. Also, prepare an extended resin brush at least **14"** long to allow you to reach the seam at all points. As shown in Figure 39, a simple way to do this is to tape a pair of tongue depressors on either side of a standard brush handle. The figure also shows how the strake halves (taped securely together) can be supported in a vertical position for seaming using our favorite high-tech jigging system—masking tape.

Catalyze a small batch of **vinyl ester resin** [95] and pre-saturate the cloth strips. Then, as shown in the Figure 39, use the extension brush to poke them down tightly into the acute angle between the two halves. Use a stippling motion to thoroughly saturate the cloth and to remove air bubbles. Allow the seam to cure completely.

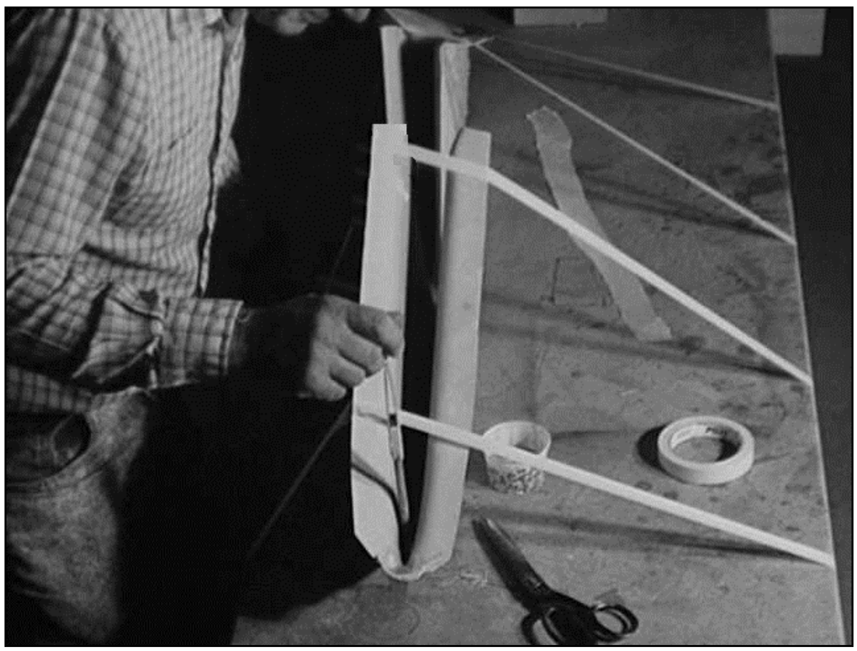


Figure 39: Seaming the Strake Halves Together

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Step 30: Cut Out the Strake Ribs

Each strake is reinforced with four internal ribs, which are cut out of one of the **12" X 12" sheets of 1/2", 5-lb. density foam** [88]. Full-sized templates for these ribs are given in Figure 40. Pin the templates to the foam and cut out **two of each** with a scroll saw or a utility knife.

We recommend that you cut these slightly oversize and sand down to a nice fit. If the ribs are undersize and do not make flush contact with the strake surface, they will tend to shrink during bonding, resulting in an uneven outer surface on the strake.

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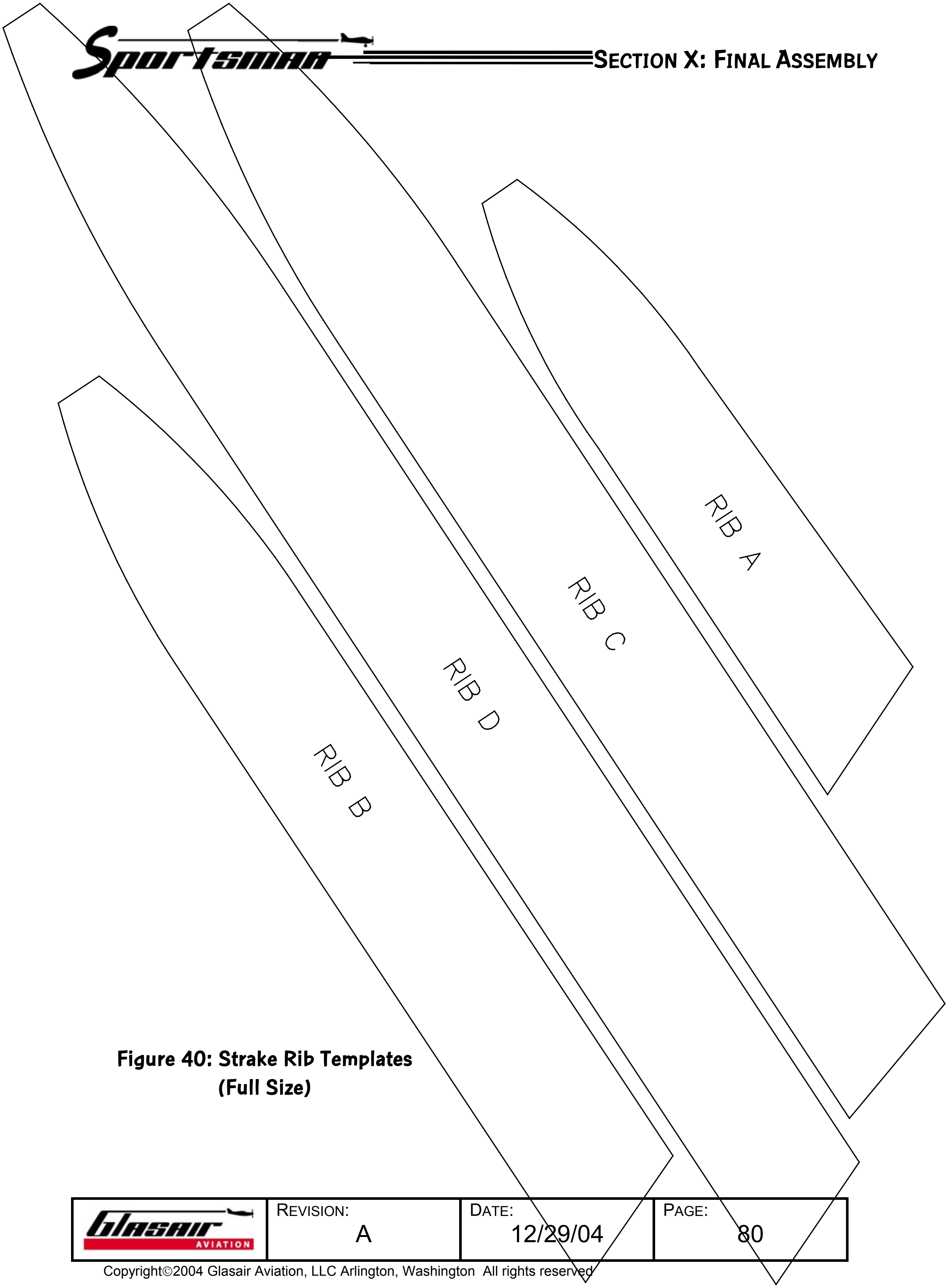

Figure 40: Strake Rib Templates (Full Size)

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Step 31: Install the Strake Ribs

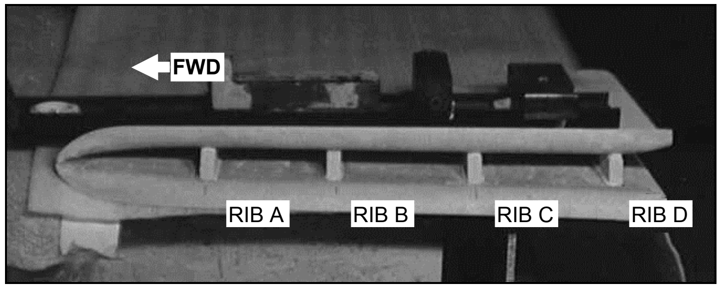


Figure 41: Placement of the Strake Ribs

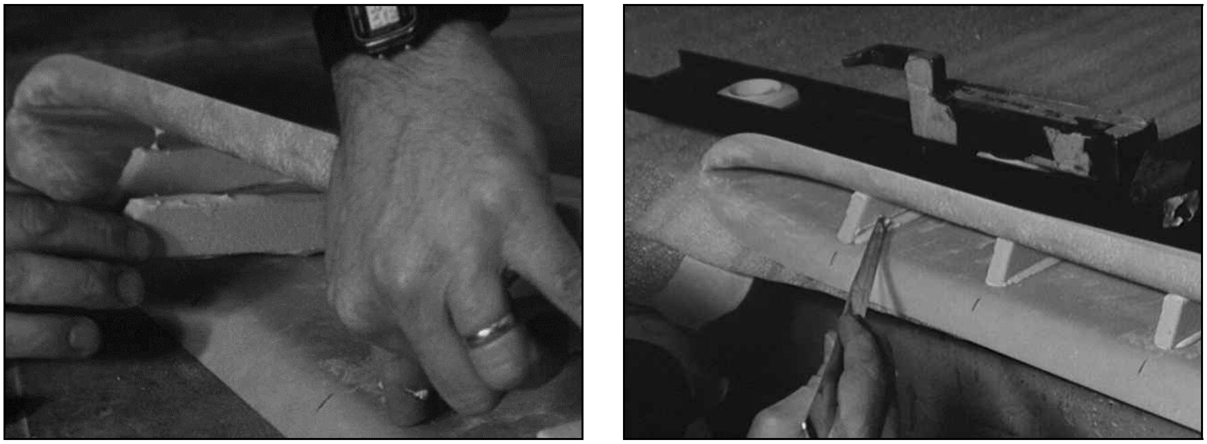
As Figure 41 shows, the four strake ribs run laterally across the strake and are spaced at roughly equal intervals. The exact placement of Ribs A, B and C is very **non-critical**—they are essentially positioned wherever they fit best between the skins of the strake. Rib D must be placed with a bit more precision to ensure that it clears the leading edge of the stabilizer.

The templates for all four ribs were sized a bit over-wide so that they could be sanded to fit. Do so now, removing just enough foam from the **bottom** edge of each rib to achieve a snug fit between the skins at the approximate locations shown in Figure 41.

Note The ribs should not fit so tightly that they distend the skins.

With the ribs friction-fitted between the skins, mark the centerlines of Ribs A, B and C on the fuselage flanges of the strake. Then hold the strake in position against the fuselage and stabilizer, carefully aligning its leading edge on the strake centerline marked on the fuselage side. Reach inside the strake from the inboard side and push Rib D aft until it's tight up against the leading edge of the stabilizer. (You may find this easier to accomplish with the help of an assistant.) Then remove the strake (with Rib D still in place) and mark the location of the **forward edge** of Rib D on the strake's fuselage flanges. When you bond the ribs in place, **center** Rib D on this mark; this will have the effect of moving the rib **1/4"** forward, providing necessary clearance between the rib and the stabilizer leading edge.

Note Rib D must be fit fairly precisely in order to ensure that the strakes meet the stabilizer cleanly. With the rib in position, press the halves of the strake tightly together against it and re-check the fit of the entire assembly against the stabilizer. Re-shape Rib D as necessary to get a good fit.



(a) (b)

Figure 42: Installing the Strake Ribs

Figure 42 shows the procedure for bonding the strake ribs in place. Begin by catalyzing a thick batch of **Q-cell** [94] and resin mixture. Use a mixing stick to spread a layer of the mixture approximately **1/8"** thick on the upper and lower edges of a rib, as shown in Figure 42a. Use your fingers to spread the strake skins slightly so you can slide the rib into position, centering it on the appropriate line.

When the rib is in place, use a "radius tool," as shown in Figure 42b, to leave a smooth fillet all the way around it and to remove the excess Q-cell. Such a tool can be either a simple length of **1/4"** dowel or can be made from any old scrap of sheet metal, plastic or thin wood. Make it **12"–14"** long and **1/2"** wide, tapering to a point with a radius of approximately **1/8"**.

For best results, begin with Rib A and proceed aft from there. After all the ribs are in place, set some weights—two or three pounds is ample—on the upper skin to hold everything down. Use a board or some comparable surface between the weights and the skins to spread the load among the ribs, although more weight will be required on Rib D than the others. (The spirit level shown in Figure 42b does the job, but we don't necessarily recommend that you treat **your** tools this way!)

When the Q-cell has cured, laminate a single **12"**-long, **2"**-wide strip of bi-directional cloth cut on the 45° bias over the **aft** face of Rib D, as shown in Figure 43. After the laminate has cured, trim and sand it down where it overhangs the ends of Rib D.

Note A gap at the **outboard** end of each rib is essential to allow any water that gets into the strake to drain. This is why all the ribs are sized to end short of the junction between the upper and lower strake halves. After installing the close-out laminate over Rib D, be sure this gap isn't sealed. If necessary, use a **1/4"** bit to drill a drain hole through the laminate in this location.

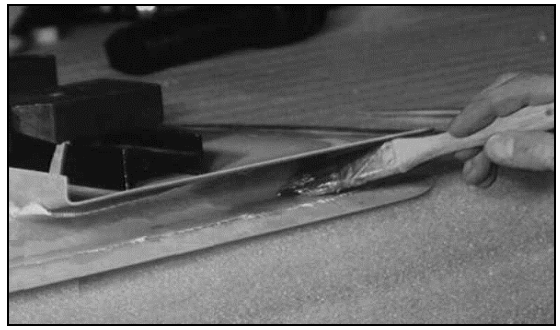


Figure 43: Rib D Close-Out Laminate

Completed: Left [ ] Right [ ]

Step 32: Adjust the Strakes and Mark Their Outlines on the Fuselage

Now that the strakes are fully assembled, you can trim and adjust them for the best fit against the fuselage and stabilizer. Use files, sandpaper and/or a rotary cutter in a die grinder to trim the fuselage and stabilizer flanges of the strakes down to the scribe lines provided. This will result in fuselage flanges about **3/4"** wide and stabilizer flanges about **1"** wide. After the flanges have all been trimmed, sand and trim the laminates you applied over the "D" ribs to allow the strakes to fit cleanly over the leading edge of the stabilizer.

After the strakes are completely sanded and trimmed, hold them in position against the fuselage and stabilizer and check the fit of the flanges. Ideally, the flanges should lie flat against the fuselage and flush with the stabilizer all along their lengths.

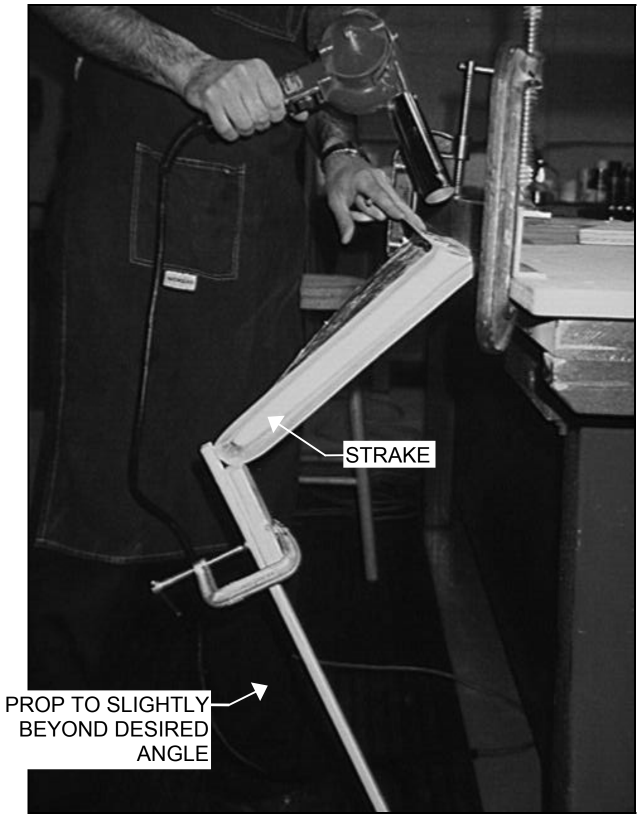


Figure 44: Adjusting the Strake Flanges with a Heat Gun

It's possible, however, that you may need to adjust the angle of one or more of the flanges to achieve a better fit. If this is necessary, use the method shown in Figure 44: clamp the offending flange flat to the bench top with a board or piece of scrap metal, bend it in the desired direction with the help of a scrap wood prop, and then use a heat gun to heat the backside of the flange radius. Bend the flange just a bit further than you want it to set in order to allow for spring-back. Run the heat gun back and forth along the radius just until it becomes too hot for you to hold your hand on the side of the flange opposite the gun. Let the strake cool completely, remove the clamps and recheck the fit.

Once you're satisfied with the fit of the strake flanges against the fuselage and stabilizer, trace the edges of the fuselage flanges onto the fuselage with a marking pen. Be sure to mark all the way from the stabilizer to the leading edge of each strake.

Completed: Left [ ] Right [ ]

Step 33: Prep the Fuselage and the Strakes

The strakes are bonded to the fuselage with resin/**mill fiber** [90] mixture. In order for this bond to achieve sufficient strength, it's necessary to remove the primer from the fuselage in the bonding area. As shown in Figure 45, this area extends about **1/2"** on either side of the strake outline you marked in the last step. Mark inside and outside perimeters of this area with a marking pen.

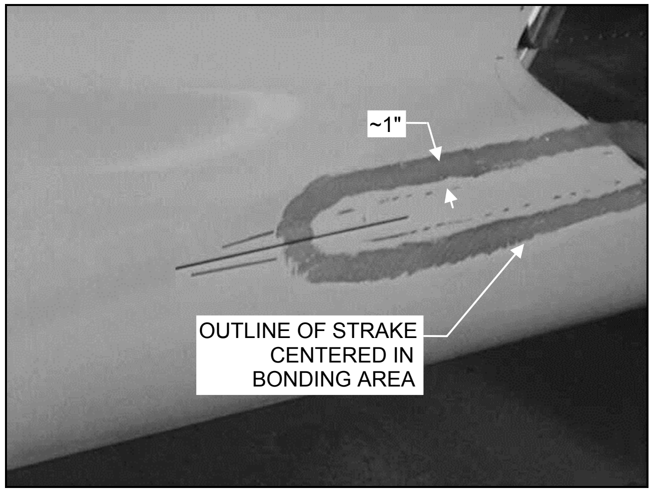


Figure 45: Removing the Primer

> **Warning** Hand sanding with coarse sandpaper is the best method for removing the gel coat because it offers the most control. Your goal here is to remove almost all the primer **without damaging the underlying laminates**. (Don't worry about small specks of primer that remain in the pores of the laminate.) Turn an electric or pneumatic sander loose on this task and you'll find it very hard to avoid sanding into the glass fibers of the outer fuselage laminate. **This is unacceptable**. **Any damage to the underlying fibers of the fuselage shell laminate results in loss of structural strength in one of the most critical areas of the Sportsman**. If you're nevertheless addicted to power tools, start **carefully** with a sander but stop the instant you begin to discern the tan-colored laminate through the white primer. Finish the job with **gentle** use of a Scotch Brite wheel in a die grinder. (Even Scotch Brite can damage the laminate, so take it easy!)

Regardless of what you use to removed the primer, finish by roughening the area thoroughly with 60- or 80-grit sandpaper. Also, roughen the **insides** of the strake flanges. Finally, using your favorite technique, remove the primer from a

1/2"-wide strip on the **outside** of the strake fuselage flanges, as shown in Figure 46.

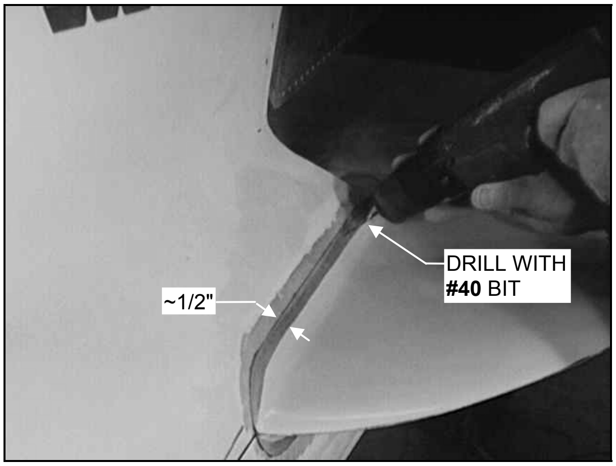


Figure 46: Drilling Cleco Holes in the Strake Flanges

Clecos work well for holding the strakes tight against the fuselage while the resin/mill fiber mixture is curing, and it's easiest to drill the Cleco holes now rather than waiting until later. Have an assistant hold the strakes firmly in position against the stabilizer and fuselage while you drill three or four **#40** holes through each flange (upper and lower) and the underlying fuselage shell. The location of the holes is not at all critical, as they will all be glassed over in any case. Simply center them by eye in the 1/2"-wide area of the flange from which you removed the primer and space them evenly over the length of the flange. If there are any areas where the flanges pucker away from firm contact with the fuselage shell, you can put extra Clecos there to pull the flange down tight.

Completed: Left [ ] Right [ ]

Step 34: Bond the Strakes to the Fuselage

Mix a small batch of thick resin/mill fiber mixture. Aim for a consistency roughly similar to household epoxy. Use a tongue depressor or squeegee to spread this mixture over the strake flanges to an even depth of about **1/16"**, as shown in Figure 47a. Place the strake in position against the stabilizer, and then carefully press it inward against the fuselage, being careful not to smear the resin on the shell. Cleco the strake in place as shown in Figure 47b.

(a) **(b)**

Figure 47: Bonding the Strakes to the Fuselage

Hint You may want to dip the tips of your Clecos in mold-release wax before inserting them. They'll pull out of the cured resin/mill fiber mixture in any case, but this will make it a bit easier.

Double-check that both strake flanges firmly contact the fuselage along their entire lengths, and drill and install more Clecos if necessary. Wipe up the excess resin/mill fiber mixture squeezed out by the flanges and let what remains cure completely. Remove the Clecos.

Completed: Left [ ] Right [ ]

Step 35: Fair the Strake Flanges into the Fuselage

To prepare the strakes for painting, sand both fuselage flanges to a feathered edge, as shown in Figure 48. Then apply a single **1"**-wide strip of bi-directional cloth cut on the 45° bias the length of each flange. The strip should lap equally onto both strake and fuselage. This strip is purely cosmetic: without it, over time, it's likely that small surface cracks would appear in the paint around the strake/fuselage junction. This strip will prevent those. After the strips cure, sand them to achieve a smooth fillet between the strake and the fuselage.

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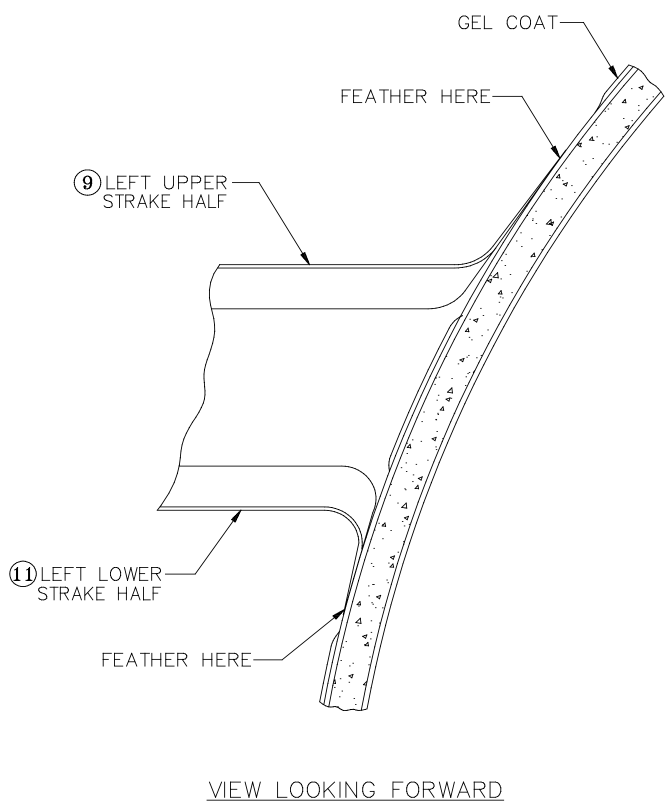

Figure 48: Feathering the Edges of the Strake Flanges

Step 36: Prep the Strakes and Fuselage/Strake Junctions for Painting

Use a lightweight body filler to fill any low spots or holes along the leading edges of the strakes and along the junctions between the strakes and the fuselage. Sand smooth.

Note The strakes function best with a relatively sharp leading edge. This doesn't mean an F-104 style knife-edge, but avoid overly blunting or rounding the leading edge while filling and sanding.

Completed: Left [ ] Right [ ]

Step 37: Apply Anti-Chafe Protection to the Horizontal Stabilizer

Now it's time to replace the layers of masking tape around the leading edge of the stabilizer with something a little more permanent. Anti-chafe protection between the strakes and the stabilizer is **extremely** important. Fiberglass is very abrasive, and the normal in-flight flexing of the strakes and stabilizer could easily result in the strakes wearing right through the stabilizer skins in short order. Clearly, that's not acceptable!

We recommend the use of the same UHMW plastic tape specified for the fuel tank installation in "SECTION IX: SYSTEMS INSTALLATION." Order P/N 033-01001-01 direct from Glasair Aviation.

Warning If you intend to paint your aluminum stabilizer but wish to wait to do so until after flight testing is completed (which is a wise strategy, by the way), you might be tempted to forego application of anti-chafe tape until after the stabilizer is painted. **Don't do it!** It's much easier to remove the protective tape, paint and re-tape than it is to replace your stabilizer skins because they've been worn through.

Trim the tape to follow the curvature of the strake's stabilizer flanges, but be sure that the tape extends at least **1/4"** or so beyond the strake flanges. Remember, what you're concerned about here is movement of the two parts relative to each other, so don't assume that they'll stay put in flight precisely the way they fit on the ground.

Once installed, the anti-chafe tape should not simply be forgotten; during the first several hours of flight, be sure to keep a close check on the tape for signs of abrasion. Add more layers if necessary. Subsequently, this should be a checklist item for every annual condition inspection of your Sportsman.

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Step 38: Placard the Strakes

Although the strakes are plenty strong for the flight loads they will experience, they are **not** designed to be used as handles for maneuvering the Sportsman on the ground. Particularly on taildraggers, it will be very tempting to use the strakes to lift the tail. For this reason, we recommend affixing a "NO LIFT" placard to the leading edge of each strake, just as a reminder to you and a caution to others.

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Step 39: Trim the Rudder Base Fairing to Fit

The **rudder base fairing** [8] closes out the gap between the bottom of the rudder and the upper surface of the horizontal stabilizer. It also covers up the inboard aft corners of the stabilizer strakes. Figure 49 shows the fairing installed on the airframe.

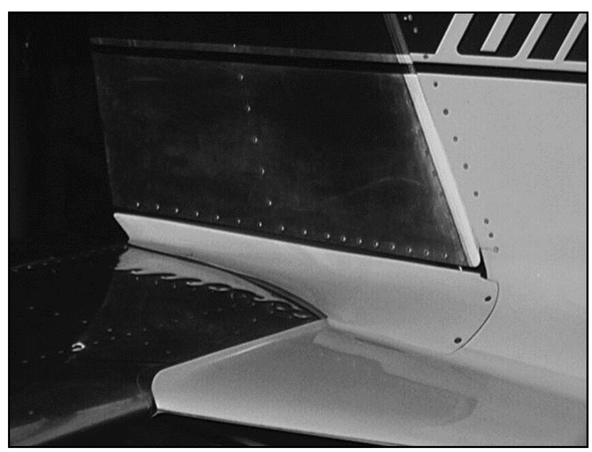


Figure 49: Rudder Base Fairing

The fairing comes from the factory with scribe lines indicating the exterior contours of the fairing all the way around, as well as the typical shape of the cutout in the upper surface for the rudder yoke torque tube. However, keep in mind that these scribe lines are intended to provide only general guidance. Every Sportsman will be a little different, especially in this area, and so as they say—your results may vary!

Before test-fitting the fairing, apply three or four layers of masking tape to the upper surface of the stabilizer where the fairing will contact it. As with the strakes, this tape simulates the plastic protective tape you'll install once the fairing is trimmed to size. On this tape, mark the longitudinal centerline of the aircraft from the stabilizer leading edge to the elevator hingeline.

The fairing is flexible and can be spread out wide to fit under the rudder or squeezed slightly to increase its height. Fit the fairing by trial and error, first sanding or cutting to **near** the scribe lines and then removing more material as necessary to achieve a good fit. Begin with the torque tube cutout, and then move to the outboard edges of the fairing. Trim these to achieve a consistent gap of **3/16"–1/4"** between the bottom of the rudder and the top of the fairing, as shown in Figure 50. Also, notch the lower edges of the fairing to fit neatly over the aft edges of the strakes. Throughout the fitting, be sure to keep the aft end of the fairing aligned with the marked aircraft centerline.

With the fairing's lower edges trimmed to your satisfaction, you can trim it to length. As Figure 50 shows, there will typically be more fairing than necessary at the forward end; you only need an overlap onto the fuselage shell of about **1"**. Trim off the excess beyond that. Similarly, at the aft end, trim the fairing so that its upper aft corner is even with the lower aft corner of the rudder and its lower aft corners are even with the elevator hingeline (see Figure 51).

Completed: [ ]

Step 40: Drill the Rudder Base Fairing

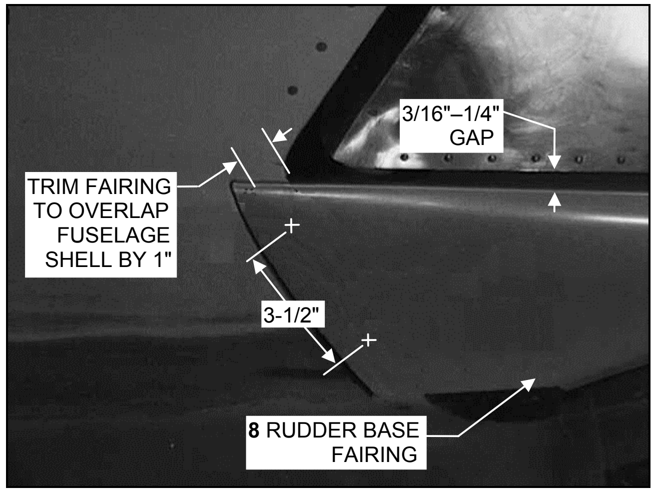


Figure 50: Trimming and Drilling the Under-Rudder Fairing

Figure 50 also shows the locations of the two mounting screw holes along the forward edge of the fairing on each side. These locations should be marked about **1/2"** forward of the aft edge of the fuselage shell. The upper location should be about **1-1/4"** below the upper edge of the fairing, and, as shown in the figure, the lower one should be marked about **3-1/2"** below the first. As these instructions imply, these locations are not overly critical, but try to place them the same way on both sides. With the hole locations marked and the fairing held tightly in place, drill through the fairing and fuselage shell at each mark with a **#19** bit. Insert AN526-8R8 round-head machine screws in these holes temporarily just to pin the fairing in place.

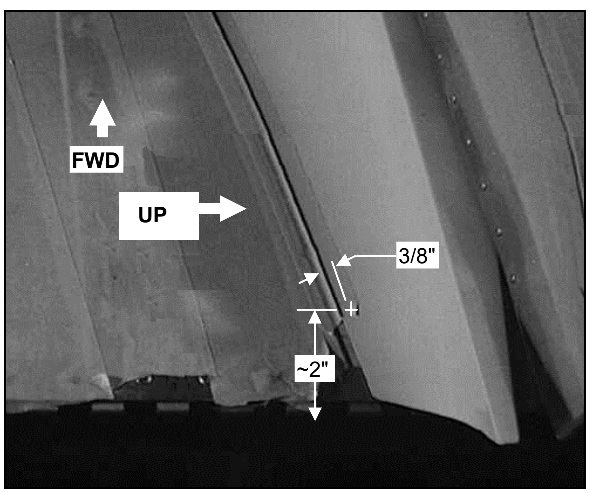


Figure 51 shows the location of the third and final mounting screw hole on each side of the fairing. Mark this location **3/8"** inboard of the lower edge of the fairing and about **2"** forward of the trailing edge of the stabilizer. Drill through the fairing and the upper surface of the stabilizer skin at each mark with a **#19** bit.

Completed: [ ]

Figure 51: Drilling the Aft Mounting Screw Holes

Step 41: Install the Nutplates and Rivnuts for the Rudder Base Fairing

The four screws at the forward end of the rudder base fairing are secured with conventional K1000-08 nutplates. Position these nutplates inside the fuselage shell and drill **#40** rivet holes. Countersink these holes on the outside of the shell to accommodate 3/32" AN426AD3 flush-head rivets. Rivet the nutplates in place, using a rivet squeezer if you have one.

For obvious reasons, nutplates can't be used for the two aft screws through the stabilizer skin. The solution to this problem is to use **Rivnuts** [65]. These consist of a female-threaded collar that can be installed like a blind rivet. As with a blind rivet, the interior portion of the collar is mushroomed against the interior surface of the skin by the installation tool, locking the collar securely in place. We recommend a little dab of 5-minute epoxy be applied during installation as well.

Note The Rivnuts supplied with the kit are specifically designed to grip thin aluminum skins securely. However, they are not optimized for use in fiberglass or steel, and so we do not recommend their use anywhere in the Sportsman not specified in this *Assembly Manual.*

The Rivnuts require a **1/4"** hole in the aluminum stabilizer skins. Use a 1/4" bit to ream the #19 holes up to final size. Deburr these holes carefully and install a Rivnut in each according to the instructions supplied with the installation tool.

Rivnut Installation Tool Option Rivnuts can be installed with a special tool much like a blind rivet puller. This tool is widely available from aircraft tool supply sources and can typically be used to install a variety of different Rivnut sizes. However, this tool is a bit pricey if you only need—as in the Sportsman kit—to install a couple Rivnuts. Glasair Aviation offers another, much cheaper installation tool sized specifically for the 8-32 Rivnuts specified here. Order P/N 081-01001-01. (If you use this tool, **ignore** the instruction to drill 17/64" installation holes; **1/4"** is the correct size.)

Completed: [ ]

Step 42: Fit and Drill the Tailcone

Because of differences in the taper of the tail, the elevator control horn will be about 1/4" offset to the RH side. Therefore, it will be typical for the slot to be shifted off center slightly.

The first step is to cut slots in the tailcone for the elevator control horns and the horizontal stabilizer aft attach bracket. As shown in Figure 52, the horn slot should be approximately **1-5/8"** wide and **5-3/4"** long. Mark a centerline down the top of the cone and then lay out the trim lines as shown. Also, mark the perpendicular trim lines **3/8"** aft of the forward edge of the cone for the attach bracket slot. Use a rotary cutting tool or a saber saw with a carbide grit blade to cut close to the lines, and then finish the slot with files and sandpaper, leaving smoothly radiused corners.

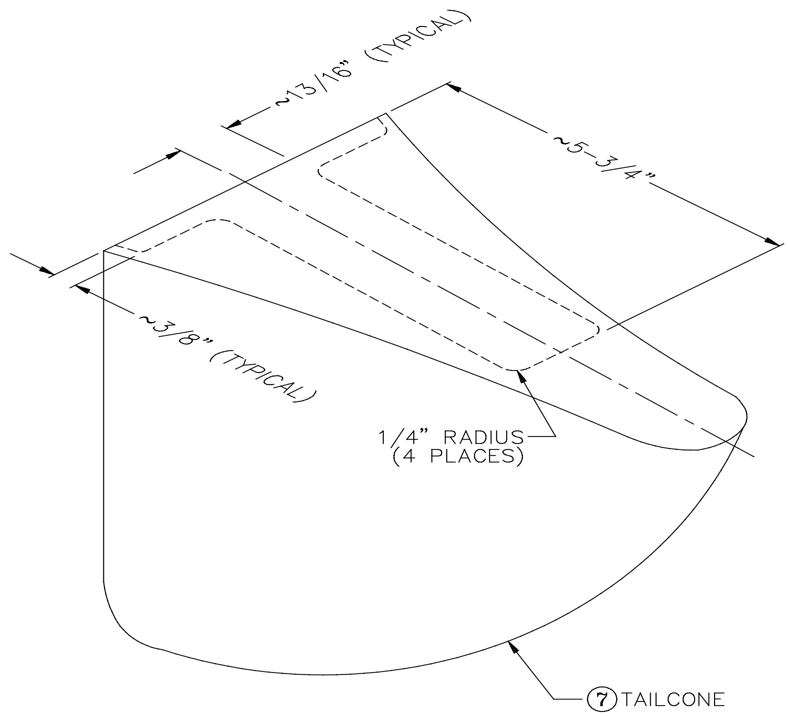


Figure 52: Cutting the Control Horn Slot in the Tailcone

Next, slide the tailcone into position over the tailcone flange of the fuselage. Trim the aft end of the fuselage as necessary to get a good fit. The forward end of the tailcone may also require trimming until the top of the cone is approximately even with the fuselage. You may need to trim more off the lower end in order to have clearance for the elevator down travel. Tape the tailcone securely in place with masking or duct tape. The tailcone is secured with four AN526-8R8 round-head machine screws into nutplates. The precise positioning of these screws and nutplates isn't critical, but the spacing shown in Figure 53 is ideal.

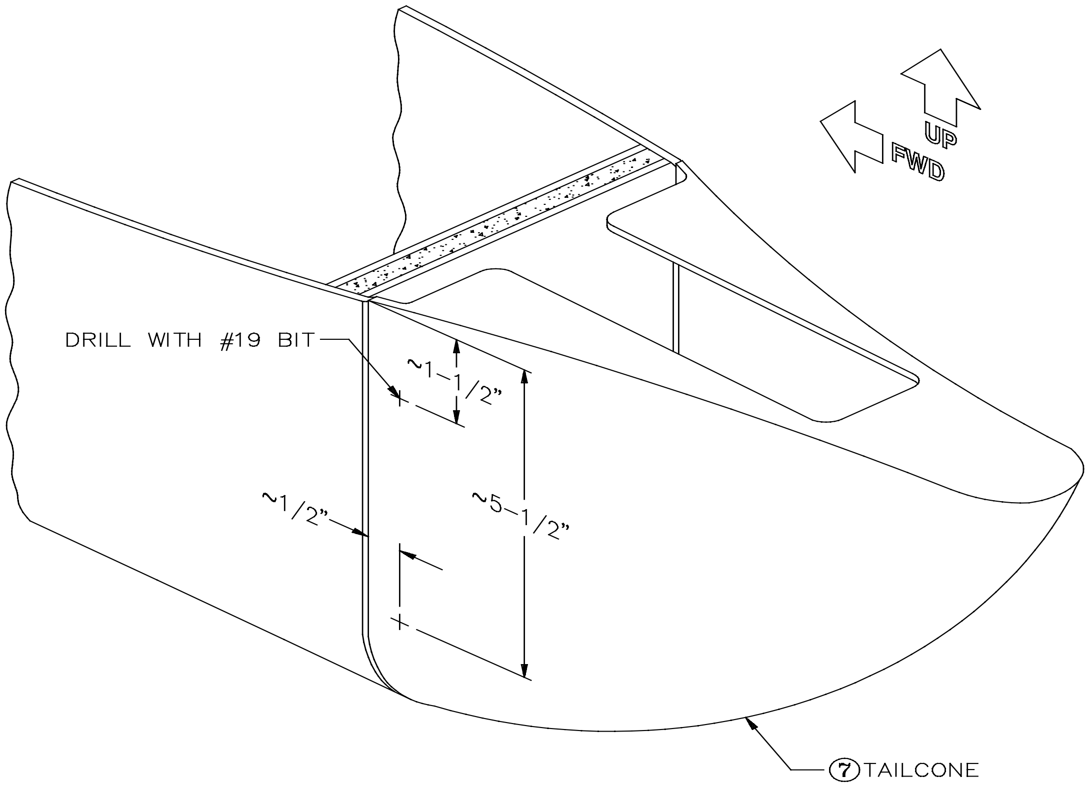


Figure 53: Drilling the Tailcone Mounting Screw Holes

Mark the hole locations on the outside of the tailcone and drill through both the tailcone and the underlying flange at each mark with a #19 bit. Then enlarge the holes in the fuselage flange only up to #10 size.

After all four holes have been drilled, use standard procedures to drill **#40** rivet holes in the fuselage flange for MF5000-08 **floating nutplates** [162]. Center the screw holes in the nutplate bases on the #10 holes in the flange. Countersink the rivet holes on the outside of the flange to accommodate AN426AD3 flush-head rivets. Rivet the nutplates in place, using a rivet squeezer if you have one.

You can install the tailcone with four AN526-8R8 round-head machine screws now if you wish, but we'd recommend just setting it aside, as it will have to be removed for final inspection anyway.

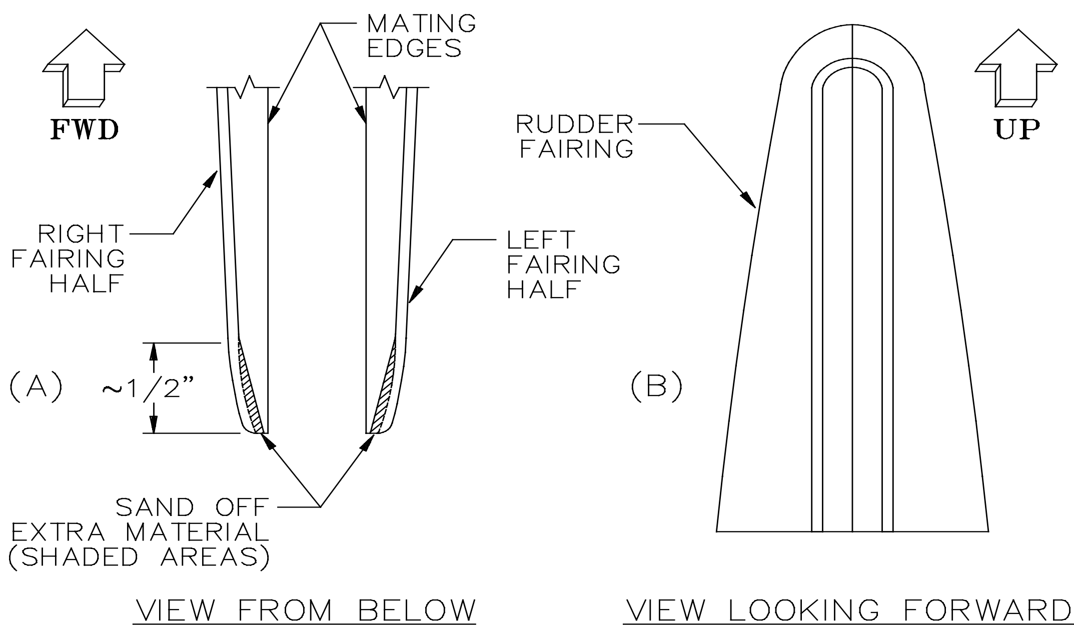
Completed: [ ]

Step 43: Seam the Rudder Tip Fairing Together

Remove the mold lip from the edges of the left and right rudder tip fairing halves.

To simplify fitting the fairing to the rudder, the two halves will be seamed together only at the forward end and along the top. The fairing halves will not be joined at their aft ends; instead, the aft end will be left open and will be trimmed off even with the trailing edge of the rudder skin. To permit this, sand inside the aft end of each half in the area where the thickness increases (about the last 1/2"), as shown in Figure 54a, until the aft end is approximately the same thickness as the rest of the laminate. After sanding, the trailing edges of the halves will not meet when placed together, but will form an elongated inverted “U” shape, as shown in Figure 54b.

Figure 54: Trim the Rudder Tip Fairing Halves



After all the trimming and sanding has been completed, use masking tape (applied on the outside) to tape the two fairing halves tightly together.

Cut two **1" X 21"** strips of bi-directional cloth on the 45° bias. Use these, with a small amount of vinyl ester resin, to seam the fairing halves together on the inside. When the resin reaches the green cure state, use a sharp knife to trim the ends of the fiberglass strips where they protrude past the fairing halves. Let the seam laminates cure completely, and then use sandpaper to clean up any remaining roughness. Remove the tape that was used to hold the halves together.

If you wish, you can use body filler to fill any gaps along the seam and sand it to your satisfaction.

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Step 44: Secure the Tip Fairing to the Rudder

In "SECTION III: RUDDER ASSEMBLY," you drilled three #19 holes on each side of the rudder at the tip and mounted nutplates centered on these holes for securing the tip fairing. On both sides of the rudder, use a fine-point felt-tip pen to mark lines parallel to the top of the rudder skin and **3/8"** below the **centers** of the #19 fairing-mounting holes, as shown in Figure 55. These lines mark the position of the lower edges of the tip fairing.

You now need to transfer the locations of the fairing mounting holes in the rudder to the tip fairing. This is complicated by the fact that the mounting holes in the rudder are hidden by the fairing when it is installed. One way to mark the hole locations on the fairing is shown in Figure 55. First, use a straightedge and a fine-point felt-tip pen to mark two lines at an angle to each other centered on each hole, extending the lines several inches below the fairing lower-edge line, as shown in Figure 55a. Then slip the fairing over the top of the rudder and tape it into place with its lower edge even with the horizontal lines marked previously. Position a flexible straightedge with one end along each of the angled hole location lines and the other end resting on the fairing; use a felt-tip pen to mark the continuation of the lines onto the fairing. As shown in Figure 55b, the point on the fairing where each pair of angled lines crosses marks the center of the underlying mounting hole. After marking all six hole locations on the fairing, remove it and drill a **#19** hole at each location. Secure the fairing to the rudder with AN526-8R7 round-head machine screws.

Note The rudder tip fairing halves in the very earliest Sportsman kits had three dimples on each side to locate the fairing mounting holes. These dimples are left over from an early mounting procedure that is no longer recommended. Therefore, you should ignore them, as they probably won't coincide with the actual locations of the mounting holes in the rudder. If you wish, you can fill the dimples with primer or body putty and then paint to match.

With the fairing in place on the rudder, mark its aft end for trimming even with the skin trailing edge, if you wish. Remove the fairing, trim it, and then reinstall it.

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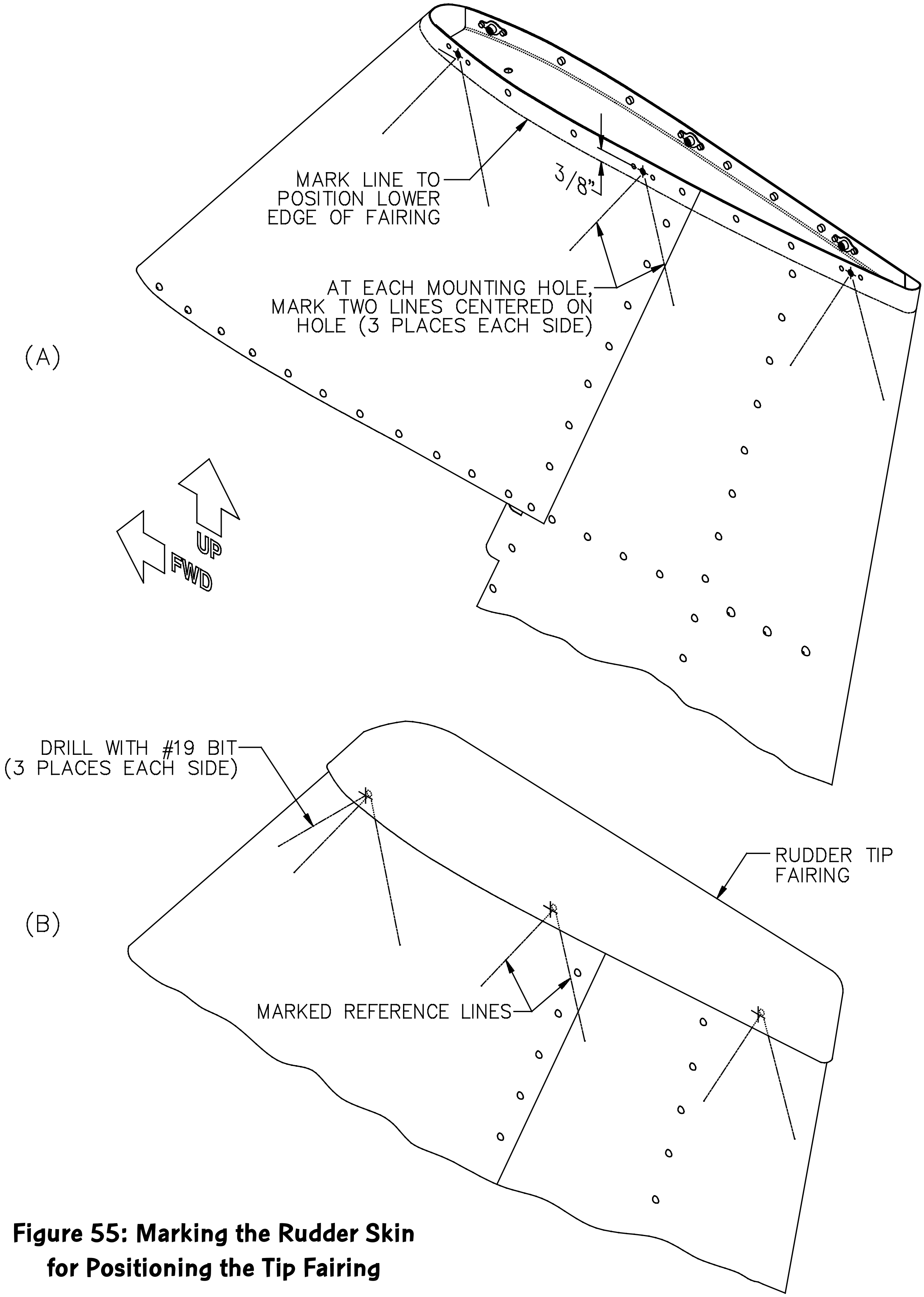

Figure 55: Marking the Rudder Skin for Positioning the Tip Fairing

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106:

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Gear Fairing Installation

This sub-section covers installation of main and nose gear wheel pants and main and nose gear leg fairings. Although the standard Sportsman kit includes all the necessary parts for these installations, they all can be considered optional, as the airplane flies fine without any of these fairings in place. Of course, there is a speed penalty to leaving them off, but if you anticipate frequent operation from rough or unimproved strips, you may prefer to pay this price.

8.00 X 6 or Larger Taildragger Options The next several steps cover the installation of main gear wheel pants over standard-sized, 6.00 X 6 main wheels for **either** tricycle- or taildragger-configured Sportsmans. The large-tired 8.00 X 6 taildragger options do not include wheel pants; if you are installing 8.00 X 6 taildragger gear, **skip to Step 56**.

Note Each main gear wheel pant consists of two molded fiberglass halves—the **main wheel pant forward half** [170] and **aft halves** [171-172]. For all practical purposes, the wheel pant halves are interchangeable between left and right main gear, but your aft halves come with suggested trim lines marked in ink which will then determine them as left and right halves, and these are part marked as –01 left or –02 right. If your wheel pants are not identified as left and right, then they will have both the left and fright hand scribe lines marked on each wheel pant.

Later versions of the wheel pants will have "windows" in them. These are locations where the primer has been removed from the pant which allows visibility to the inside where the brackets are being drilled and installed greatly simplifying the process.

Step 45: Install the Outboard Attach Bracket

The wheel pant is bolted to the main landing gear on the inboard and outboard side. The inboard half is attached to the bracket that is fixed to the brake mounting flange. The outboard half of the wheel pant attaches to the **outboard attach bracket** [174], which is secured to the nut plate that is riveted to the strap on the axle nut. Align the bracket vertically so the flanges on the "v" point outboard and bolt the bracket to the axle nut using an **AN4-3A bolt** [176] as shown in Figure 56. The longer of the two legs should point up. The same part works on both the left and right side.

Completed: [ ]

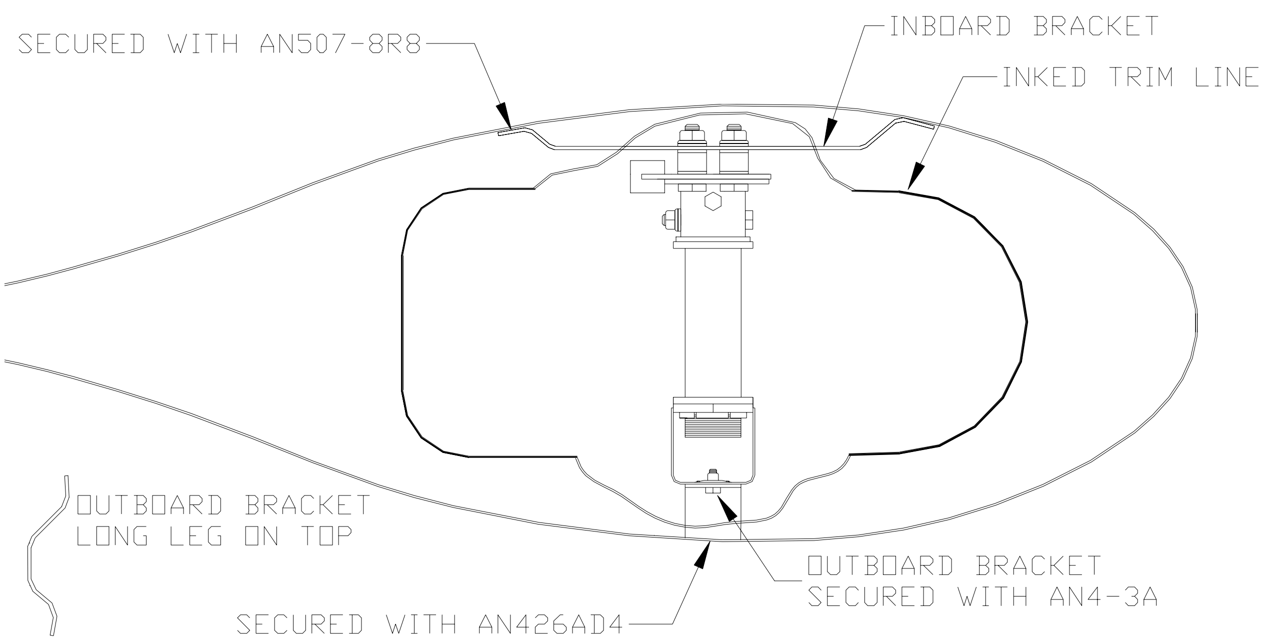

Figure 56: Installing the Pants on the Attach Brackets

Step 46: Position the Wheel Pants on the Gear

The wheel pants come with inked lines that show the **approximate trim lines** for assembly and tire clearance. The large marked cutout on the inboard side of the aft pant is for clearance around the brake caliper. Additionally, you will find marked locations where the fasteners will eventually be located. On later versions of the wheel pant, "windows" will be provided where the primer has been removed for easier visibility through the pant.

When centered properly on the gear, each main wheel pant should aim at a point below the leading edge of the horizontal stabilizer which is **42"** outboard of aircraft centerline. Begin by marking this line on the ground to serve as a construction aid when aligning the pants.

Start by cutting out to the trim line around the lower half and around the brake caliper on the aft wheel pant. **Do not start cutting on this line but work your way out to it, beginning perhaps 1/2" from the trim line.** Leave the clearance tight for now. Only after the wheel pant is secured to the brackets, final tire clearance can be marked and trimmed.

Allow for a **.38-.5"** gap between the tire and the upper portion of the pant as well as the sides. Set this gap by wrapping across the tire profile with a 1/2" wide cardboard strap that measures approximately .38-.5" thick. Tape the ends of the strap to the inner and outer hub to hold it in place. This strap will set an even gap all across the tire. The joggled edge on the aft pant half should be located **1.0"** forward of the axle centerline as shown in Figure 57.

The aft end of the pant should be approximately 9.5" above the ground for the tricycle configuration. For tail draggers, raise the tail up to approximate flight attitude and use the same 9.5" dimension. As you are trimming, sight the aft end of the wheel pant to the point below the horizontal stabilizer. The joggle flange should be located approximately 1" forward of the axle.

Mark the center of each flange with a big, dark "x" or point at the 8 locations shown in Figure 57. If you have the later version of the pants with the "windows" this mark will show through the pant. If not and the pants are primed, then attempt to sand off the primer to see through the pant or measure the distances to the center points from the floor or some other fixed point as shown in Figure 57. When one half is secured and held with Clecos, the second half can be located in similar fashion and by measuring off the joggle line and some other fixed point.

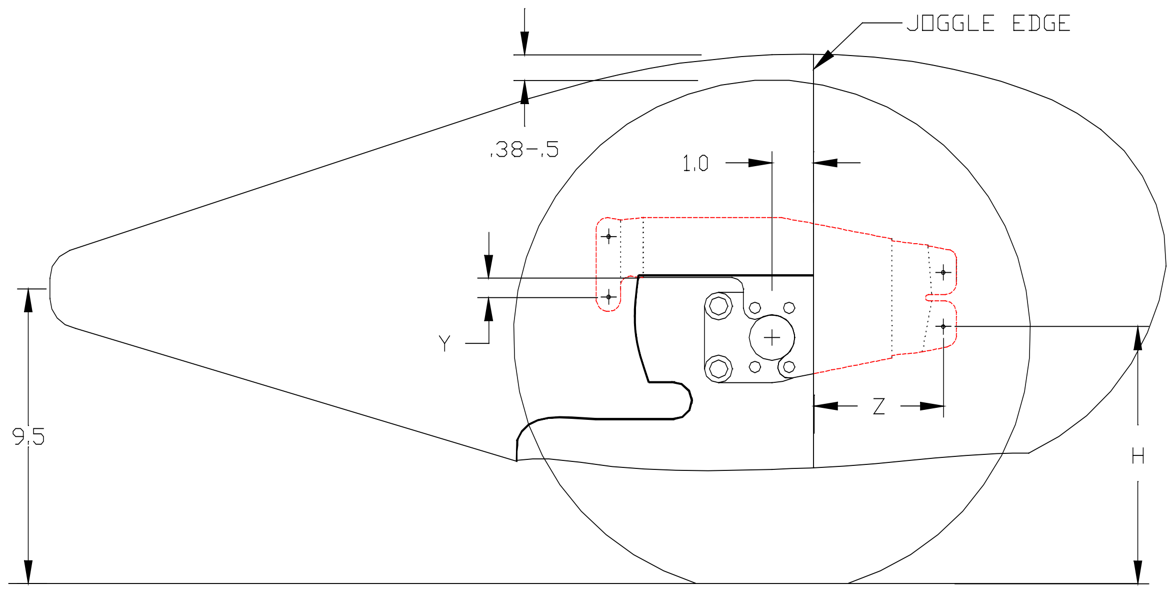

Figure 57: Positioning of the Wheel Pant Relative to the Axle

When close to the final position, measure back to the center of the nutplate on the axle nut and it should be fairly close to the 1.0 dimension aft of the joggle. Next, measure up to the flanges on the brackets and verify that the six locations marked in ink on the aft wheel pant (two on the aft end of the inboard attach bracket and two each on the upper and lower flanges of the outboard bracket) are positioned over the flanges. Make any adjustments necessary and drill through the wheel pant and the flange with a **#30** drill and cleco as you go.

Next, drill around the perimeter of the joggle flanges in the seven locations marked and cleco these as you progress.

Before disassembling the two pants, you should have two holes through both the aft and forward pant common to the inboard attach bracket, four holes through the aft pant common to the outboard bracket and seven holes around the joggled perimeter.

Completed: Left [ ] Right [ ]

Step 47: Laminate the Reinforcement Plies for Screws

The inboard side of the wheel pant attaches to the inboard bracket using AN507-8R8 screws as shown in Figure 56. You must build up the fiberglass so the material is thick enough to countersink for the head of the screw.

Cut some small patches of fiberglass and do a three layer laminate directly over the four holes on the inboard side. Do the same on the outboard side of the pant to build up material for the AN426AD4 rivet that will attach the outboard bracket to the wheel pant.

There is no need to laminate around the joggle perimeter since the joggles were manufactured with additional plies for the screw heads.

After the reinforcement laminates have cured, pass drill through the pant and new laminate at each of the drilled location with a **#30** bit.

Reinstall the wheel pants on the wheel. Pass drill through the pant and **inboard** bracket with a #20 drill for the screw. **Do not drill through the outboard bracket.**

Pass drill with a #20 drill through both pants in the seven locations around the joggled perimeter.

Completed: Left [ ] Right [ ]

Step 48: Install the Nutplates and Rivet on the Outboard Bracket

Countersink the inboard side of the pant four places for the AN507-8R8 screws. Then countersink the perimeter seven holes for the same screws.

Next, countersink the outboard side of the pant four places for the AN426AD4 flush head rivet. Using AN426AD4 rivets of the appropriate length, rivet the outboard bracket to the wheel pant.

Finally, install four **MF5000-08 nutplates** [177] on the inboard bracket for the screws and then install the same nutplates on the inside of the joggled flange in the seven locations around the perimeter.

Completed: Left [ ] Right [ ]

Step 49: Bond in the Aft Pant Bulkhead

A closeout bulkhead needs to be bonded inside the aft pant in order to keep debris from collecting in the back of the pant. A preformed, flanged **bulkhead** [173] has been provided and is very easy to install.

Test fit the bulkhead inside the aft pant. Mark the location and prep both sides for bonding by sanding and cleaning the surfaces. Mix a small thick batch of resin Q-cell mix and wipe it along the flange of the bulkhead. Carefully press the bulkhead into position and allow to cure.

Completed: Left [ ] Right [ ]

GEAR LEG FAIRINGS

There are two ways to fair the main gear legs. One is using sheet metal and piano hinge to form a fairing and is the same method that has been used on most of the GlaStars. It can be easily removed to facilitate the inspection of the gear. The Sportsman prototype uses a fiberglass fairing that is bonded directly to the gear. The Whittman style gear (used on the Sportsman and GlaStar) is a round gear and inherently tends to wobble in the fore and aft direction. This bonded fairing makes for a sturdier gear in the fore and aft direction but it does not increase the bending strength of the gear. A footstep has been built into the fairing, which makes getting in and out easier. The down side of the fairing is that it is a permanent installation and cannot be removed without effort and destroying the fairing. Both methods are described below. **Steps 51-60 describe the laminated version and Steps 61 – 64 describe the sheet metal version.** **Reference the additional photos at the end of Section X in the manual.**

Step 50: Laminate the Strut

The plane needs to be propped up or suspended by the lifting eyes so that there is no bending in the gear strut. The weight of the wheels and tires is insignificant and OK if they are installed. To protect the surface, tape off the fuselage with several layers of masking tape within a six inch or greater radius of the gear strut, extending the tape to ten or twelve inches aft of the strut.

Tape off the brake assembly and anything else you wish to protect from resin drips at the lower end as well. Lay a large piece of cardboard on the floor under each gear strut to catch resin drips.

Clean the gear strut thoroughly with a degreaser or solvent. Sand the painted surface with 100 grit sand paper. Rough up the surface only. It is not necessary to sand through the paint to bare metal. Apply a single ply of 7781 cloth or any similar weight fiberglass cloth with Vinylester resin around the struts. (Make a paper template out of butcher paper to size the cloth or measure the circumference with a tape measure. Be sure to add enough for a 1/2 " overlap.) Be sure that the cloth wraps completely around the strut and overlaps itself by a half-inch minimum as shown in Figure 58. Vinylester resin shrinks when cured, so this first ply is the most important one to provide a strong, clinging bond to the strut. Try to make a tight wrap with little or no air bubbles. Cut the cloth on a 45-degree bias to minimize fraying at the edges.

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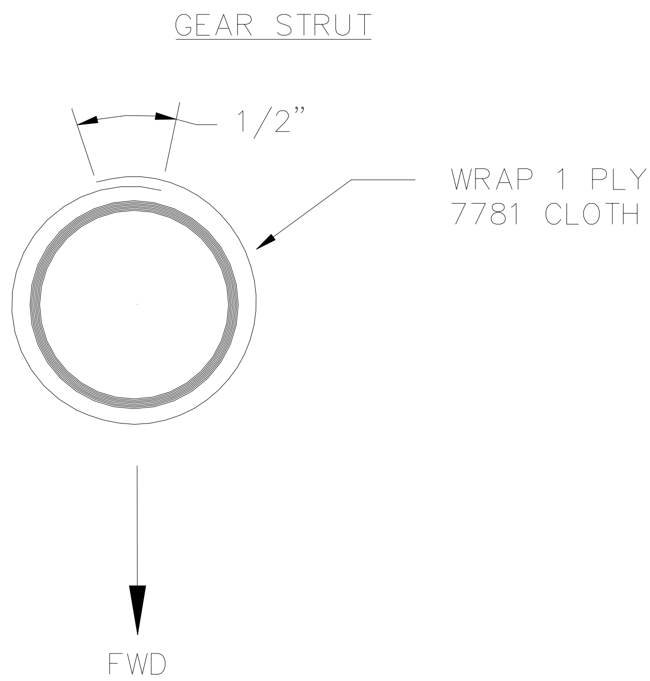
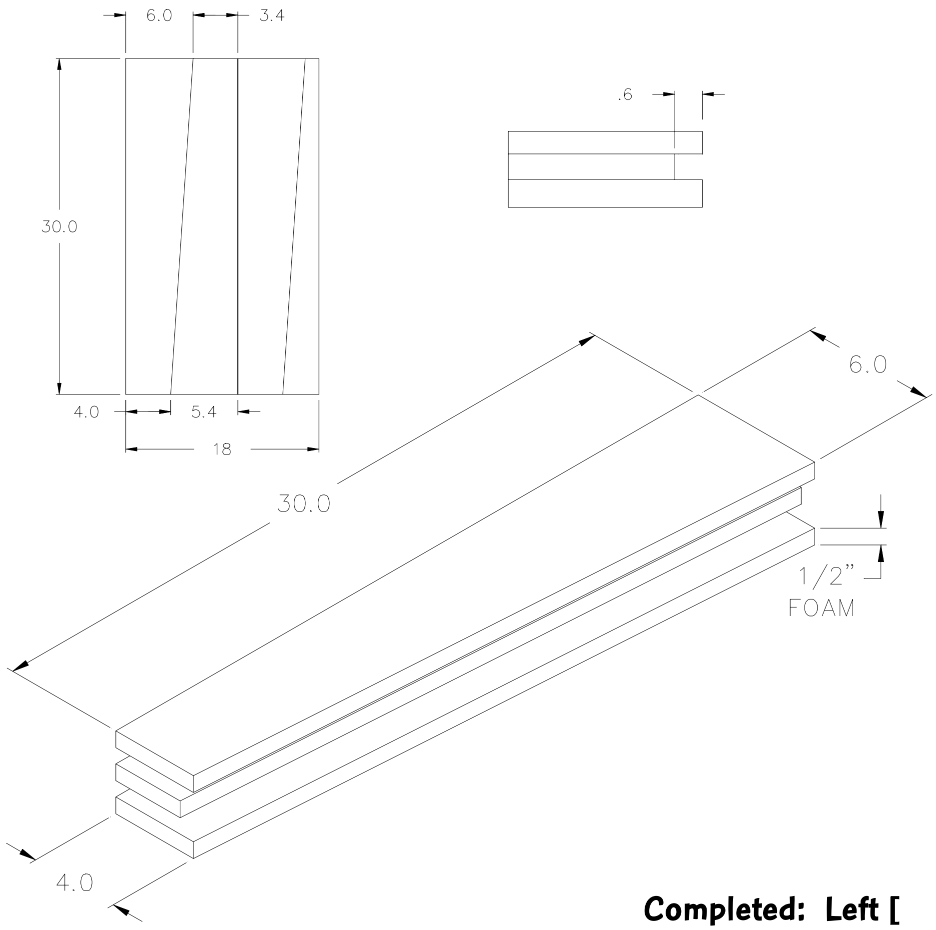


Figure 58: Wrapping the Gear

Step 51: Bond the Foam Together

Take the **1/2" inch thick 5# foam sheet** [178] provided and cut the shapes out so that when bonded together, they will form two fairings 1-1/2" inch thick as seen in Figure 59. The (side profile) width of the fairings can vary according to your taste. On the Sportsman, we sized them six inches wide at the top and four inches at the bottom. The center piece of foam is set back .6 inches from the tapered edge to make a channel for the brake line. They give the plane and gear a sturdy look as opposed to a thinner fairing or no fairing at all (yuck). Bond the foam pieces together using a mixture of vinylester resin and Q-cell the consistency of a milkshake. Smear a thin layer to both foam faces and squeeze them together. Lay a piece of wax paper on a flat bench and use a flat board and evenly distributed weight to hold the foam pieces together to cure overnight.

Note: Save any leftover foam for the optional foot-step described in Step 57.



Completed: Left [ ] Right [

Figure 59: Bonding the Foam

Step 52: Shape the Foam

Sand angles on the forward end while checking the fit to the gear strut and grind a notch in the middle as shown in Figure 60. We used a small, hand-held die grinder with a rotary file to carve out the notch. Someday you may need to replace a brake line, so make the notch large enough to remove and install a new line. If using a braided stainless brake line, carve a notch big enough to remove and install the brake line with fitting installed. The foam notches easily, but the challenge is in making a straight notch since the bond line makes a hard edge. If you have a helper handy, have them firmly hold a straight edge along the foam edge for you to use as a guide in keeping your grinder straight, or simply lay the foam on a flat table and let the table surface be the guide to keep the grinder straight. (The bond line tends to make the cutter kick-out sideways producing a crooked notch). If the notch isn't perfect, don't sweat it. It will be hidden!

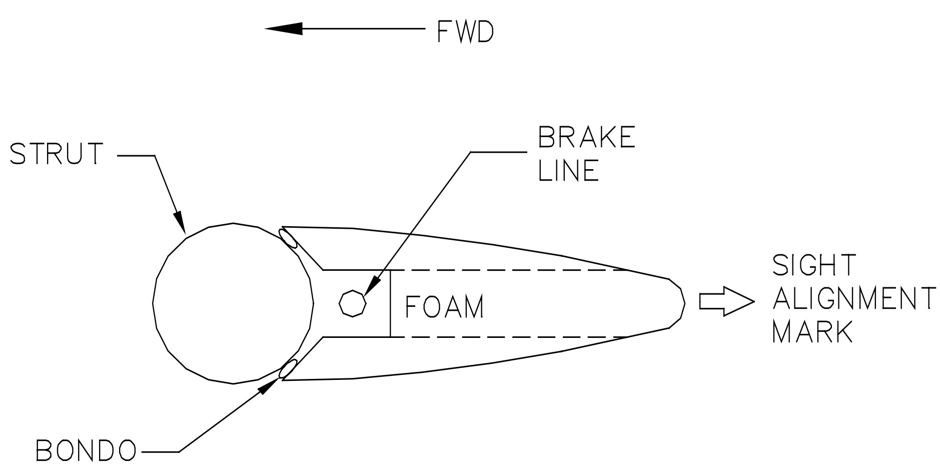


Figure 60: Shaping the Foam

Once the notch is done, use a sanding block with 60 grit or larger paper and sand the foam blocks to a symmetrical airfoil shape as shown. Don't make the trailing edge sharp. A larger radius is much easier to laminate than a sharp one. A sharp radius will trap air bubbles and provide unnecessary frustration! Position the brake line (flexible) tubing so that it exits the fuselage just aft of the gear leg. You may want to wait to drill or notch this hole until after the exact position of the fairing is determined in Step 58.

Lastly, the foam pieces need to be trimmed at the top and bottom. At the top, sand the foam so that it is within 1/8 to 3/16" at the leading edge and tapers away from the fuselage to a distance of 1/4 to 3/8" at the trailing edge. The wider distance is necessary at the trailing edge to account for fore/aft movement of the strut. Don't get it over 3/8 inch wide or the silicone intersection fairing described in step 59 won't have enough to cling to. Trim the bottom of the fairing as desired. Keep in mind that you won't want the fairing to interfere or complicate changing the brake pads. We left our foam long, and did the final trimming to provide brake assembly clearance after the fairing was finished.

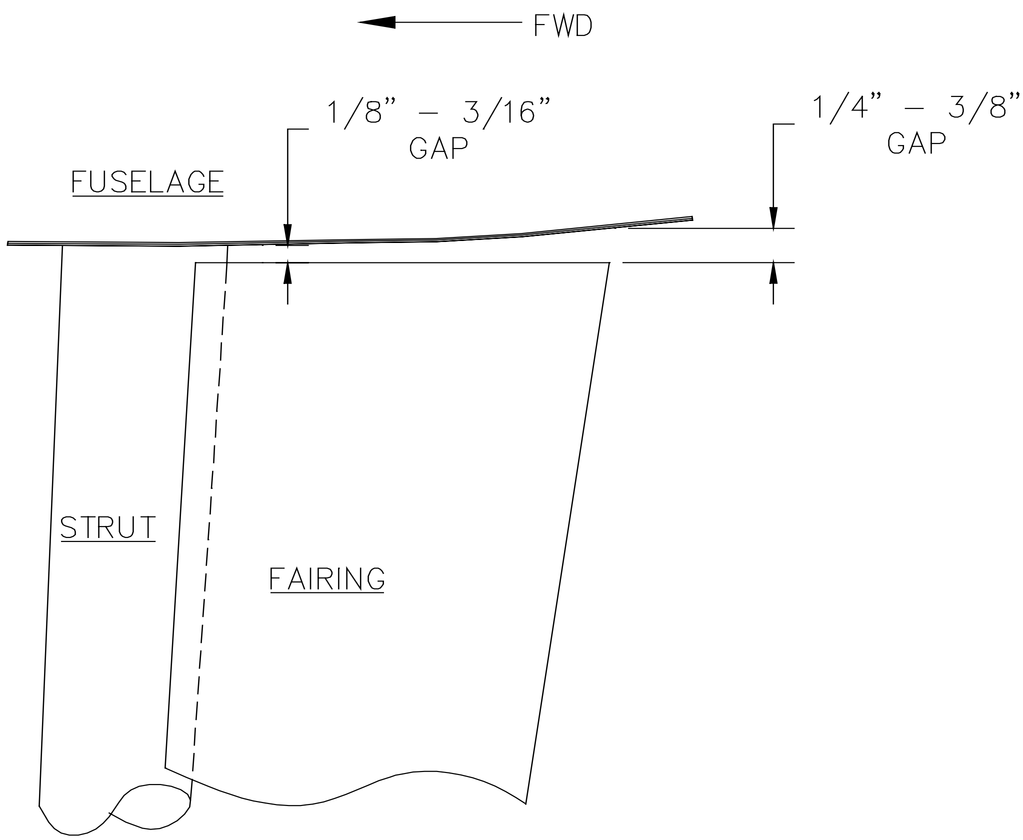


Figure 61: Trimming the Fairing at the Fuselage Junction

Completed: Left [ ] Right [ ]

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

53?

Page 113: [illegible]

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Step 53: Bonding the Foam to the Strut

A helper will make this step a little easier. Have the helper hold the fairing in position, or tape it in position if you can't find a helper. Go back to the tail and sight from a position approximately 12" outboard from the tail cone and 12" down on either side. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a board in its place and make a couple of sight marks equally spaced to each side. Sight to the trailing edge of the foam fairing and direct your helper to move the trailing edge in or out until it is centered and in line with your eye. Make an alignment mark on the fuselage at the foam trailing edge. Repeat this procedure for the opposite side. Also check that the position of the bottom of the fairing is above the brake assembly. Since the brake assembly slides inboard approximately 1" on studs, it will be impossible to change brake pads easily with the fairing in the way.

When satisfied, DOUBLE CHECK that the fairing alignment is the same from side to side. These are essentially fins that can steer your plane in an undesired way if not equal on both sides. You want them aligned in the slipstream for minimal drag, but it is far more important that they be installed at the same angle side-to-side.

Once satisfied with the alignment marks, trial fit the fairing in place once more with the brake line inserted in the notch. Keep in mind that it will be a bit of a wrestling match to keep the brake line in the notch and from smearing the bondo, so your helper can assist you to holding things in position.

Mix a small golf-ball size batch of auto body putty and quickly wipe a small bead onto each flange of the foam (on the outer edge) as shown in Figure 62. It is not necessary to cover the entire foam contact points. The purpose of this bond is to simply hold the foam in place while you laminate the outer plies. It provides little of the strength for holding the fairing in place. You mostly want to be sure that excess bondo doesn't squeeze into the notch, which will really complicate the future option for replacing a brake-line.

Hold the foam in the proper alignment until the bondo sets up (3-5 minutes). While holding it in place, keep it straight and be sure not to induce a twist in the fairing. Once the bondo reaches a rubbery consistency, cut or scrape any excess that squeezed out. Tug on the brake line to be sure it is free before the bondo sets up too hard. **Completed: Left [ ] Right [ ]**

Step 54: Filling the Gaps

Mix up a 100 gram batch of resin and divide it into two equal cups. Mix one cup with Q-cell to the consistency of a very thick milk shake or paste. (It shouldn't' t be runny) With a plastic squeegee, smear this mixture into any low spots between the foam and the strut.

Mix the second cup with any left-over from the first batch and add Q-cell to the consistency of a thin shake. Smear a thin layer over the entire surface of the foam to seal it; almost like a wipe-on followed by a wipe-off. You do not want to do any sanding after this operation, so be sure the surface is smooth. If in doubt, wipe it all off. The pores of the foam will still be filled.

Completed: Left [ ] Right [ ]

Step 55: Laminating the Fairing

This step can be done with the gear on or off the plane depending on your preference. If it is easy for you to remove them, then it is by far easier to laminate with the gear removed. Prop them on a bench or saw-horses and do all the laminating with the gear in a more horizontal position. Also, mixing several batches of 100 grams each is better than one large batch as it will tend to exotherm in the cup and reduce the wet-out time.

The completed fairing will be anywhere from **4-6 plies thick** depending on your preference. For a tricycle on hard surface operations, we'd suggest four plies. For tail-draggers or tricycle operations on unimproved strips, we'd suggest six plies thickness. Note: If you intend to install the foot-step described in Step 57, use a six ply thickness. Make a paper template for one 'wrap' and double the size of the template for a two-wrap laminate. We installed the laminates two-plies thick at a time. Make sure you cut the cloth on a 45 degree bias or close to it and make it several inches larger in size than the template. You might want to cut only one piece and see how it works out. Adjustments can be made to the template after you've applied the first laminate.

Wet out the foam on both sides and apply the laminate edge on the mid point of the leading edge Wrap it (evenly) aft on the outside face and begin wetting it out.

Once it is wet with all bubbles stippled out, wrap it around the back-side and completely around the front-side again as shown in Figure 62. Have a helper wet out the back-side while you wet the front-side again or vice-versa since the back-side is the hardest to do (if the gear remains on the plane).

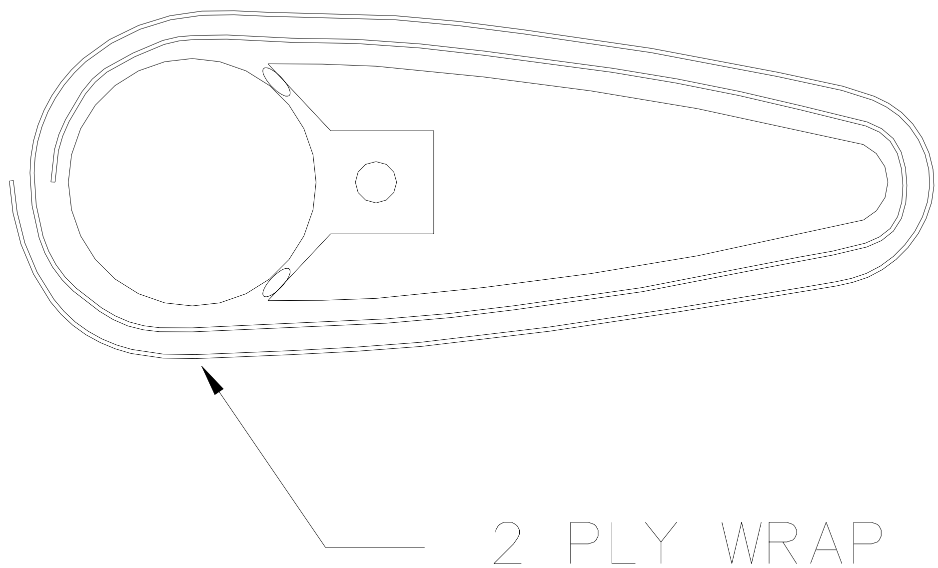


Figure 62: Laminating the Fairing to the Strut

Force any air bubbles out to the edges. If you had trouble laying the cloth flat, creases can be removed by tracing the cloth bias to the edge and pulling gently to remove the crease. Lastly, make the final wrap around the back-side, then back around to the leading edge and trim with scissors close to the same spot where you began. We suggest starting/stopping and layering any overlaps at the leading edge since it will be easiest to sand and shape here prior to application of the final finish.

Trim away any excess cloth that bunches against the fuselage or hangs below at the bottom. It doesn't have to be perfect at this point, since you will remove the strut and sand the edges to the desired gap at the end. If you did your best but came up short on the cloth at either end, don't worry! It is only a fairing and will still function fine. Add in a separate chunk of cloth if you wish, but try to avoid overlaps of cloth along the flat sides of the fairing or the end result will be a lumpy fairing and will require more filler to make it look good. The overall ply thickness is a goal-not a must do.

Let the first application cure, then after any adjustments to the cloth template or procedures, add the remaining laminates (two plies at a time) until the desired thickness is reached. We found that to attempt more than two-ply thickness in a 30-minute time slot is very tough to do. You will likely run out of resin gel-time plus it is difficult to manage a larger piece of cloth. You don't have to wait until the resin is completely cured, but enough so the underlying plies won't move on you. Alternating from left gear to right gear works out well to allow for the opposite side to cure.

Completed: Left [ ] Right [ ]

Step 56: Optional Foot Step

If desired, a foot-step can be added to the fairing which provides a place to stand when filling the fuel tanks and no ladder is available. On the Sportsman (taildragger struts), we added such a step as shown in Figure 63. We also found it handy for climbing in and out of the plane and wiping the windscreen. **This step does not work well for the tricycle configured airplanes as the main gear strut is too far aft to be useful.**

The step is added by taking a piece of the left over foam and sanding it into a crescent-moon shape and attaching it to the strut (with bondo) approximately level with the waterline as shown in Figure 63. Fill in any voids with the thick Q-cell mix and seal the foam with a thin mixture and laminate (8) plies onto the upper and lower surface. Be sure to taper the laminates onto the strut making each ply overlap the last one by 1/4 inch. The last ply should extend 1.5 - 2" onto the strut.

To begin, cut and wax a piece of aluminum sheet to lay against the top surface of the foam step and laminate three or four of the lower plies against the aluminum sheet as shown in Figure 64. The purpose is to get the laminates to extend 1/2 inch beyond the foam so the upper and lower laminates are bonded together and form a thick, sturdy edge. Once these initial lower plies are cured, peel up the aluminum and rough sand the smooth surface of the fiberglass. Continue laminating until all eight plies are built up on top and bottom.

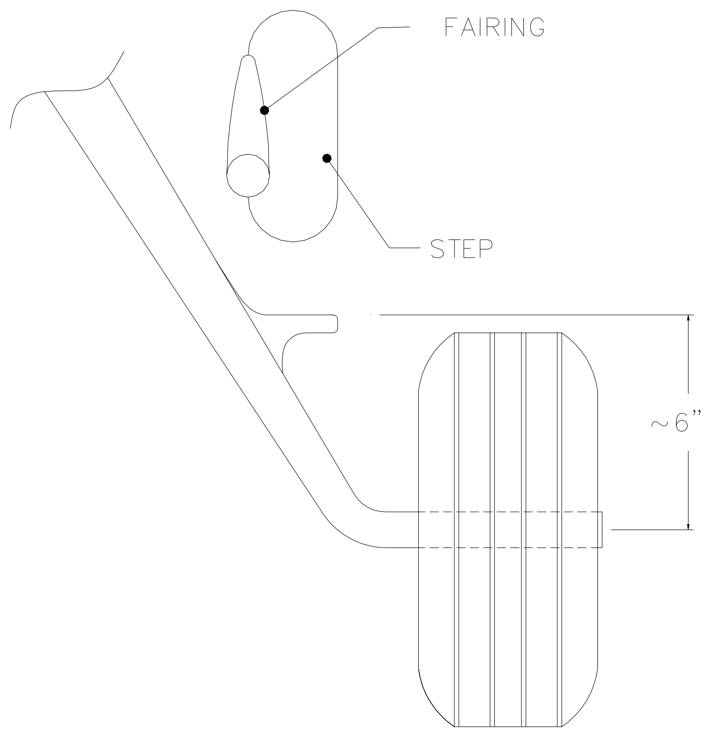


Figure 63: Optional Foot Step

When cured, sand and shape the thick edge, taper sand the laminates where they overlap onto the gear fairing and sand any bumps or irregular surfaces on the gear fairings. As a final preparation prior to paint, you can either use auto body putty or a mixture of resin and Q-cell to coat the surfaces and sand to a smooth finish. If painting, you can use a heavy build primer (we used Marhyde Ultimate 2K Urethane Primer) on top of the body putty; most of which will be applied and sanded off to fill the low spots and cloth texture.

Once the primer has been sanded to a 320 finish, the fairings will be ready for final paint coats. Typically, a thin sealer primer will be sprayed just before the top-coat. Gel coat provides a tough surface very resistant to rock chips. Gel coat may be sprayed directly over the bondo or Q-cell surface and built up thick enough to sand and polish to a shine matching the fuselage. It can also be sprayed over the top of the Urethane fill primer.

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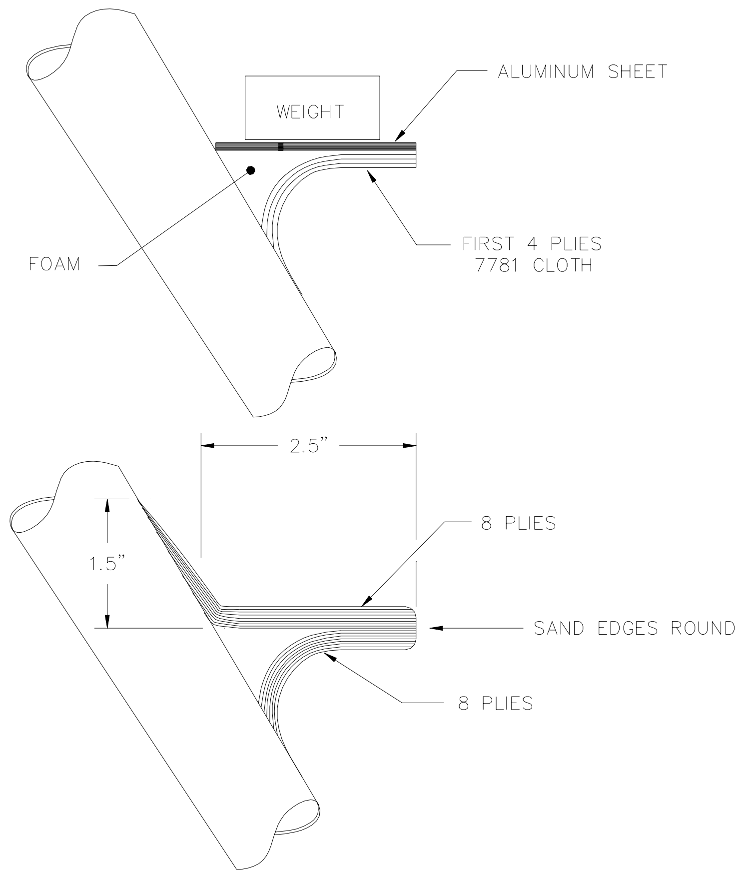

Figure 64: Laminating the Step

Step 57: Final Installation and Trimming

Trim and sand the fairings at the upper end to the gap dimensions shown in Figure 61 and on the lower end to allow enough room to slide the brake caliper assembly off the wheel. Install the gear struts into the sockets and thread the brake line into the fuselage.

Completed: Left [ ] Right [ ]

Step 58: The Intersection Fairing

Do this last step while the plane is on the ground and the weight is on the gear.

Tape off the fuselage in the immediate area right around the gear strut with a piece of wax paper. Tape it tight and avoid wrinkles where possible. Take a round object such as a large 50 cent or silver dollar size washer and trace lines onto the wax paper and the gear fairing at the tangent point of the washer (see the arrows in Figure 65) as it is moved around the entire intersection. Take some masking tape (1/2" vinyl electrical tape works better) and tape off the wax paper and gear leg fairing just 1/16" outside of these lines. Add more tape as a protective buffer beyond the first strip. The wax paper will keep the intersection fairing separate from the fuselage and allow for a simpler removal of the gear in the future.

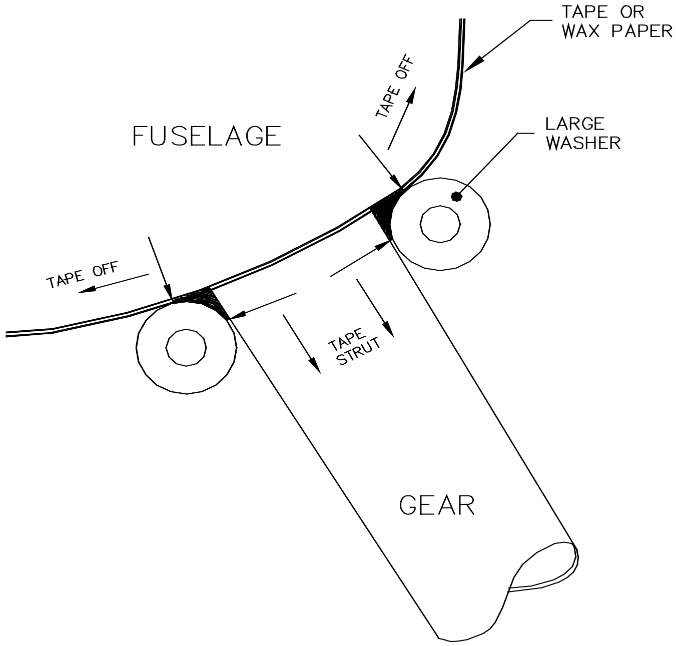

Figure 65: Applying the Intersection Fillet

Take a tube of GE Silpruf SCS 2000 Sealant (this is the same product used to bond in the Plexiglas windows; we recommend black or gray) and squeeze in a pile of it between the tape. The object is to get enough of it in place (with the hole taped over) so that a final sweep can be made around the entire circumference without stopping. If too much Silpruf is in place, it will spill over the edges and pile up too high on the tape. Not enough, and you'll end up with low spots. Don't worry if it takes a few tries, because the Silpruf dries slowly and you will have plenty of working time to get it nice and smooth. Start on the backside of the strut and wipe smoothly around the front and end it on the backside.

Any marks left from when you lift the washer will be minor and hidden on the back. When satisfied with the final wipe, carefully remove the tape without touching the Silpruf for at least 24-48 hours.

After it has fully cured, remove the gear enough to remove the wax paper from the fuselage and the Silpruf..

Completed: Left [ ] Right [ ]

Step 59: Apply Non-Skid to the Step Surface

Make a paper template of the flat surface of each step. From some adhesive backed non-skid material, cut out the shape from the templates and apply to the steps.

Stand back, admire your handiwork and give the steps their first structural load test.

Completed: Left [ ] Right [ ]

Step 60: Cut Out, Bend and Fit the Main Gear Leg Fairings *(sheet metal version)*

The main gear leg fairings (for all gear configurations) are simple, bent sheet-metal parts. Each fairing consists of an upper half overlapping a lower half. The joint between the halves allows the gear leg to flex without kinking the fairing. Lengths of piano hinge riveted along the trailing edges of the fairing halves hold them

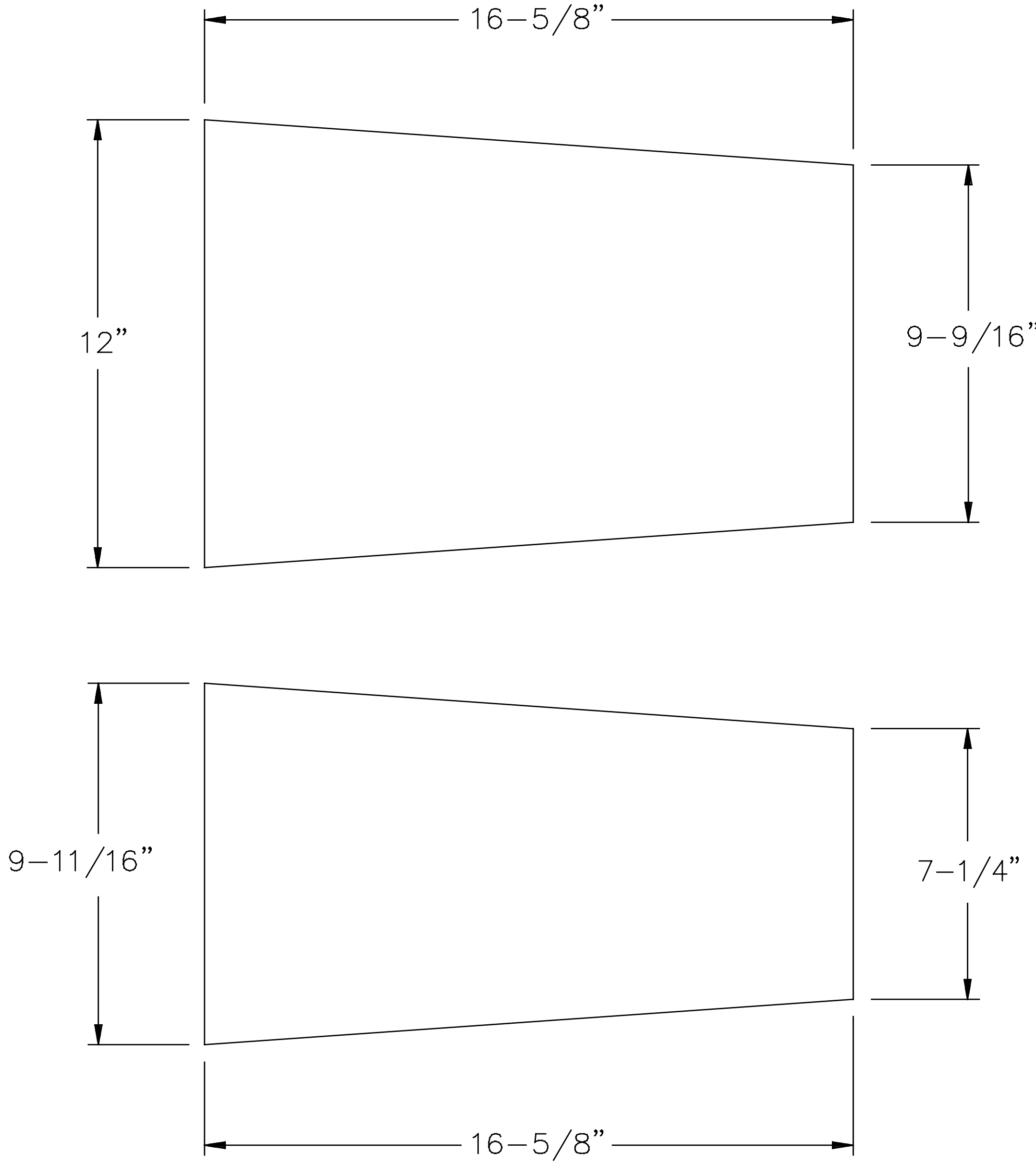

Figure 66: Flat Patterns for the Main Gear Leg Fairing Halves

together around the leg, and the hinge pin also holds the fairing in position relative to the fuselage and gear leg.

The first step in fabricating the fairings is to cut the flat patterns out of the supplied **.020" X 12" X 36" aluminum sheets** [68]. Figure 66 shows the dimensions for the upper and lower halves; the flat patterns are identical for the left and right sides. Lay these dimensions out on the sheet with a fine-point marking pen and cut the four pieces out with snips. Thoroughly deburr all the cut edges.

The next step is to bend the flat pieces to create the aerodynamic shape of the fairing halves. There are all kinds of complicated ways to accomplish this, but we recommend a simple one: bending the metal around a broomstick.

First, mark a longitudinal centerline down each piece. Then find a broom handle or any comparable cylindrical object—a wooden dowel, a piece of pipe, etc.—with a diameter of between **3/4"** and **1-1/8"**. The piece should be at least **20"** long so that it hangs beyond both ends of the fairing by at least a couple inches. Clamp the fairing piece between the broom handle and the bench top with the broom handle aligned about **3/4"** to one side of the fairing centerline. The centerline itself should be aligned with the edge of the bench. See Figure 67a.

Hint If you're using an actual broom handle or wooden dowel, simply sand a flat spot at each end to accommodate C-clamps. If you use a metal pipe, you'll have to devise some type of cleat to clamp each end down.

Next, as shown in Figure 67b, position a **20"**-long 1 X 4 under the overhanging half of the fairing. Push the 1 X 4 up from below to bend the sheet around the broomstick, taking care to keep the board parallel to the broomstick (and thus to the centerline of the fairing). As the bend progresses, move the board in as close to the broomstick as possible to keep the bend relatively tight.

Hint The bending may go easier if you have an assistant to help you manage the 1 X 4. Also, you may find it useful to secure the edges of the fairing piece to the bench top on the other side of the broomstick with duct tape just to make it less likely that the sheet will try to slide around during the bending.

Keep folding the metal over until the outside edges of the piece touch. Then remove the pressure and measure the distance between these edges after the metal springs back open. Ideally, as shown in Figure 67c, you'd like about a **5-1/2"** opening at the wide end of the upper fairing and about a **3"** opening at the narrow end of the lower fairing; the gap where the two halves meet should be about **4-1/4"**. If necessary, reposition the fairing, broomstick and 1 X 4 and bend the metal further.

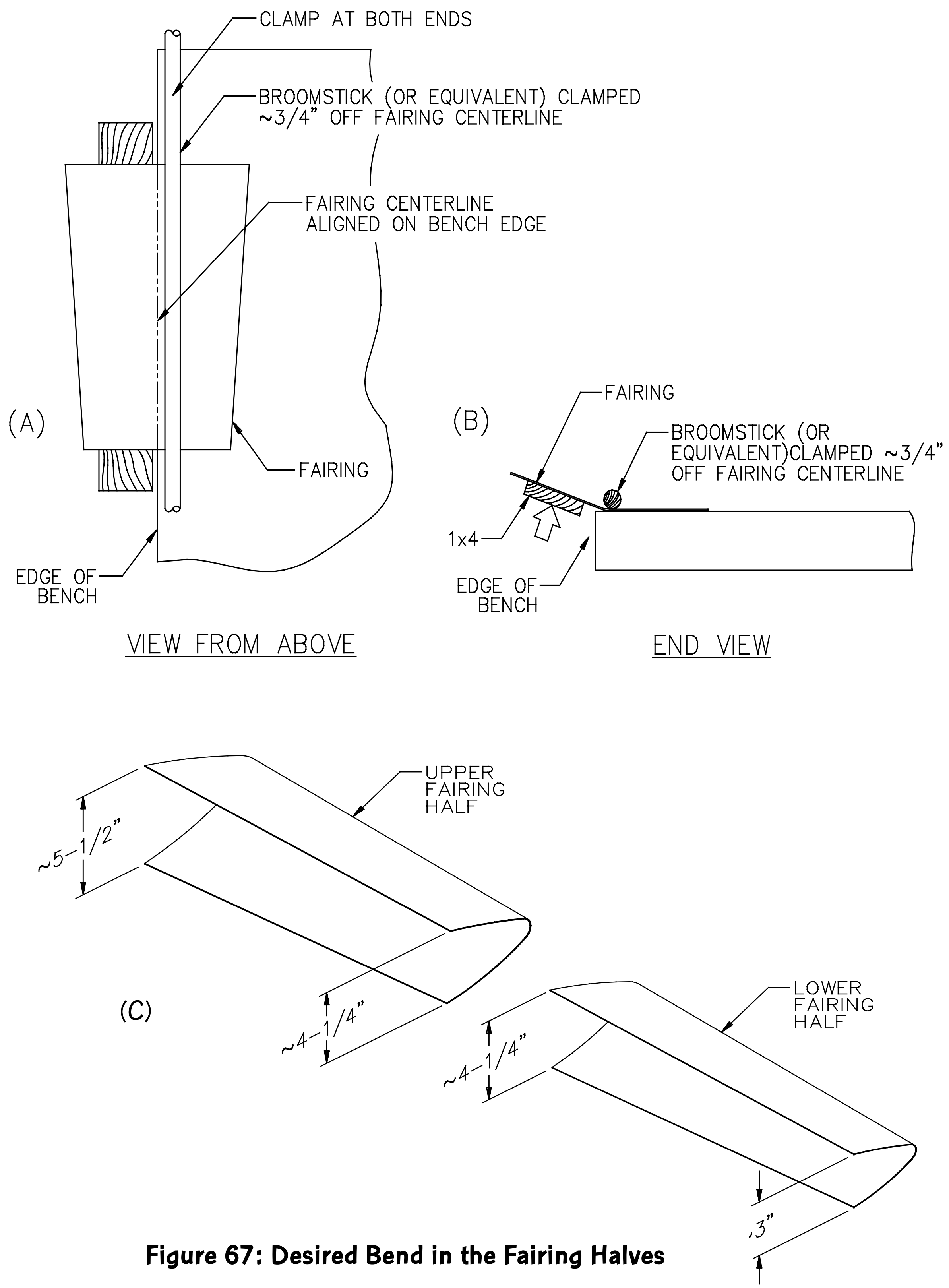

Figure 67: Desired Bend in the Fairing Halves

Finally, the ends of the fairing halves must be trimmed to fit. This is best accomplished through trial and error. Begin by taping the upper and lower halves together to form one long, tapering fairing. Lap the upper fairing half over the lower one by **5/8"**. Then slide the taped fairing over its gear leg from the **forward** side and trim the upper end to fit tightly against the curvature of the fuselage and the lower end to clear the axle and brake line. Use offset snips to trim just a bit at a time off the fairing until it fits to your satisfaction.

Note Be sure to assess the fit of the fairings with their trailing edges held tightly together.

Landing Gear Options Builders intending to convert back and forth between tricycle and taildragger landing gear should be aware that the fairings will fit for **only one configuration or the other**, primarily because the tricycle and taildragger gear legs exit the fuselage at different angles. Since they are glued to the landing gear struts, the foam stiffener blocks (described in Step 63, below) will be reused as will the sheet metal screws at the overlaps of the fairing halves. Additional sheet metal and hinge stock for the extra set of fairings are included in the gear conversion kits available from Glasair Aviation.

Thoroughly deburr the trimmed edges, leaving the halves taped securely together.

Completed: Left [ ] Right [ ]

Step 61: Install Piano Hinge Along the Trailing Edges of the Fairing Halves

Piano hinges are used to hold the trailing edges of the gear leg fairings together. Remove the pin from the **72" length of rolled hinge stock** [164] and set it aside. Then put the hinge halves back together and cut **four 16"** lengths of hinge. The location of the cuts relative to the hinge knuckles is unimportant in this case. Also, cut the hinge pin into **two 36"** pieces and, if you wish, bevel an end of each piece with a bench grinder.

Mark the hinge halves so they can be reunited with their mates, and then separate them. On one half of each pair, mark and center punch a row of rivet hole locations, as shown in Figure 68. These holes should be centered on the tab of the hinge half and should be spaced roughly on **1-1/2"** centers. The uppermost and lowermost holes should each be about **1/2"** from the ends of the hinge half. All told, each hinge half should accommodate about **eleven** hole locations, but neither the number nor the spacing is particularly critical.

With the upper and lower fairing halves still taped securely together with a **5/8"** overlap, arrange marked hinge halves from two pairs along the inside of one trailing edge of the fairing. As shown in Figure 68, the pin holes of each hinge half should be located **3/8"** forward of the fairing trailing edge. Vertically, the hinge halves should each be positioned about **1/2"** from the ends of the fairing halves, which means that their other ends will fall right on the edges of the 5/8" overlap between the two fairing halves, as shown.

With the hinge halves held in position (tape may help), drill through the hinges and the fairing at each of the marked locations with a **#40** bit. Cleco as you go.

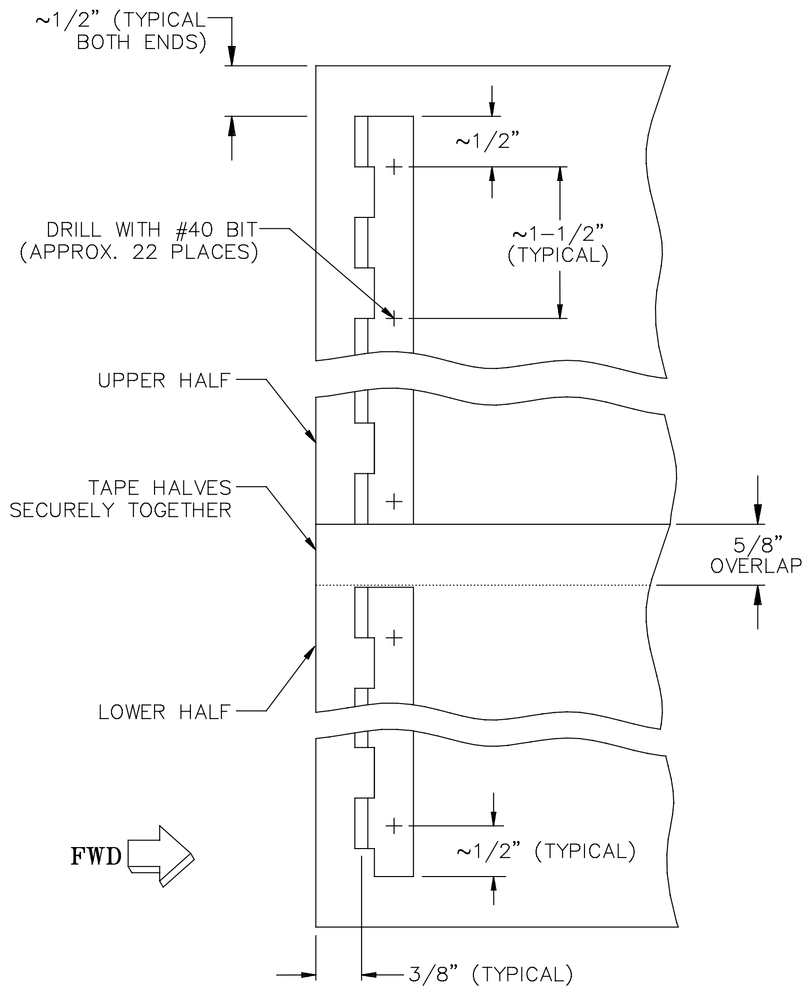

Figure 68: Positioning and Drilling the Fairing Trailing Edge Hinges

Hint It's imperative that the pin holes of both hinge halves line up with one another, so insert one of the 36"-long hinge pin through both halves prior to drilling.

Now, with one pair of hinge halves Clecoed to one trailing edge, pin the matching halves back in place with one of the 36"-long hinge pins. Draw the trailing edges of the fairing together and tape them securely, as shown in Figure 68.1. Next, lay out a row of rivet holes to match the drilled row but mark these locations on the **outside** of the undrilled fairing trailing edge. Then lay a strip of scrap wood or a dowel a couple inches longer than the fairing into the vee formed by the two hinge halves of each pair. Pressing this piece of wood down into the vee will hold the undrilled hinge halves flat against the undrilled fairing trailing edge for drilling. Use a **#40** bit just as you did for the other side, and Cleco as you go.

Note Given the tight clearances, you will probably have to remove the opposite Cleco for each hole you drill to avoid drilling into the Cleco. Likewise, you will probably be unable to Cleco opposing holes on both sides. Just alternate every other hole.

After the drilling is complete, remove all the Clecos and tape, and deburr all the holes. In order to accommodate 3/32" AN426AD3 flush-head rivets, the holes in the fairing must be dimpled, and then the holes in the hinge halves must be countersunk to accommodate the dimples. (If necessary, refer back to "SECTION VI: WING ASSEMBLY" to refresh your memory on this procedure; you used it on the leading edge skins and forward spars.)

After all the holes have been dimpled or countersunk, as appropriate, corrosion-proof the parts to your satisfaction and then rivet the hinge halves in place.

Completed: Left [ ] Right [ ]

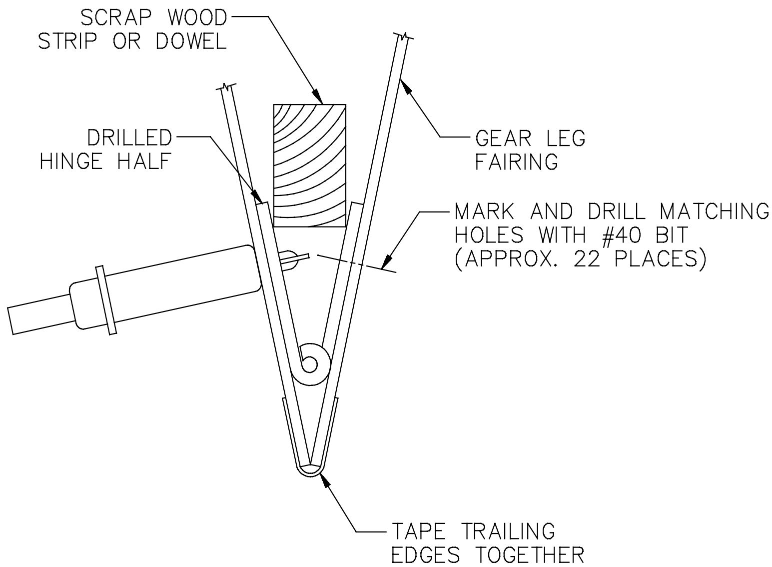

Figure 68.1: Aligning the Undrilled Hinge Half

Step 62: Install the Main Gear Leg Fairings

Installation of the fairings consists of little more than pulling them over the gear leg and pinning the hinge halves together. Try it once, however, and you'll realize (if you haven't already) that there's no room to insert the hinge pin! The fuselage is in the way if you try it from above and the wheel and brake are in the way if you try it from below. The solution for the **tricycle gear** Sportsman is to drill a small hole in the fuselage shell and insert the pin from inside the airplane. This method offers the added benefit of serving as a way of securing the upper end of the fairing fore-and-aft, because the upper end of the pin will remain inside the fuselage. For the **taildragger** Sportsman, the hinge pin cannot be inserted from inside the fuselage because a cage tube is in the way; instead, the taildragger's wheel and brake must be removed to insert the pin from below.

Position the fairing around the leg and temporarily tape the trailing edges tightly together. Rotate the fairing around the leg until the airfoil shape of the fairing is oriented in the direction of flight, and then make a small mark on the fuselage where the upper, trailing edge corner of the fairing falls. Remove the fairing and, for the **tricycle** gear Sportsman, make a second mark approximately **3/8" forward** of the first mark and drill a **#40** hole through the fuselage shell at this location.

Note On our tricycle-geared Sportsman prototype, this hole came out just outboard of the aft shell attach fitting. Before drilling, eyeball your hole location relative to the aft attach bracket screw heads on the outside of the shell to assure yourself that you won't be coming up under the fitting. Adjust your hole location as necessary.

Now replace the gear fairing. Pull the trailing edges together so that the hinge halves mesh and, for the **tricycle** gear Sportsman, insert one of the hinge pins through the hole from inside the fuselage. (You can do the left side yourself with one arm through the baggage door, but you'll need an assistant for the right side.) For the **taildragger**, insert the pins from below.

Hint A very light coating of WD-40 or other lubricant will make insertion of the pin much easier.

When the hinge pin reaches the other end of the hinge, there should still be several inches protruding from the insertion end of the hinge (the upper end for the tricycle gear Sportsman, and the lower end for the taildragger). For the **tricycle gear** Sportsman, mark the location on the pin where it disappears through the fuselage floor. For the **taildragger**, mark where the pin disappears into the lower end of the hinge. For both gear types, put a right-angle bend in the pin at the marked point and, then, cut off the excess pin so that your right-angle hook is about **1"** long. For the **tricycle gear** Sportsman, this end can be left loose under carpeting, as in our prototype, or you can devise some simple way of retaining it against the fuselage floor. Secure the **taildragger** hinge pin to the inside of the fairing with a retainer like the ones used to secure the elevator hinge pins. In any case, be sure to make the pin easy to remove, because you will need to remove the gear fairing periodically for brake line inspections and so on.

The final step in installing the gear leg fairings is to fabricate and install a foam stiffener block around the gear leg where the fairing halves overlap. Prepare to make this block by removing the hinge pin, separating the upper and lower fairing halves, and then pinning the upper half only back in place. Use a little tape to hold it in position against the fuselage shell, aligning it with the mark made previously.

Next, as shown in Figure 68.2, fit a pair of cardboard scraps (each about **2" X 6"**) around the gear leg and the brake line just below the bottom of the upper fairing half. Use snips and trial and error to cut out the mating edges of the scraps until they fit tightly around the leg and brake line as shown. Then tape the two pieces together, slide them up tight against the bottom of the fairing, and trace the outline of the fairing onto the cardboard.

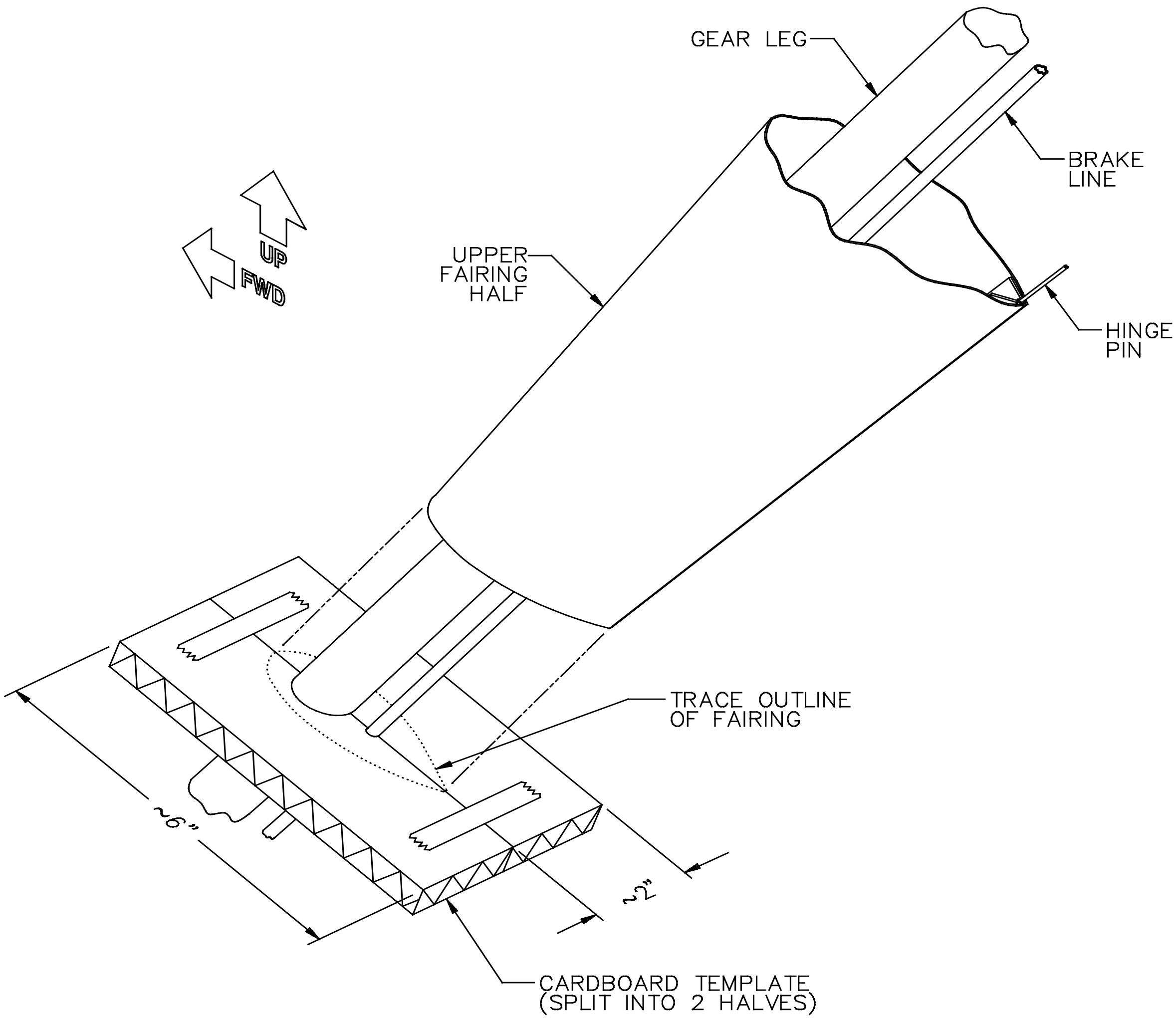

Figure 68.2: Making Cardboard Templates for the Foam Stiffener Blocks

Next, separate the two cardboard pieces and cut out the fairing airfoil shape you just traced. Use the resulting templates to mark the shapes onto the **3" X 4" sheet of 1/2", 40-lb. foam** [89]; use a bandsaw or scroll saw to cut them out.

> **Note** It's possible that your cardboard templates will be a bit longer than the 4"-long foam, but this is not a problem. Simply let the **aft** ends of the templates hang over the end of the foam.

Once you have the foam stiffeners cut out, use regular household epoxy to glue the pair of blocks opposite each other on either side of the gear leg and brake line, as shown in Figure 69. The blocks should be located vertically such that their **lower** faces are even with the **bottom** end of the **upper** fairing half. When gluing the blocks in place, take care to keep the split line between them aligned with the direction of flight. Let the epoxy cure thoroughly before proceeding.

When the epoxy has cured, trial fit the gear leg fairing (both the upper and lower halves) over the blocks. Use coarse sandpaper to reshape and resize the blocks as necessary to allow the fairing halves to close tightly around the blocks with the hinge pin in place.

> **Note** It's suggested that if the builder intends to switch back and forth between landing gear types, the brake line hole be enlarged to accommodate the fitting nut on the caliper end of the brake line.

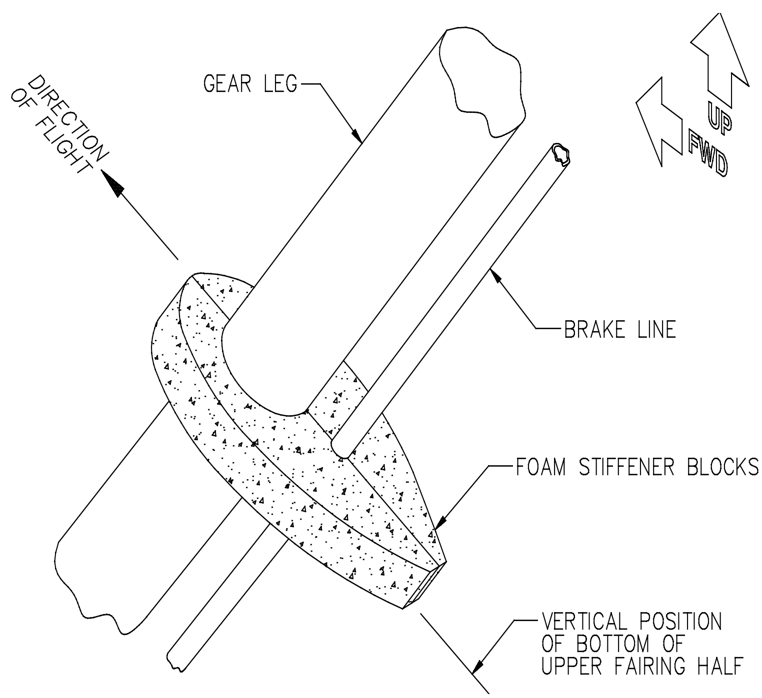

Figure 69: Gluing the Stiffener Blocks to the Gear Leg

Finally, with the fairing halves pinned in position around the blocks, drill a **#40** hole through both fairing halves and into the **inboard** stiffener block. Use a drill stop to set the depth of cut at about **5/16"**. The hole should be centered fore-and-aft on the gear leg (but miss the leg) and should be located vertically about **1/4"** above the bottom edge of the upper fairing half. After drilling, install a **#6 X 3/8" self-tapping screw aft of the gear leg** [107] in the hole. See Figure 70.

Completed: Left [ ] Right [ ]

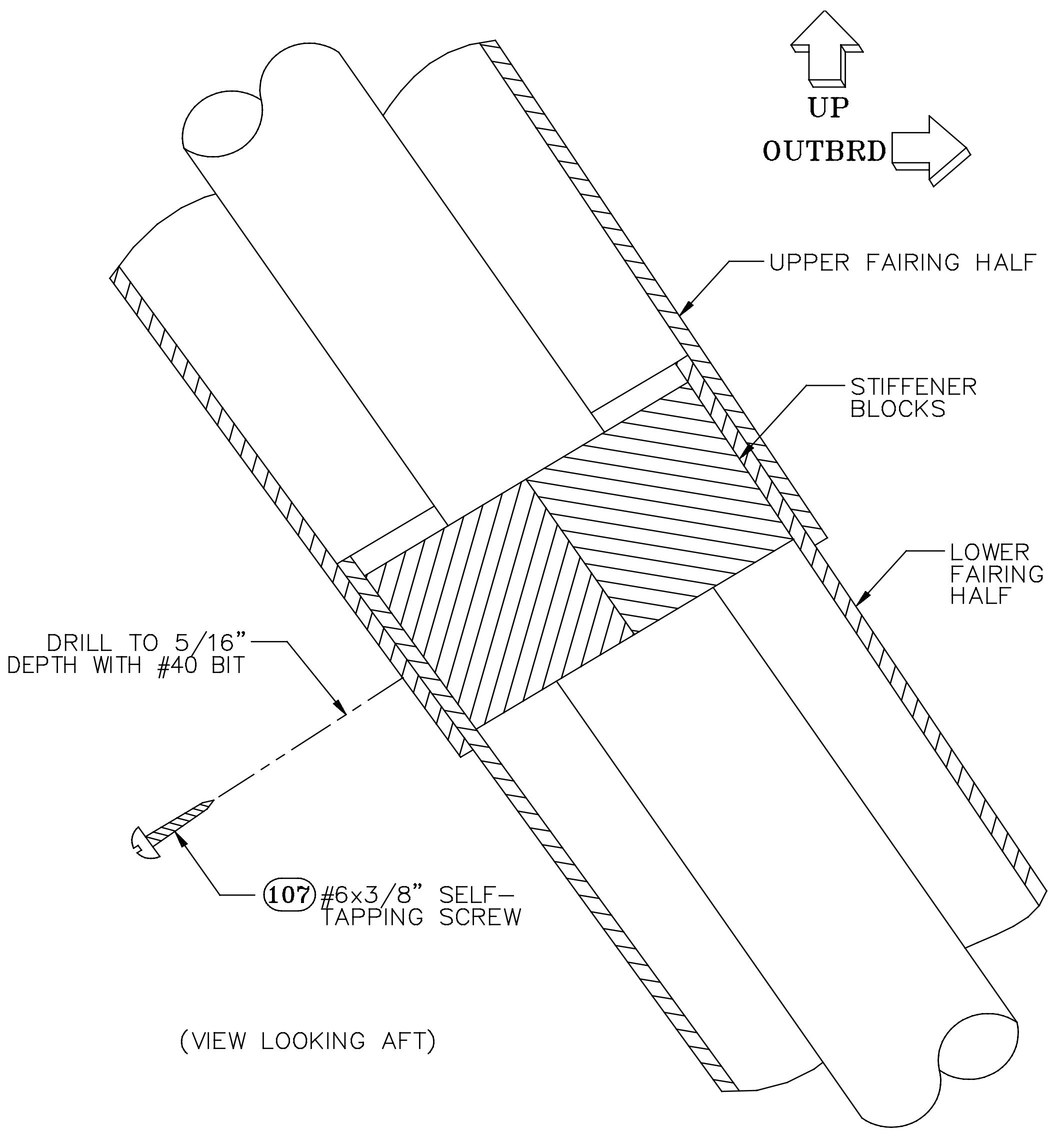

Figure 70: Installing the Stiffener Block Screw

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Step 63: Reinforce the Fastener Locations on the Nose Wheel Pants

Taildragger Options If you're installing taildragger landing gear, **skip to Step 74**.

To position the nose wheel fairing properly, the airplane should be sitting on the gear.

The Sportsman nose wheel pants are designed to fit over a 5.00 x 5 wheel and tire assembly. The pants come in two halves, the **forward nose wheel pant** [182] and **aft nose wheel pant** [183]. The fastener locations are marked on each nose wheel pant. A three-layer laminate of bi-directional cloth must be added to the inside each pant half so the countersunk screw heads do not pull through. Cut (12) **1.5" x 1.5"** patches of cloth to provide three-layer reinforcements at the four screw locations common to the fork and the towbar bracket shown in Figure 71. Make the forward ones long enough to cover the entire towbar bracket flange.

Laminate these pads in place. All three layers can be applied in one operation.

Note Kits delivered approximately after September 1, 2004 will have the reinforcement patches installed (you can see them) as well as have "windows" where the primer has been removed in certain locations to simplify assembly.

Completed: [ ]

Step 64: Trim the Nose Wheel Pant Halves and Drill the Forward Mounting Holes

Eight **AN507-8R8** screws [186] fasten the two halves together along the joggle flange. Two **AN507-10R8** screws [187] attach to the towbar attach bracket and two **AN509-10R24** [188] attach the aft pant to the forks.

Install the **towbar bracket assembly** [184] to the nose fork using 4 **AN4H3A** [185] drilled head bolts. Trial fit the two pant halves together, paying attention to how the two halves mate. Both of these parts come with the recommended trim lines and fastener locations marked in ink. Drill a #40 hole through the largest of the inked locations common to the towbar assembly on both the left and right side. This hole is where the towbar pins will connect to the nose fork.

As you did on the main wheel pants, wrap the tire across the tread with cardboard straps to set a .38-.5"gap between the tire and the pant. Tape the ends to the wheel hub. Begin trimming for the tire and the gear strut until you meet or are close to the dimensions shown in Figure 71. The leading edge of the forward pant half is approximately 12.5" forward of the axle. At this position, the forward pant should be against the towbar bracket assembly on the nose fork and the #40 hole that you drilled should be inside the towbar bracket socket. Tape a spacer 7/8-1" thick on top of the nose fork pivot in order to set the flat part of the pant above the nose fork as shown in Figure 71. Tape the two pant halves together.

(Figure 71.1 illustrates a simple, alternative method of locating these blind holes.) Using the hole ink markings on the forward pant as a guide drill a #30 hole through the pant in the hole immediately aft of the towbar pin. The hole is 11/16" aft of the towbar pin hole. Then open this hole up to a #10 so it is concentric with the towbar bracket and cleco them together.

When you are satisfied of the positioning of the pants, drill and cleco through the eight locations around the perimeter of the joggle flange with a #40 drill.

Completed: [ ]

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

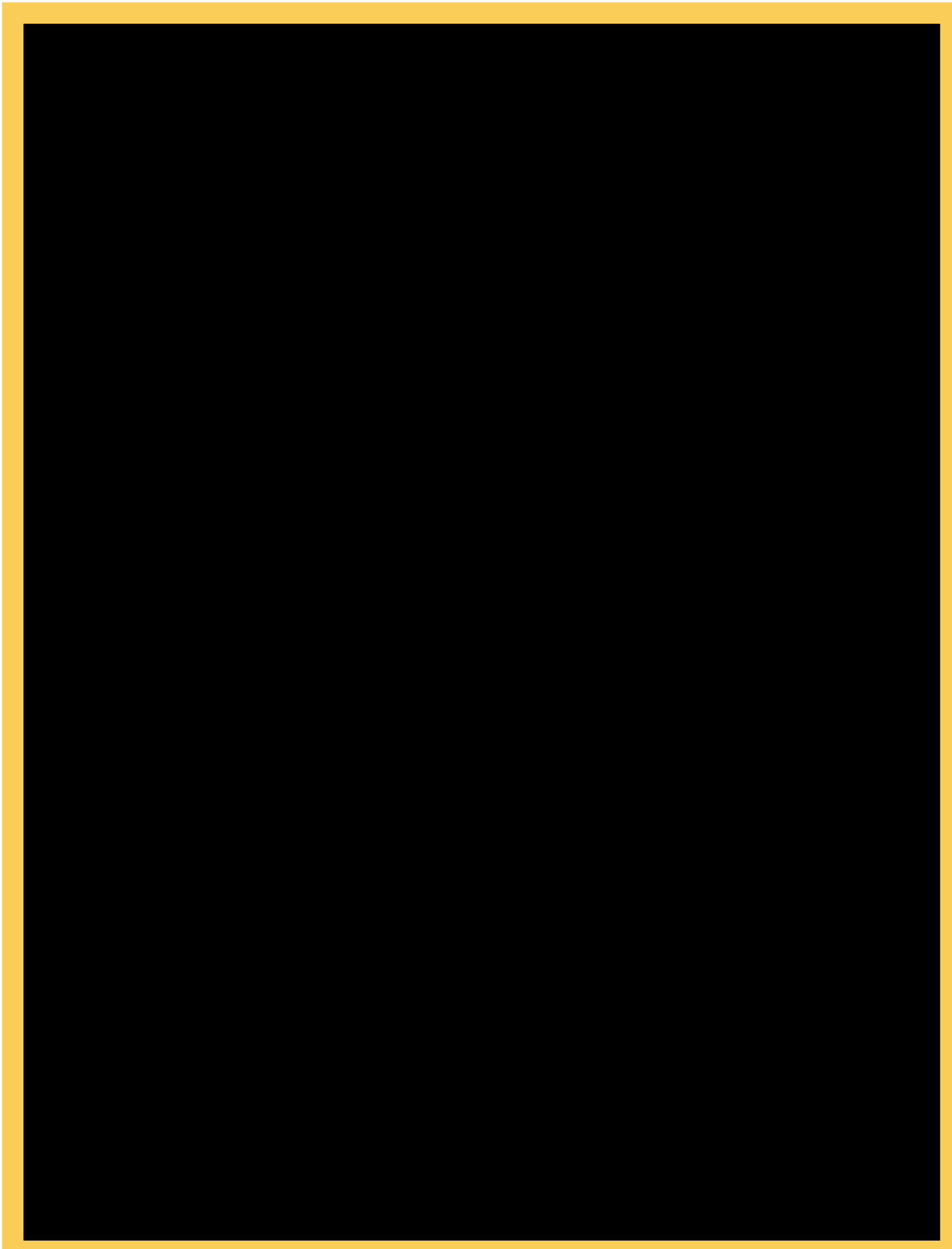
Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: [redacted]

[redacted]

[redacted]



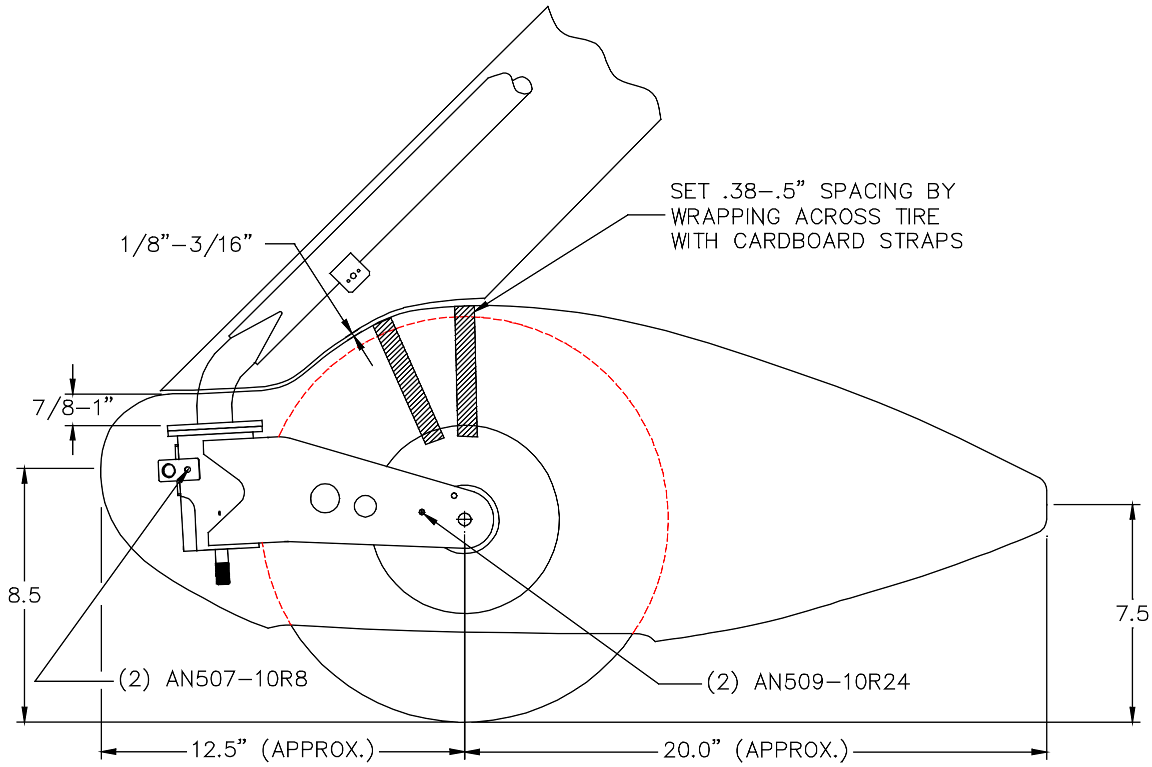


Figure 71: Nose Wheel Pant Installation

Step 65: Measure and Bond the Aft Fairing Spacers

In this step you must locate the #10 hole off the nose fork (the one showing (2) AN509-10R24 screws) forward of the axle as shown in Figure 71) and then match drill the pant. No simple task considering you are trying to locate a hole in the nose fork from the outside of the wheel pant!

The first thing you will notice is that the pant is approximately 1-1/8" outboard of the fork arm. This space must be filled in with a piece of 20# foam and laminated to the pant to act as a structural spacer shown in Figure 72. Measure the distance between the nose fork and the pant where this screw will go. You might want to do this by taping various spacers with a 3/16" diameter hole in them until the gap between the fork and the pant has been filled.

When you have the spacers sized on both sides, you can then make two 1" diameter (or square) pads from 1/2" 20# foam laminated together until they are the same thickness as the spacers that you just made. Seal the spacer with resin on all sides. Drill a 3/16" diameter hole in the center of each of these.

There are several ways to bond the spacer to the pant and locate this hole position, of which two methods will be described. Read both methods before you decide which way to proceed.

In the first method, the spacers will be temporarily positioned and fixed to the nose fork. Adhesive will be applied to the outer surface of the spacer where it makes contact on the pant. The pant will then be positioned back on the wheel assembly allowing the spacer to cure to the pant. When that has cured, the pant and spacer can be removed and the hole pass drilled through the foam spacer To do this, insert a short #10 stud (cut the head off a bolt or screw) into the fork through the mounting hole so the end of the stud sticks outboard of the fork by 1/4" or so. This is just enough to center and retain the fairing spacer about the bolt, but not too much to where the pant cannot be stretched outboard off the bolt when removing the pant after the spacer is bonded.

Mix a small batch of very thick milled fiber adhesive and apply some to the outboard face of the spacers and the inside surface of the pant in the spacer proximity. Carefully install the fore and aft pant halves and hold the aft fairing centered and in trail to the wheel. After this has cured, remove the aft pant half by pulling the pant and spacer away from the fork half so the stud is free. Then pass drill from the inside of the spacer through the pant fairing with a #10 drill. If satisfied with the results, reinforce the adhesive with a good fillet of additional adhesive and then apply a two layer laminate over the top of that getting a good wrap on the spacer and the pant itself as shown in Figure 71.2.

Alternatively, locating the hole can be accomplished by setting up a jig on the floor next to the nose fork assembly as shown in Figure 71.1. The jig would have a means of locating the hole center by positioning a pencil or pen over the hole and then being able to repeat this positioning whether the wheel pant is on or off the nose fork assembly. Once you have located and drilled the hole in the pants, use an adhesive mix to bond the spacer to the pant and then apply the two layer laminate as described in the previous paragraph.

Completed: [ ]

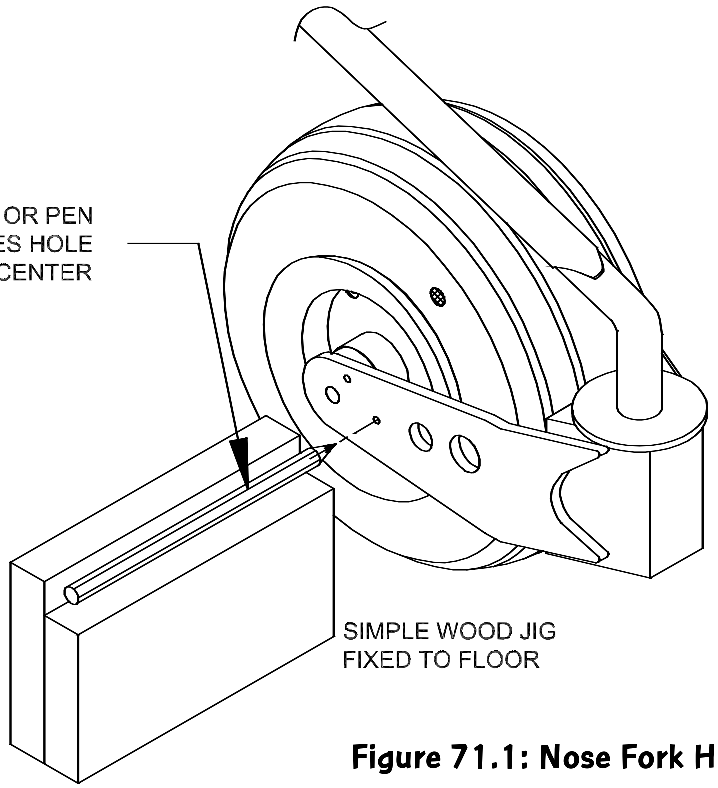


Figure 71.1: Nose Fork Hole Locating Jig

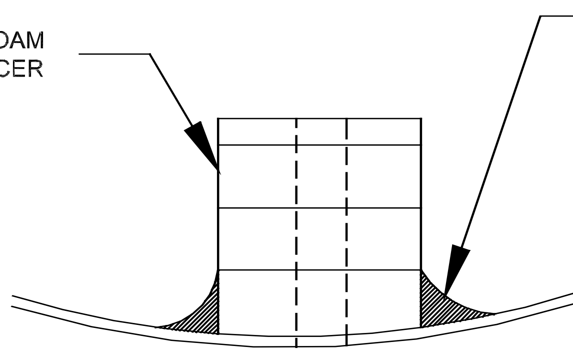


Figure 71.2: Bonding the Laminated Spacers to the Wheel Pant

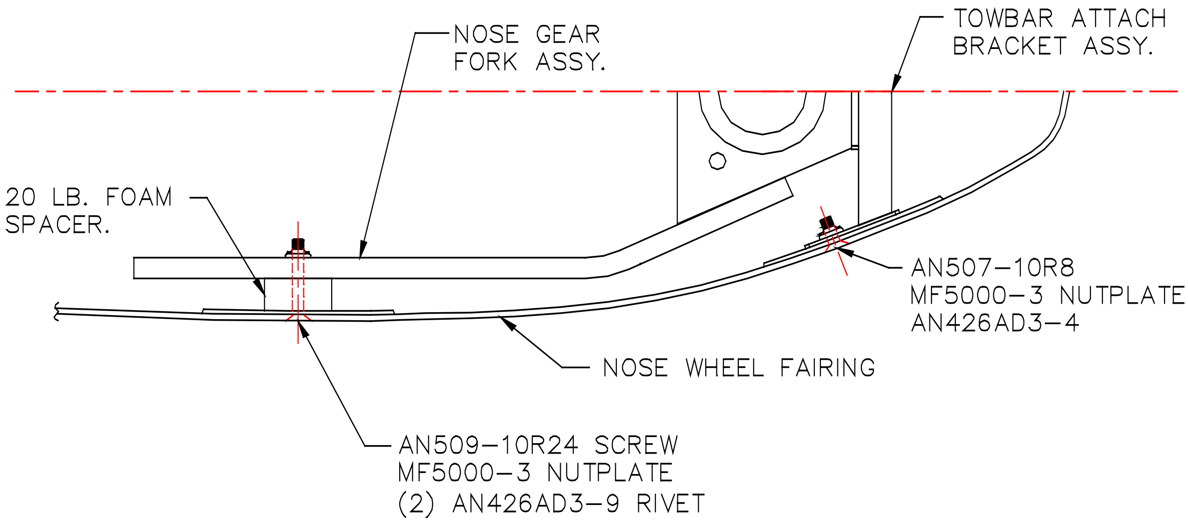


Figure 72: Installing the Nose Wheel Fairing Spacers

Step 66: Install the Nutplates on the Wheel Pant and Nose Fork Assembly and Countersink the Pant

Position and install MF5000-3 **floating nutplates** [189] at each of the four screw holes, two on the inside of the nose fork and two on the inside of the towbar bracket as shown in Figure 72. Countersink these holes on the outside of the fork and towbar bracket flange to accommodate 3/32" AN426AD3-9 flush-head rivets, and use these rivets to install a nutplate at each location.

Next, countersink the wheel fairing for the four #10 screws.

Install eight MF5000-08 **floating nutplates** [190] around the perimeter of the joggle flange. Countersink the outside of the wheel pant for the eight AN507-8R8 screws.

Install the nose wheel pant using all the hardware.

Completed: [ ]

> **Towbar Option** Glasair Aviation, LLC's custom towbar (P/N 471-0645-101) makes single-handed ground handling of the Sportsman a breeze. Of lightweight aluminum construction, the towbar is anodized bright red for visibility.

Step 67: Reinforce the Trailing Edges of the Nose Gear Leg Fairing Halves (Tricycle Gear Only)

The fiberglass **nose gear leg fairing** consists of a **left** [180] and a **right** [181] half. Lengths of piano hinge will be riveted inside the trailing edges of these halves to join them, just as the main gear fairing trailing edges were joined. To insure that the rivets securing the hinge halves have plenty of material to grab, it's necessary to reinforce the trailing edges of the fairing halves with a single-layer laminate of bi-directional cloth.

On fairings shipped after September 1, 2004, the following step should not be necessary. If your fairing trailing edge thickness measures .055 or greater then skip the reinforcement plies. If it measures less than .055 then cut two **1" X approximately 20"** strips of cloth on the 45° bias and laminate one in place on each fairing half, as shown in Figure 73. At green cure, use a sharp utility knife to trim the laminates where they overlap the edges of the fairing halves.

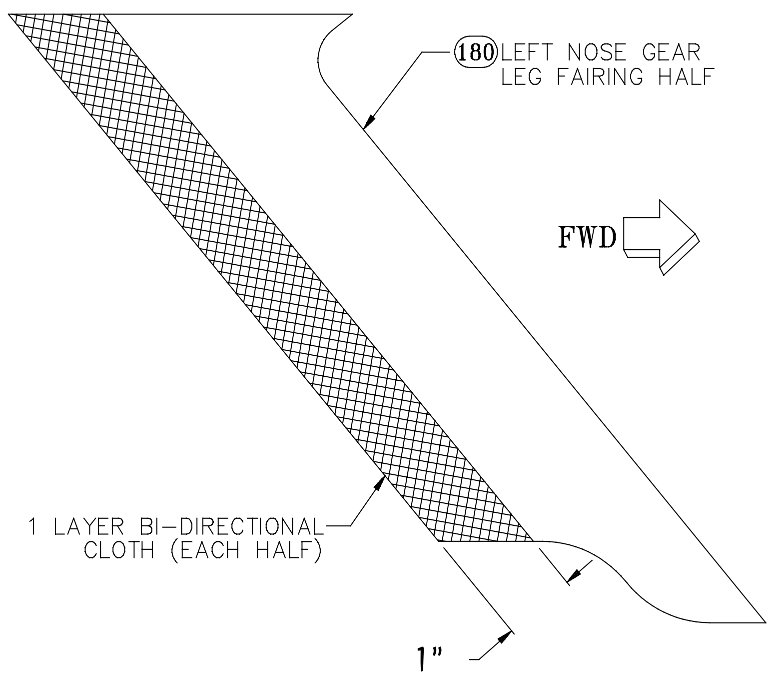


Figure 73: Reinforcing the Nose Gear Leg Fairing Halves

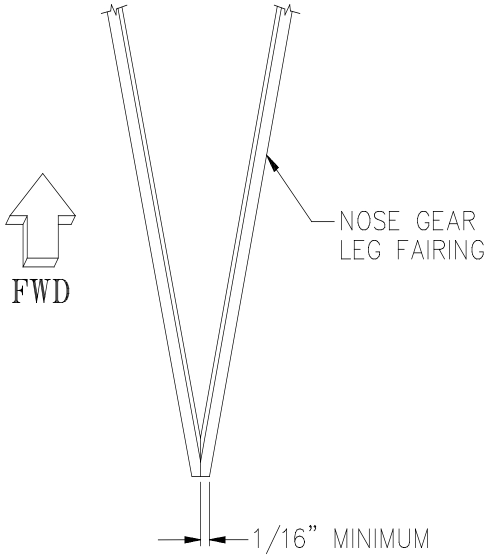


Figure 74: Beveling the Trailing Edges

After the reinforcement laminates have cured fully, use a long sanding block to taper the trailing edges of the halves so that they fit together flushly. However, you don't want to sand these down to a real knife-edge. As shown in Figure 74, leave a blunt edge on **each** trailing edge at least **1/16"** thick.

Also, sand the leading edges of the fairing halves to remove any mold lip, leaving straight, smooth mating edges.

Completed: Left [ ] Right [ ]

Step 68: Install Piano Hinge Along the Trailing Edges of the Fairing Halves

Tape the left and right fairing halves tightly together with masking tape or duct tape along both the leading and trailing edge seams. Hold the assembled fairing with its trailing edge flat on a bench and slide a **16" length of rolled hinge stock** [191] into the vee of the trailing edge, as shown in Figure 75. Insert the hinge into the fairing until it is spaced 1.5" from the top end of the fairing at one end. Don't push the hinge down into the trailing edge vee; just let the hinge find its own best vertical location. Then securely tape both hinge halves to their respective fairing halves with pieces of tape at each end.

Put the hinge halves together **without** the pin and cut them to a final length of **15"**. Cut the hinge pin to a length of **15-1/2"** and put a 90° bend in the last **1/2"** of one end. Bevel the opposite end of the pin, slightly to make insertion easier.

Next, use lots of tape to secure one of the hinge halves to each fairing half, using the line you marked as a fore-and-aft reference. In the vertical direction, Figure 76 shows that each hinge half should begin **1.5" below the upper edge**. Using a try square, mark a reference line from this point on each fairing half, as indicated in the figure, and position the hinge halves as shown.

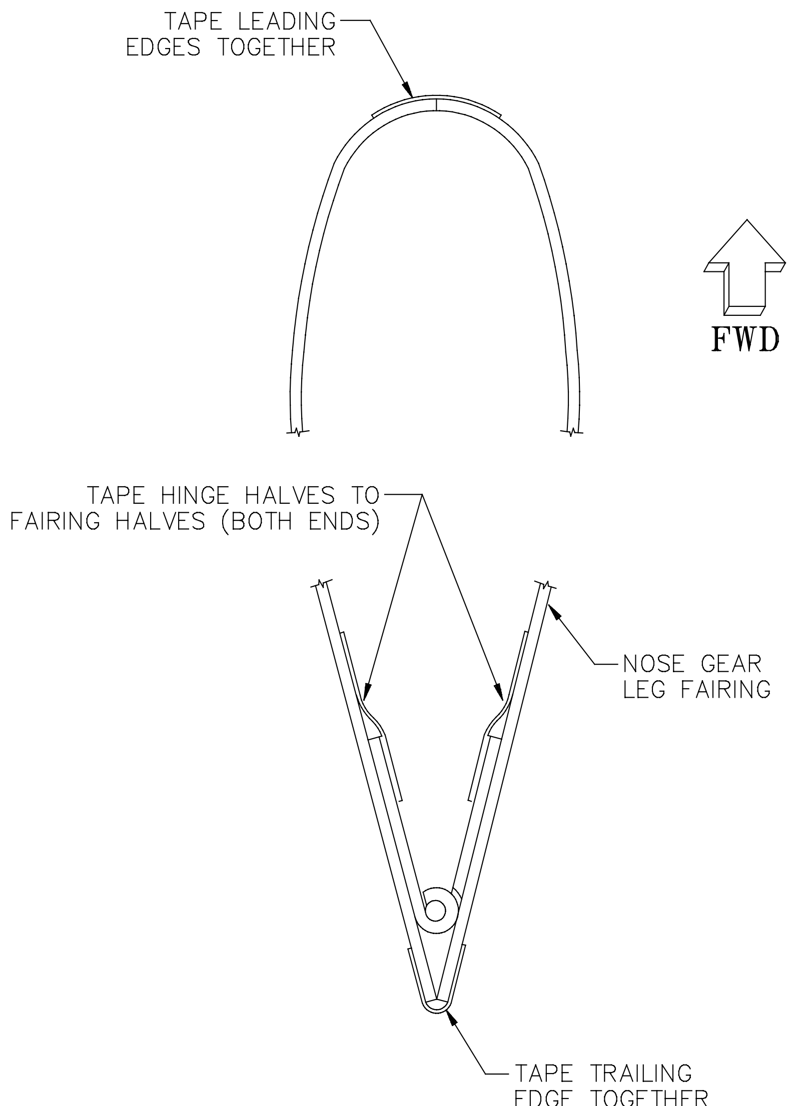


Figure 75: Positioning the Trailing Edge Hinge for Drilling

With the hinge halves taped securely in place, mark and drill **eleven** rivet holes in each according to the dimensions given in Figure 76: The holes at each end should be **1/2"** from the end of the hinge, and the intervening holes should be equally spaced roughly on **1-1/2"** centers. All the holes should be centered fore-and-aft on the hinge flange and should be drilled with a **#40** bit. Cleco as you go.

After the drilling is complete, un-tape the hinge halves, and then deburr them. Countersink the holes on the outside of each fairing half to accommodate 3/32" AN426AD3 flush-head rivets.

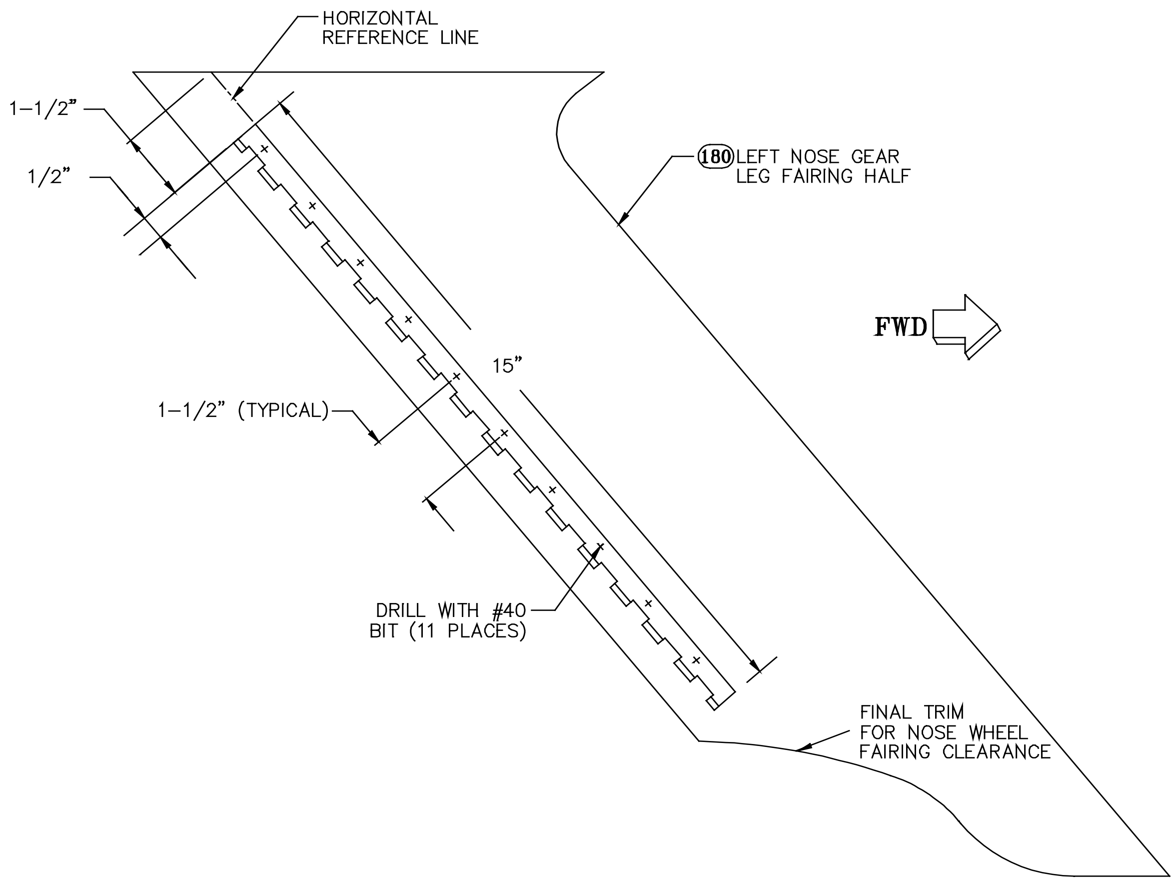


Figure 76: Marking and Drilling the Hinge Halves

When the fairing is installed on the nose gear leg for the final time, the hinge pin will have to be safety-wired in place. To facilitate this, fabricate a clip according to the dimensions shown in Figure 77. The clip can be made out of any scrap of **.020"** aluminum.

After bending the **3/8"** tab at one end of the clip, position it over the **lower** end of one of the hinge halves so that the bent tab is roughly **1/4"** beyond the end of the hinge. Then use the lowest two rivet holes in the hinge as guides to drill matching **#40** holes through the clip. Finally, drill a pair of closely spaced **1/16"** holes in the tab to complete the clip. Deburr all the holes.

With the safety wire clip finished, you're now ready to rivet the hinge halves to their respective fairing halves. Use 3/32" AN426AD3 flush-heads. Remember to switch to a longer rivet for the two holes through the safety wire clip.

Completed: Left [ ] Right [ ]

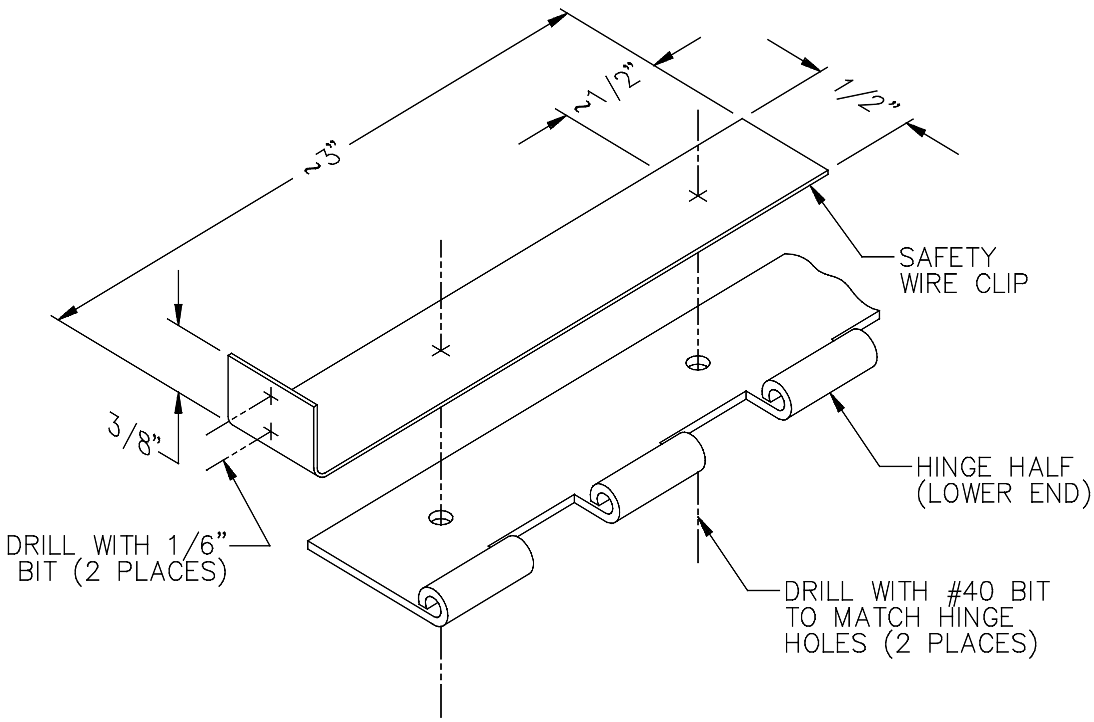


Figure 77: Fabricating the Hinge Pin Safety Wire Clip

Step 69: Reinforce the Strut Mounting Hole Locations

The nose gear leg fairing will be secured to the leg strut with four screws—two per side. The areas where these screws penetrate the fairing must be reinforced with extra laminates on the inside of the fairing halves. On fairings shipped after September 1, 2004, these reinforcements plies which are easily visible are already done and the following step should not be necessary. Otherwise, begin by cutting **twenty-four 2"-square** pieces of bi-directional cloth on the 45° bias **or twelve 2"-square** pieces of DBM. Figure 78 shows where these pieces should be applied. Prepare the inside of the fairing halves in these locations with an acetone wipe-down and laminate **six** bi-directional **or three** DBM cloth squares at each location.

Let the laminates cure fully, and then mark the exact middle of each reinforced area. Drill through the fairing halves at these four locations with a **#40** bit. These holes will serve as pilot holes for the drilling of the fairing mounting brackets.

Completed: Left [ ] Right [ ]

Step 70: Seam the Fairing Halves Together

Assemble the two fairing halves by mating the hinge halves and inserting the pin temporarily. Tape the leading edges of the fairing halves tightly together with masking tape or duct tape, and then remove the hinge pin. Insert a couple scrap wood blocks between the trailing edges of the fairing halves to hold the fairing open between **1-1.5"**. This gap provides access for the application of the leading edge seam laminate.

Cut two **2"**-wide strips of bi-directional cloth on the 45° bias. Each strip should be in the neighborhood of **25"** long. Lay these strips **inside** the fairing over the leading edge seam, lapping equally onto the left and right halves. Let the laminates cure with the wood blocks still holding the fairing open. This will make the fairing easier to install.

Sand the leading edge to remove the primer 1/4-3/8" on either side of the seam. Laminate 1 ply 7781 to the leading edge. Sand smooth and blend to contour after the laminate cures.

As the laminates reach green cure, trim them even with the upper and lower edges of the fairing with a utility knife.

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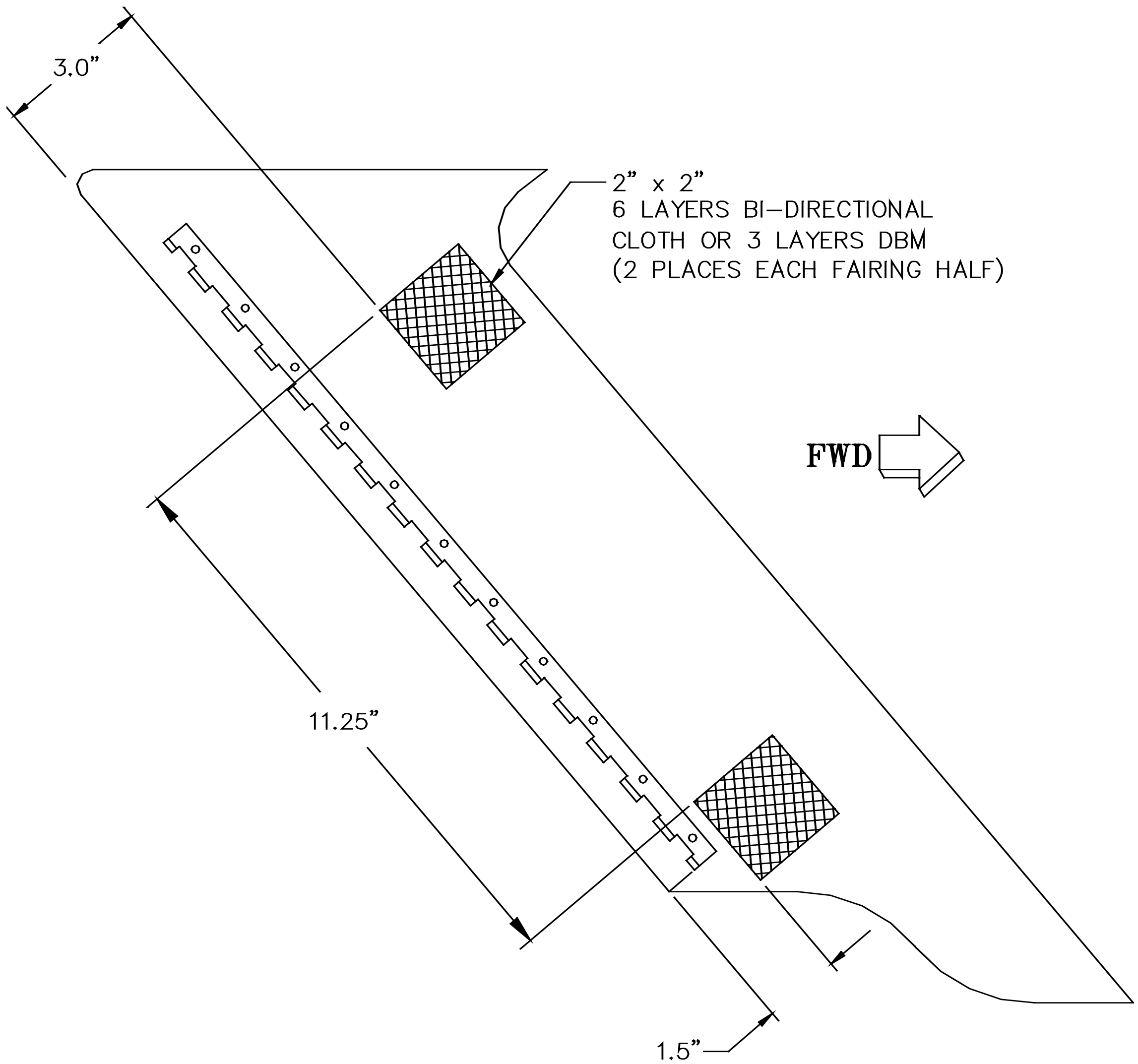

Figure 78: Reinforcing the Mounting Screw Locations

Step 71: Fit and Install the Nose Gear Leg Fairing

> **Note** Trial-fit the fairing with its trailing edges hinged together, as this will determine the shape of the fairing. Also, if you have not yet mounted your engine cowling, you **should** postpone this step until your cowling is in position.

After September 4, 2004, the nose gear fairings are fabricated without primer in the fastener locations. This will provide an opaque window to see through to aid in locating the attach tabs. Inserting a light inside the fairing will help with locating the location of the attach tabs. The same method of locating the blind attach tabs on the nose wheel fairing can be used here as well. Refer to Figure 71.1 for more information.

The lower cowling needs to be installed. The upper portion of the gear leg fairing will fit inside the joggled slot on the scoop portion of the cowling. Remove the internal portion of the nose gear cutout leaving a 5/8" wide flange along the joggle joint as shown in Figure 78.1

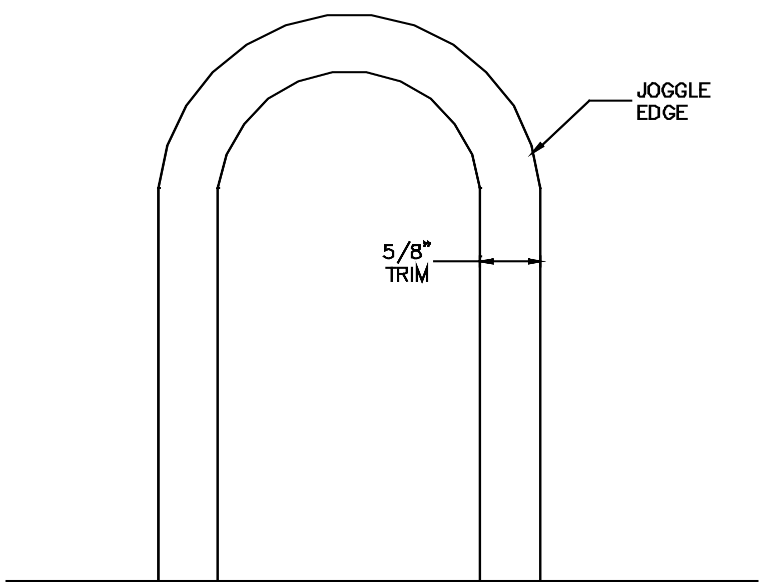

Figure 78.1: Cowling Joggle Flange

The nose gear strut shock channel will need to be relieved on gear struts delivered prior to September 2004 due to a slight interference with the cowl scoop. Relieve the forward flange of the channel (where the rubber bushings are) with a 1-2" drum sander as shown in Figure 78.2. Touch up the bare metal with some gray paint. Do not trim beyond the .19" dimension, which is clear of all welds.

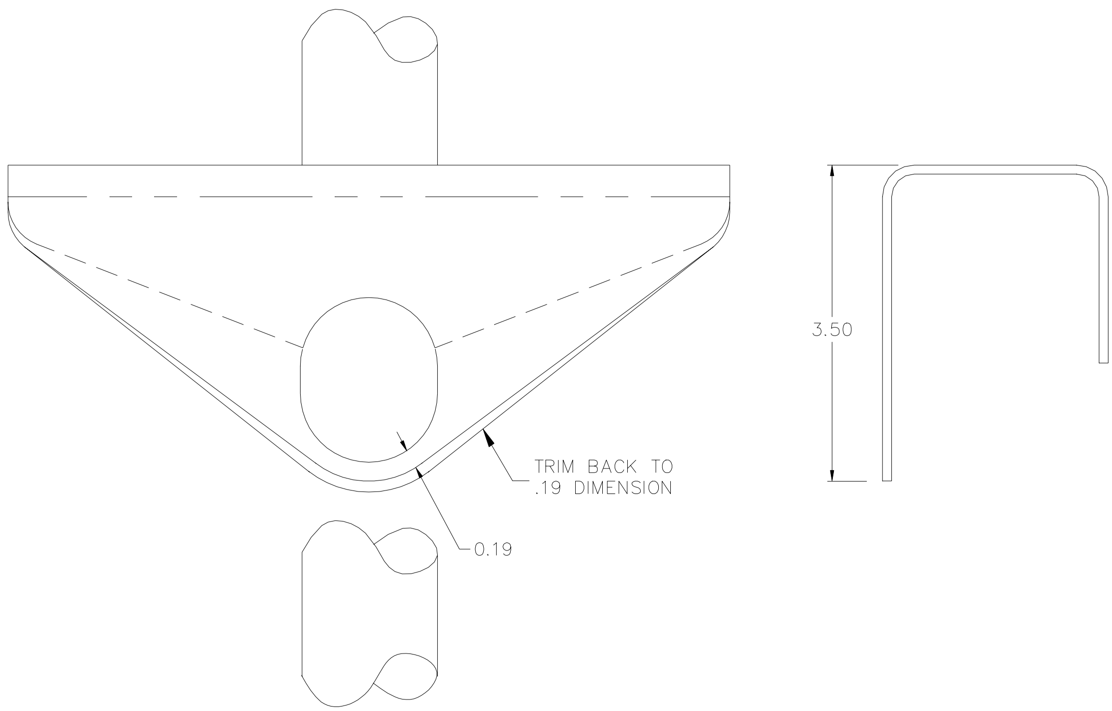

Figure 78.2: Relieving the Nose Gear Leg Channel

Position the fairing over the gear strut and begin to trim the lower end until the clearance between the nose wheel pant and the fairing is approximately 3/16" on the lower end and tapering to 3/8" on the top of the nose wheel fairing as shown in Figure 79. You will have to trim a significant amount off the upper edge near the top of the wheel pant. You will also have to relieve some on the top near the channel on the gear leg.

Pivot the fairing fore and aft until you feel the attach tabs making contact with the fairing. When the fairing fits to your satisfaction and the tabs are visible in the opaque windows, drill through the center of each of the four tabs with a #30 drill. (Or use your hole marking jig to drill the four holes.) Cleco as you go.

When you are satisfied with the fit, drill the holes up with a #20 drill and deburr. Install MF5000-08 nutplates at each of the four tab locations. Countersink the fairing for the AN507-8R8 screws.

Finally, reinstall the fairing and the hinge pin along the trailing edge. Install the four AN507-8R8 screws and safety wire the hinge pin in place.

Completed: [ ]

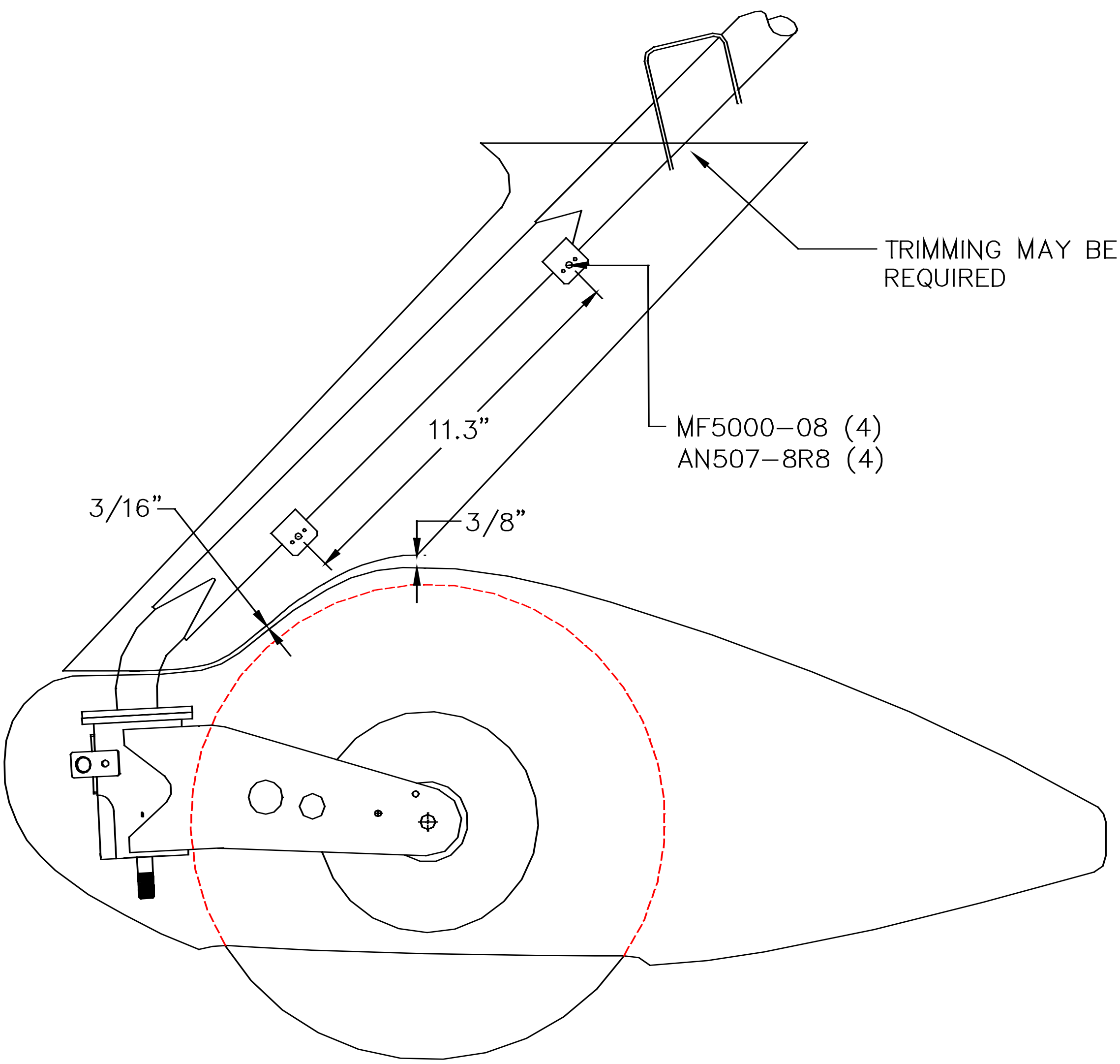

Figure 79: Installation of the Nose Gear Fairing

Final Wing Assembly

In this sub-section, you will complete construction of the wing, including final riveting of all remaining skins, installation of the fuel tanks, installation of the wingtip fairings, etc. To accomplish most of these tasks, you'll need to return your wings to the jig (one at a time, of course!). Check that the jig uprights are still plumb and true. Make sure that all fuel tank vent lines, the pitot line and any optional electrical wiring are installed and securely fastened to the airframe as specified in "Section IX: Systems Installation." Check that the aileron and flap bellcranks, pushrods and cables are secure and properly safetied. Check for free movement of all control system components and for lack of interference with the wing structure. Make a final check of all the rivets securing the lower wing skins, the lower hat section stiffeners, the wing ribs, and the flap and aileron control system components; remove and replace any unsatisfactory rivets. When satisfied, return the wing to the jig. The fuel tanks obviously will not be in the wing during riveting. **Reference the additional photos at the end of Section X.**

Hint This would be an excellent time to have your local EAA technical counselor inspect your project. Such an inspection not only brings an experienced, knowledgeable pair of eyes to bear on your project at a critical stage but may also qualify you for lower aircraft insurance rates. Contact EAA for the names of counselors in your area.

Step 72: Cleco the Upper-Surface Hat Section Stiffeners to the Spars

Cleco the upper surface hat section stiffeners between the forward and aft spar flanges. Be careful to install each stiffener in the correct location.

Make a final check that everything is in readiness for riveting the wing skins. If you have not already done so, apply the fuel tank anti-chafe tape to the upper hat sections in the area of the fuel tank(s).

Completed: Left [ ] Right [ ]

Step 73: *Drill the Flap Track Rib Rivet Holes*

Back in "SECTION VI: WING ASSEMBLY," you drilled all the upper-surface skin holes with the exception of the holes over the **flap track ribs**—the short ribs on either side of the inboard and outboard flap tracks. These were omitted because it's vitally important that the flap tracks themselves be perpendicular to the aft wing spar to prevent binding in the flap roller bearings, and at the time you were drilling the other cove rib rivet holes, the flap tracks hadn't been positioned yet. Later, when you installed the flap track reinforcement angles in Step 63 of SECTION VI, you squared the tracks and locked them into position.

Now, Cleco the center and inboard upper main skins in place on the wing structure. Make a final check for squareness between the flap tracks and the aft spar, focusing your attention on the top of the tracks. While the bottoms are held square by the reinforcement angles, it's still possible that the tops might be slightly out of square, and this is your last chance to correct them. If a track is found to be out of square, bring it into position by inserting an appropriately sized piece of scrap wood between the flap track rib and the adjacent flap cove rib.

When you're satisfied that everything is properly aligned, drill through the skin and the flap track rib flange with a **#40** bit at each of the pre-punched skin holes. There are five holes per rib. When the drilling is complete, remove the skins and deburr the holes in both skins and all four flap track ribs.

Completed: Left [ ] Right [ ]

Step 74: Rivet the Upper Wing Skins

Use the following sequence to rivet the upper wing skins and hat sections:

A) Use 1/8" AN426AD4 flush-head rivets to rivet the **outboard** skin and the forward ends of its hat sections to the forward spar flange, **except** for the rivet hole at the overlap between the outboard and center skin. Use the procedures described in "SECTION II: TOOLS AND TECHNIQUES" to choose the correct length rivet for each location, being aware that you will need a half-size longer rivet where both the hat sections and the skins attach to the spar flange. Also, follow standard procedures for installing a line of rivets: rivet at the ends and the center of the line first, and then install rivets halfway between existing rivets, continuing in this manner until the entire line is filled.

Note You'll have to lift up the trailing edge of the upper skin to gain access to the inside of the wing for your bucking bar. You can use lengths of wide masking tape or duct tape to hold the skin up out of the way. It might be a good idea to Cleco or clamp a length of 1/4" plywood or aluminum angle to the trailing edge of the skin to reinforce it and keep it from buckling. At least be aware of the possibility of kinking the skin, and exercise appropriate care.

Rivet the outboard skin to its hat section stiffeners and to the main ribs with 3/32" AN470AD3 universal-head rivets. Do not rivet the tip rib yet, you will do this after the final installation of the aux tank. Work back and forth across the skin in a spanwise direction, starting at the leading edge and gradually laying the skin down onto the wing as you proceed toward the aft spar. As you approach the aft spar, the gap between the aft spar and the skin will decrease, so you will have to gain access for your bucking bar through the lightning holes in the rear spar, the inspections holes in the skin or from the ends of the skin through the rib lightening holes. **Do NOT** rivet the outboard skin to the aft spar flange yet; just Cleco the skin to the aft spar for the time being. Also, do not rivet to the rib at station 141.75; the outboard skin will be riveted to the rib with the center skin later.

B) Now Cleco the **center** skin in place and rivet the forward edge of the skin to the forward spar flange using 1/8" AN426AD4 flush-head rivets, **except** for the rivet hole at the inboard end where the center and inboard skins overlap. (However, you **should** rivet the overlap between the center and outboard skins at this time). A couple of the rivets in the area of the strut beam assembly are difficult (but not impossible) for bucking; use 1/8" AAPQ-44 structural blind rivets in these locations if absolutely required.

> **Note** We have had difficulty obtaining the long AAPQ-44 rivets necessary for these few holes. Thus, your kit may contain Cherrymax CR3212-4-8 blind rivets instead; these are entirely equivalent.

Rivet the center skin to the ribs, using the same procedures as you used in Step A for the outboard skin: work back and forth in the spanwise direction starting at the front, moving aft and laying the skin down as you go. Use 3/32" AN470AD3 universal-head rivets. Rivet the outboard skin to the center skin at the same time, of course. Work through the inspection holes in the lower wing skin. **Do NOT** rivet to the rib at station 69 or to the aft spar yet. The center skin will be riveted to the rib at station 69 with the inboard skin; all the skins will be riveted to the aft spar after all the wing skins have been riveted to the ribs and hat sections.

C) Cleco the **inboard** skin in place and rivet it to the forward spar flange and the forward ends of the hat sections using the same procedures as described in Step A for the outboard skin and in Step B for the center skin. **Do NOT** rivet the hole at the inboard end that lies over the root rib (Main Rib 1) location. Use 1/8" AN426AD4 flush-head rivets.

Rivet the inboard skin and the inboard end of the center skin, to the rib at station 69 and to the hat sections aft of the forward spar, using the same procedures as described in Steps A and B. Use 1/8" AN470AD4 universal-head rivets in the skin splice at station 69; use 3/32" AN470AD3 universal-head rivets in the hat sections. **Do NOT** rivet Main Rib 1 (the root rib) yet; it will be riveted after the fuel tanks have been installed.

D) Make a final check to verify that the wing jig is straight and true and that the wing is untwisted; this is important because any twist remaining in the wing will be locked in once the wing skins have been riveted to the aft spar. When you are satisfied that the wing is straight, proceed to rivet the upper skins and the aft ends of their hat sections to the aft spar flange. (Rivet the aileron and flap bellcrank bracket/spar flange attach angles at the same time.) Use 1/8" AN470AD4 universal-head rivets. Follow standard procedures for installing a line of rivets. In areas that are absolutely inaccessible for bucking (above the flap bellcrank bracket, for example), use 1/8" AAPQ-4 structural blind rivets.

E) Finally, use 3/32" AN470AD3 universal-head rivets to rivet the upper skins to the flap and aileron cove ribs and the flap track ribs.

Completed: Left [ ] Right [ ]

Step 75: Install the Fuel Tanks and Rivet the Tip and Root Ribs to the Spars and Skins

Prepare the fuel tanks for installation by removing the plugs and/or sealing tape from the vent line boss at the outboard end of the tank and the filler opening on the top of the tank. Then slide the tanks into the wing all the way to the main rib. Verify the threaded bosses are perpendicular to the ribs and the out skin. Adjust as necessary like you previously did back in Section IX, Step 54. Cleco the root main rib and the tip rib in place with a pair of Clecos through the forward spar and the root nose rib. Then Cleco the cove ribs in place with a pair of Clecos through the aft spar and the main ribs. Finally, add additional Clecos through the upper and lower skins into the main ribs.

Rivet the root ribs in place according to the following schedule.

A) Bolt the root ribs to the forward and aft spar using your AN3 bolts, washers and nuts. Don't forget the radius fillers you cut to fit under the head of the bolt and the nuts.

B) Install the AN509-10R10 screws in the upper and lower flanges of the spar common to the flange on the root rib.

Page 155: [redacted]

[redacted]

Page 157-167: An optional method of installing the trailing edge skins will be provided, and these pages will be expanded.

Page 157: The note on the top of page 157 will be changed to read as follows:

The following several steps can be accomplished with the wing in or out of the jig, at your convenience. Our experience is that most of these procedures are probably easier if the wing is upside down and supported on a table. There are two methods of installing the cove skins on the fuselage. One is to rivet the rivet the cove skins to the wing as has been traditionally done. The second method, which is used at our Customer Assembly Center, involves using a structural adhesive to bond the trailing edge doublers to the skins and using only a few rivets at the end of each cove skin. This second method is described as an optional method.

Figures 80-83 will be added to the instructions, which define the layout and trimming of all the cove skins.

The last sentence in the third paragraph will changed to read as follows: The aft tab on the flap cove ribs may also be removed if necessary as shown in Figure 85. Revision A mistakenly mentioned the center tab.

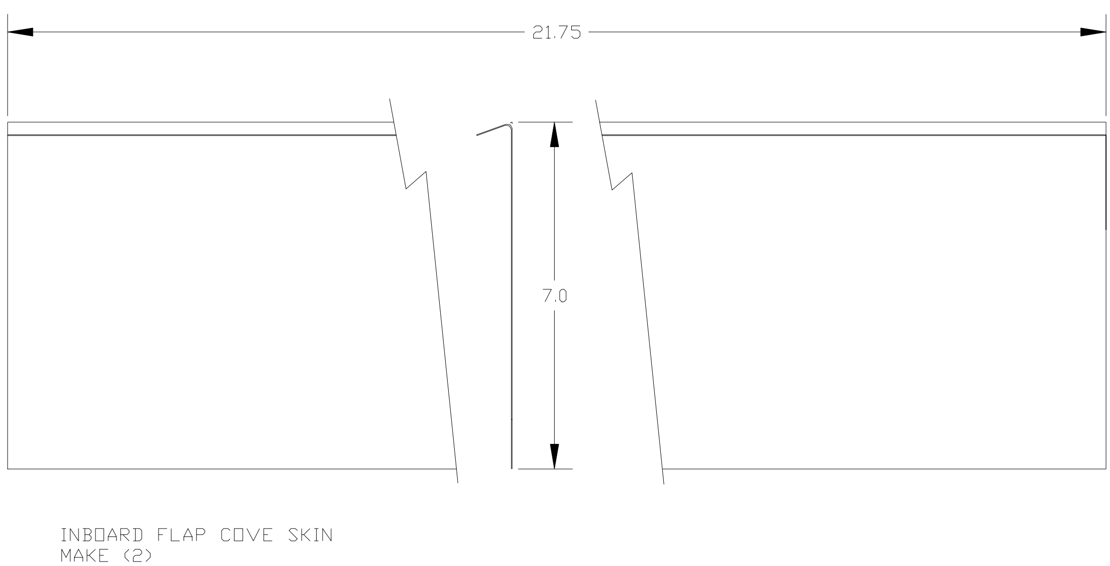

Figure 80: Inboard flap cove skins

C) Rivet the root main rib aft of the forward spar to the lower inboard main skin and doubler with 1/8" AN470AD4 universal-head rivets.

D) Rivet the root main rib aft of the forward spar to the upper inboard main skin with 1/8" AN470AD4 universal-head rivets.

E) Rivet the lower inboard main skin to the root cove rib with 3/32" AN470AD3 universal-head rivets.

F) Rivet the upper inboard main skin to the root cove rib with 3/32" AN470AD3 universal-head rivets.

G) Rivet the tip ribs to the forward and aft spars with 1/8" AN470AD4 universal-head rivets.

H) Rivet the upper and lower skins to these tip ribs with 3/32" AN426AD3 flush-head rivets. Double dimple the skin and the ribs if you have not already done so.

Completed: Left [ ] Right [ ]

Step 76: Install the Filler Necks and Fuel Caps

Using an appropriate thread sealant (our mechanics favor Pro-Seal or Pro-Seal equivalent type sealant available through Spruce and other aircraft supply companies), install a **fuel tank filler neck** [46] into the filler opening of each tank (or the appropriate flush cap option that you have chosen). Thread these in until they're good and snug. Then install a **fuel cap** [45] on each neck.

Completed: Left [ ] Right [ ]

Step 77: Connect the Fuel Tank Vent Lines and the Aux Tank Fuel Line to the Tanks

Reaching in through the inspection holes, tighten the all the connectors at the end of each vent line and feed line to their appropriate fittings on the tanks.

Note Use of thread sealant is **not** recommended for nylon fittings.

Completed: Left [ ] Right [ ]

Step 78: Rivet the Inspection Hole Doublers to the Wing

In "SECTION IX: SYSTEMS INSTALLATION," you riveted nutplates to the inspection hole doublers and taped them inside the wing. Un-tape them now and Cleco them in place for final riveting, making sure they're oriented the same way they were when they were drilled. Rivet the doublers to the skins with 3/32" AN470AD3 universal-head rivets.

You can hold off on this step until you have absolutely completed every step that will be done on the inside of the wings. It is much easier to reach inside and access a system when the cover rings have not been installed.

Completed: Left [ ] Right [ ]

Page 155: Step 76 will be expanded to include the following information:

If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to lift up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the cap and the skin.

Page 157-167: [redacted]

Page 157: [redacted]

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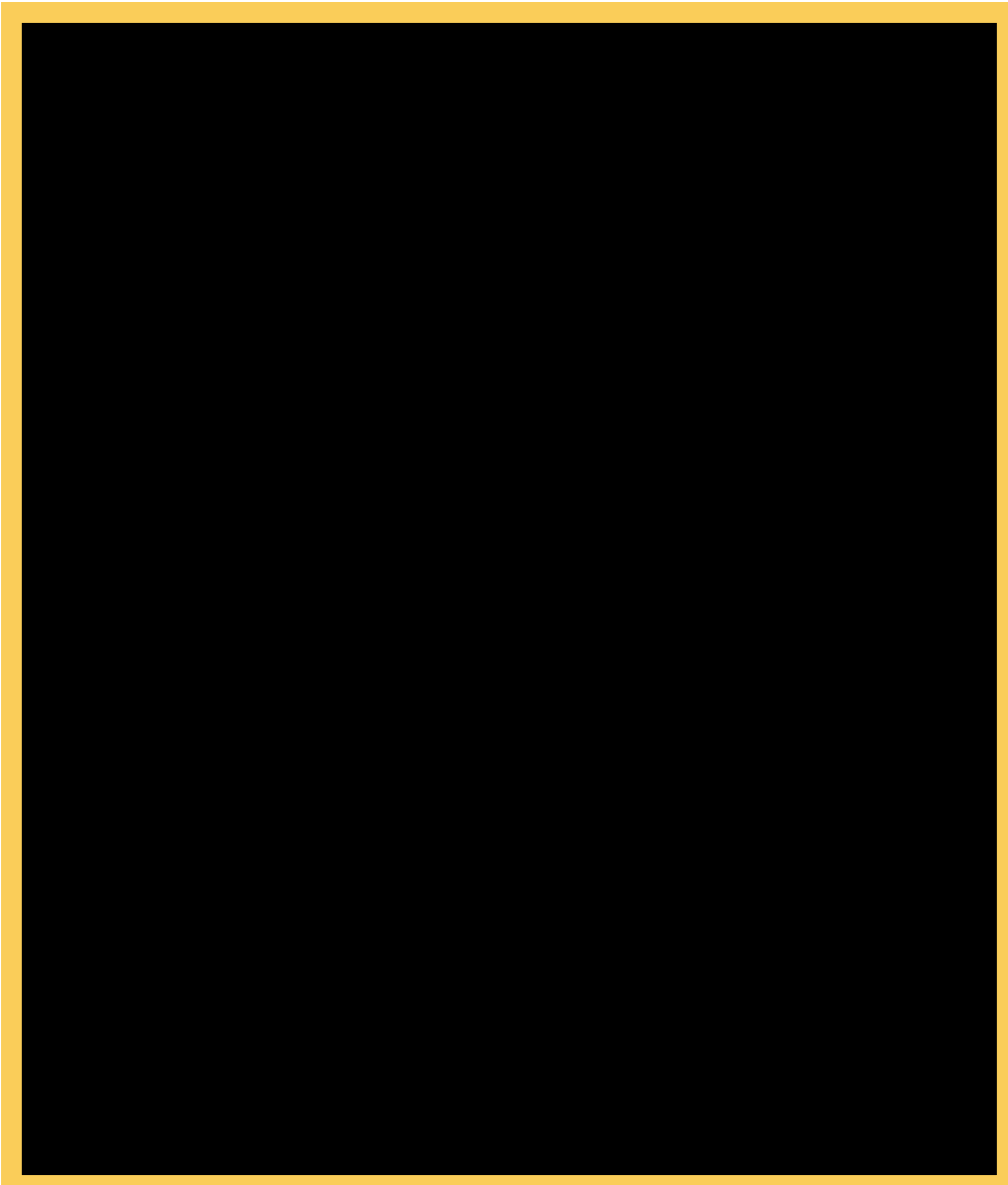
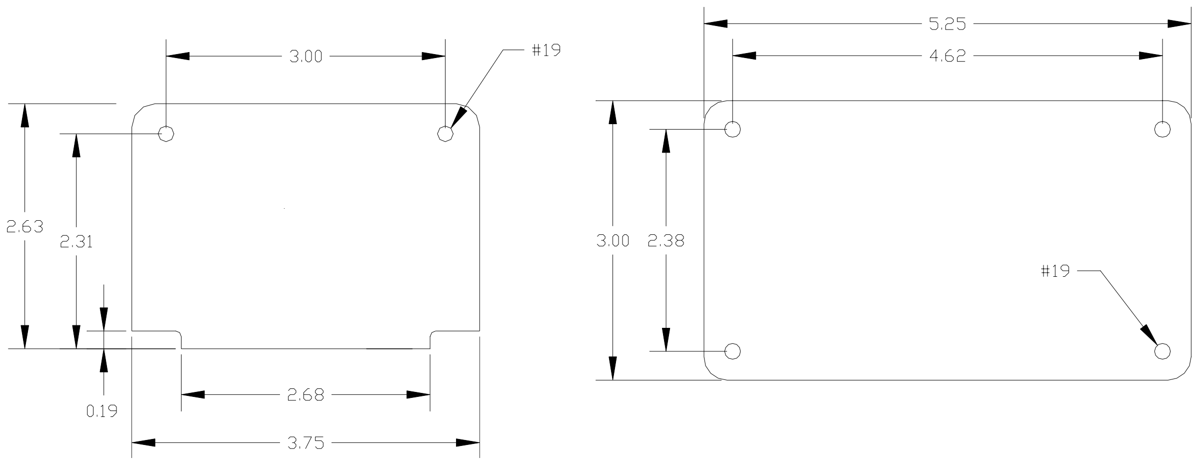


Page 160: Step 79.1 will be added describing the fabrication of the cove access hole covers. Hardware for the covers is already included in your kit. The covers can be made from any .016, .020 or .025 aluminum and are used for the inboard and outboard flap cove skin pulley cutouts. Secure the covers using (12) 450-0211-081 nutclips and (12) AN526-8R6 pan head screws.



The following will be added to Step 80: It is acceptable to trim the aft end of the cove rib to within 2*d from the last skin rivet if it interferes with the doubler. Alternatively, you may sand down the width of the doubler at the location of the rib if necessary.

Note The following several steps can be accomplished with the wing in or out of the jig, at your convenience. Our experience is that most of these procedures are probably easier if the wing is installed on the fuselage. Be sure to take extra care with the left wing to avoid damaging the pitot tube, if you have installed one.

Step 79: Cut the Cove Skins to Length

The flap and aileron cove skins fit between the trailing edges of the upper and lower main skins to close out the aft end of the wing. The cove skins are made of thin aluminum sheet with an angled flange bent along one edge; the flange rivets to the lower wing skin aft of the cove ribs. From the lower wing skin, the cove skins wrap up and aft along the aft ends of the cove ribs. The center areas of the cove skins are riveted to tabs on the aft ends of the cove ribs; the upper edges of the cove skins are riveted, along with a trailing edge doubler, to the upper wing skins.

From an **inboard/outboard flap cove skin** [32], cut one piece **21-3/4"** long for the inboard section of each wing and one piece **22-1/4"** long for the outboard section, as shown in Figure 85. From a **center flap cove skin** [33], cut two pieces **31-1/2"** long for the center sections of each wing. Use offset sheet-metal snips to cut the cove skins.

The Sportsman Flap fits very tight in the cove rib area. Make sure you fit this skin as far forward as possible. The lower trailing edge may need to be trimmed as well, so keep your rivet line in tight to the radius. The center tab on the flap cove rib may also be removed if necessary.

From an **aileron cove skin** [34], cut one piece **12-1/2"** long for the inboard section, one piece **42-1/4"** long for the center section and one piece **11-1/4"** long for the outboard section of each wing, as shown in Figure 86.

Note Figures 80 through 84 have been omitted.

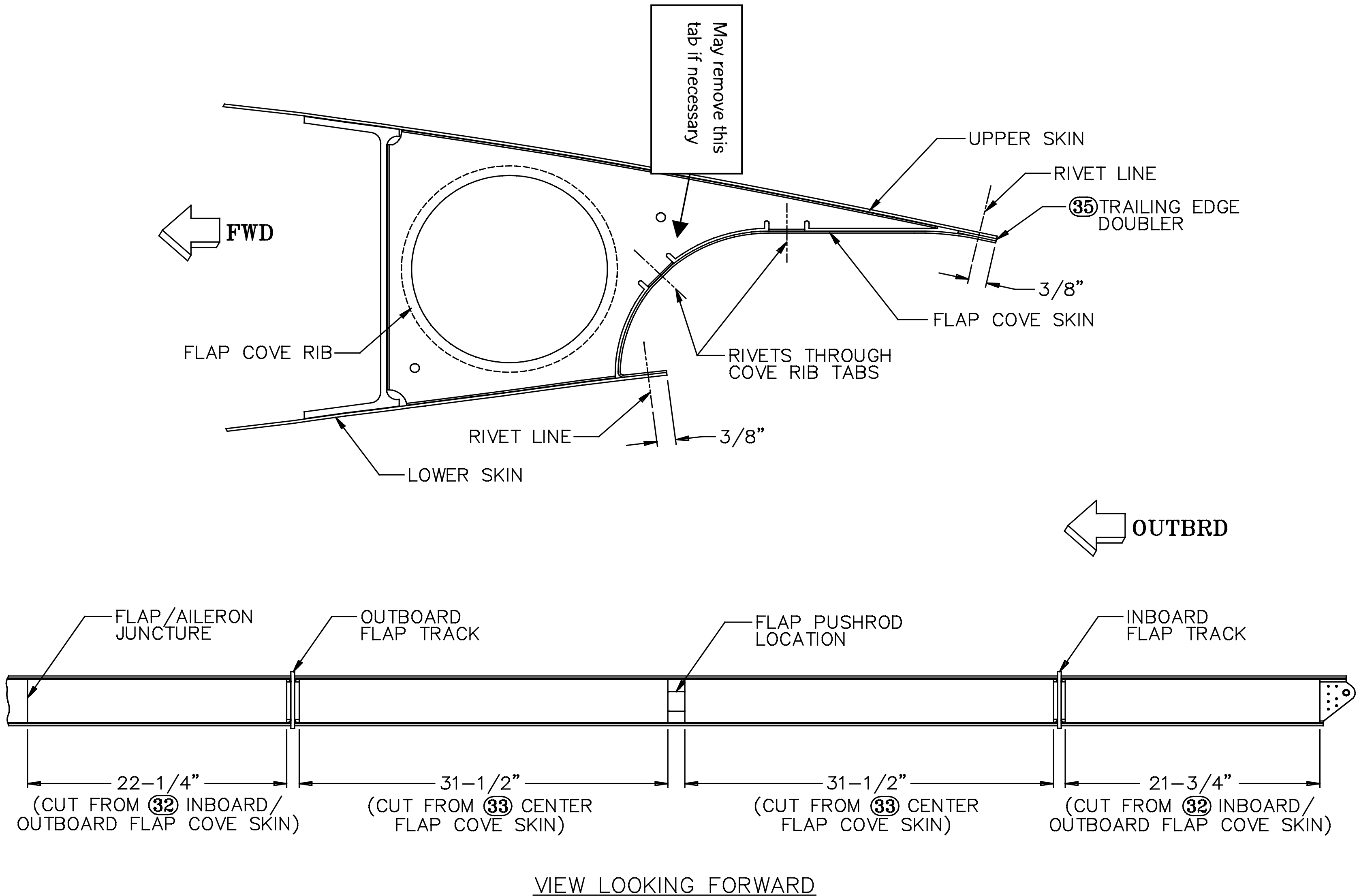


Figure 85: Cutting the Flap Cove Skins

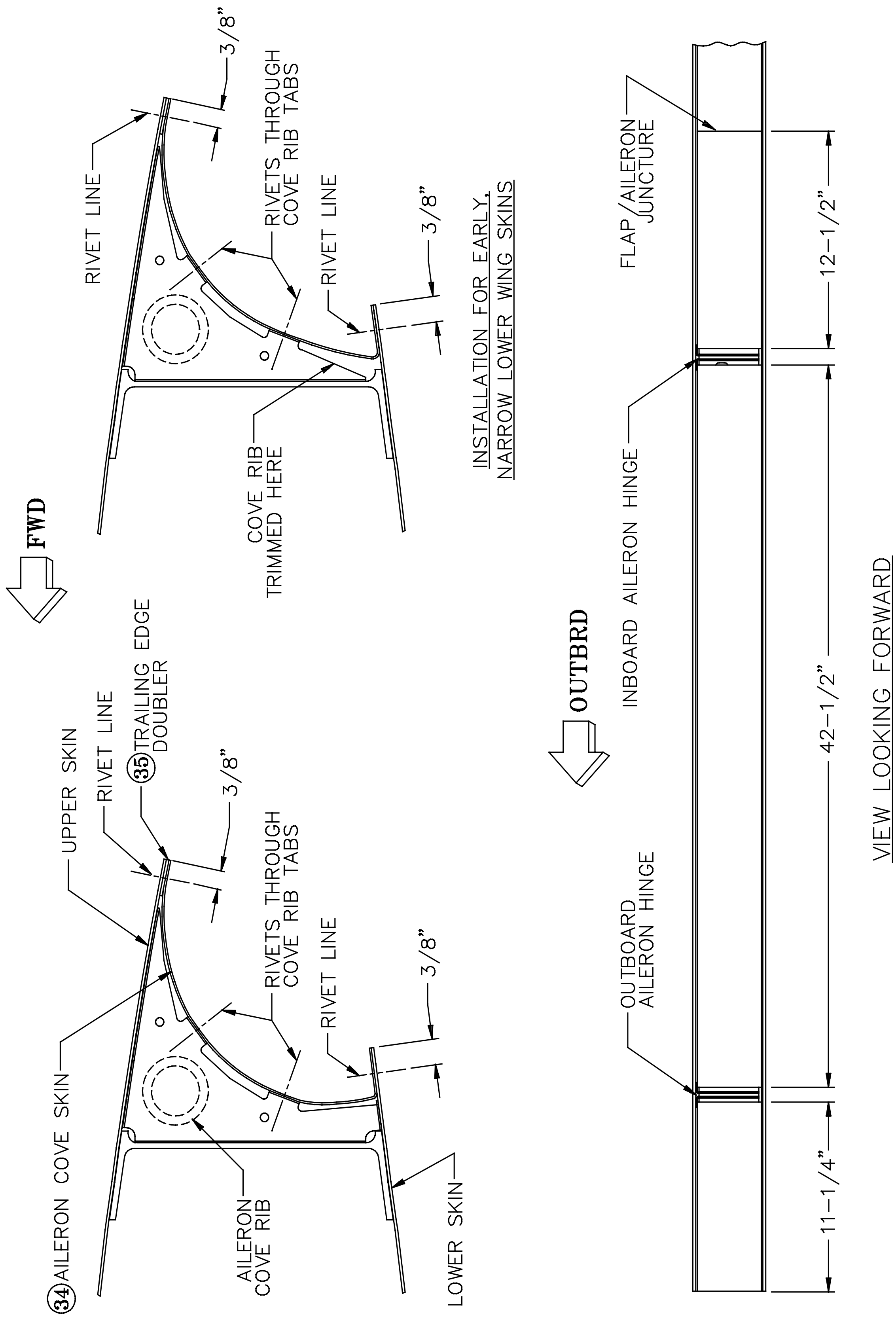


Figure 86: Cutting the Aileron Cove Skins

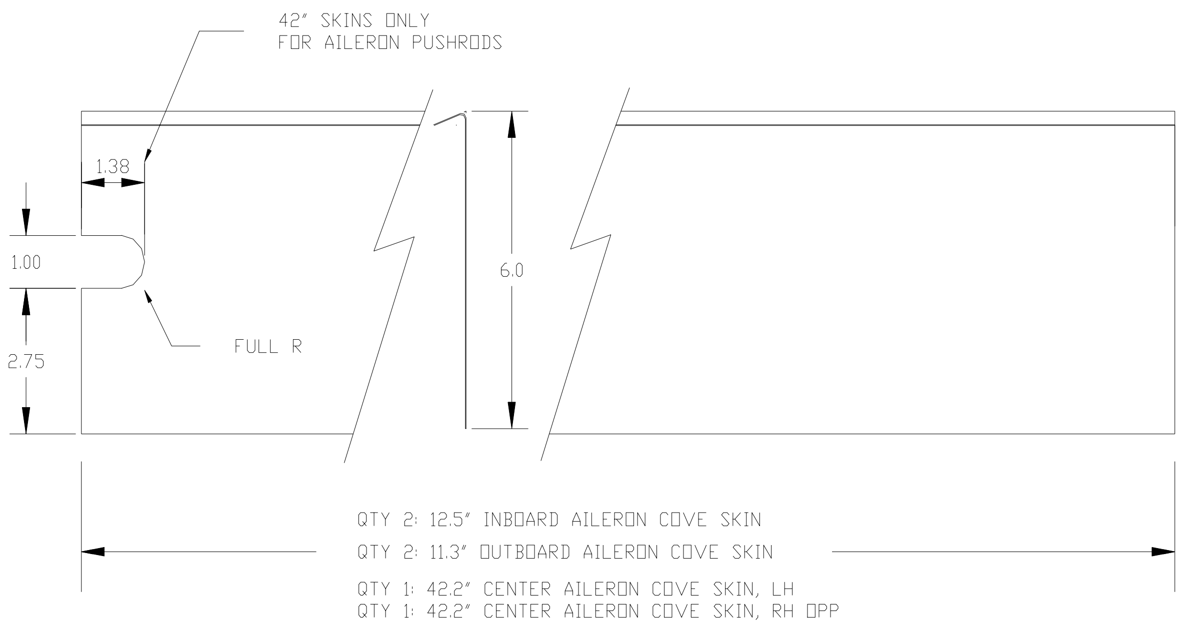
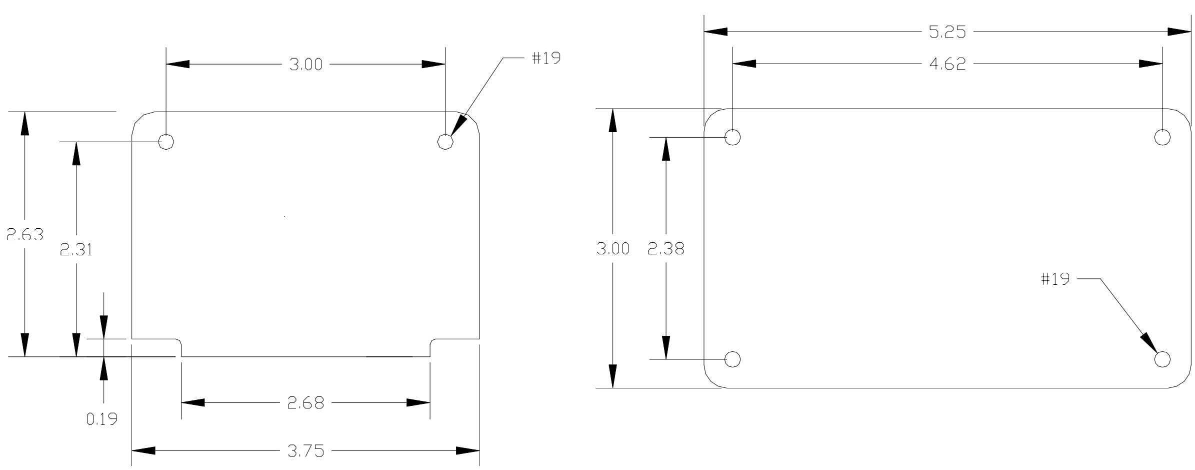


Figure 83: Aileron cove skins

Page 160:



Check the fit of all the cove skin pieces in their respective locations. Make sure that none of them interferes with the flap track guide arms, the aileron hinges or the flap or aileron pushrods. Adjust the lengths of the pieces as necessary and then deburr all the cut ends.

Note Don't be concerned if the edges of the cove skins are not even with the edges of either the upper or the lower wing skins. At each joint, the longer skin will be trimmed to match later after the rivet holes have been drilled.

Completed: Left [ ] Right [ ]

Step 80: Fit the Trailing Edge Doublers

The wing skin **trailing edge doublers** [35] are .032" X 3/4" X 48" aluminum strips. These will be riveted between the upper wing skins and the flap and aileron cove skins the full length of the wing trailing edge. The doublers will simply be butted end-to-end rather than overlapped in any way.

The flap section of the wing trailing edge is just under 111" long, so it will take **two** of the **full-length**, **48"**-long doublers plus **one** section just under **15"** long. Lay two full-length doublers along the wing trailing edge and trim a short length from a third one to fit. It doesn't matter where the joints between the doublers are located; position them anywhere you choose.

The aileron section of the wing is about 67-1/2" long. Use **one full-length** strip, and **one** strip about **19-1/2"** long. Trim the short strip to fit your wing, using the remainder of the strip you trimmed for the flap section.

Completed: Left [ ] Right [ ]

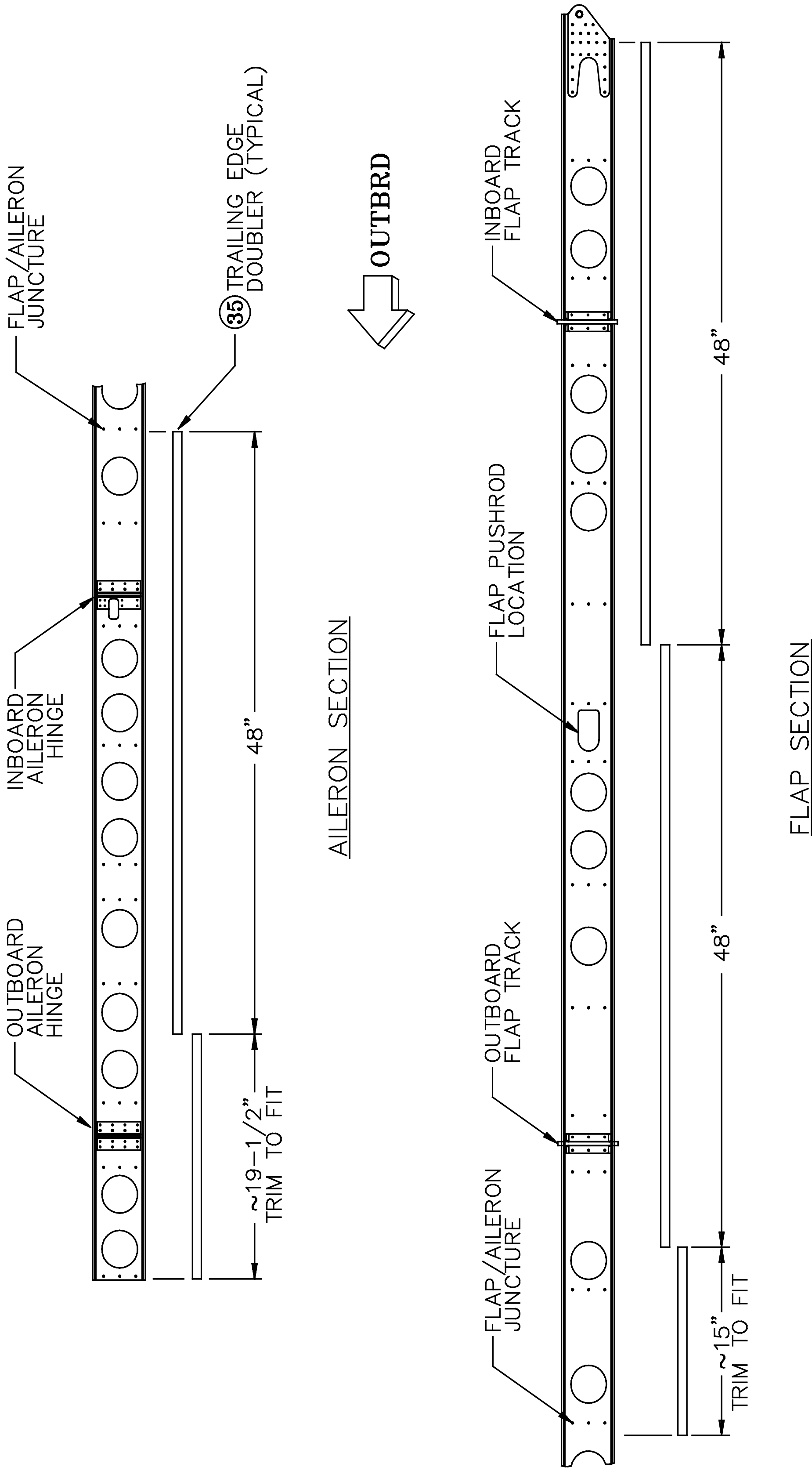


Figure 87: Cutting the Trailing Edge Doublers

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Step 81: Fit and Drill the Cove Skins

You now need to transfer the locations of the rivet tabs on the cove ribs to the cove skins. Hold each cove skin in its correct spanwise position with the straight (un-flanged) edge just below the tabs on the aft sides of the cove ribs, as shown in Figure 88a. Mark the spanwise centers of the tabs onto the edges of the cove skins, and then use a tri-square to continue these marks down across the surfaces of the cove skins.

> **Note** Figure 88 shows the innermost flap cove skin, but the marking procedure is identical for all the skins.

Next, you must mark the vertical locations of the cove rib tabs. Place the inboard flap cove skin in position and lightly clamp it to both the upper and lower wing skins, as shown in Figure 88b. Sight from the inboard end of the wing to mark the vertical centers of the cove rib tabs onto the end of the cove skin. Remove the cove skin and measure from the edges of the cove skin to the marks; use these measurements to mark the rivet hole centers at the spanwise cove rib tab locations of all the flap cove skins.

> **Note** To facilitate positioning the cove skin, pre-bend the curved portion around a pipe, a broomstick or a cardboard shipping tube.

Follow similar procedures to transfer the locations of the centers of the aileron cove rib tabs to the aileron cove skins; work from the outboard end of the wing for the aileron skins. After all the holes have been marked, clamp the cove skins and the trailing edge doublers into position at the trailing edge of the wing.

> **Note** All of the sheet metal pieces involved here are quite thin and easily deformed. We recommend clamping strips of wood to the assembly to help keep the skins from rippling under the pressure of the drill when drilling rivet holes. Also, you will probably have to notch the trailing edge doublers in the aileron area to fit around the aileron cove ribs and the aileron hinge ribs. Without such notches, you will be unable to position the doublers far enough forward to match the trailing edges of the upper skins and cove skins.

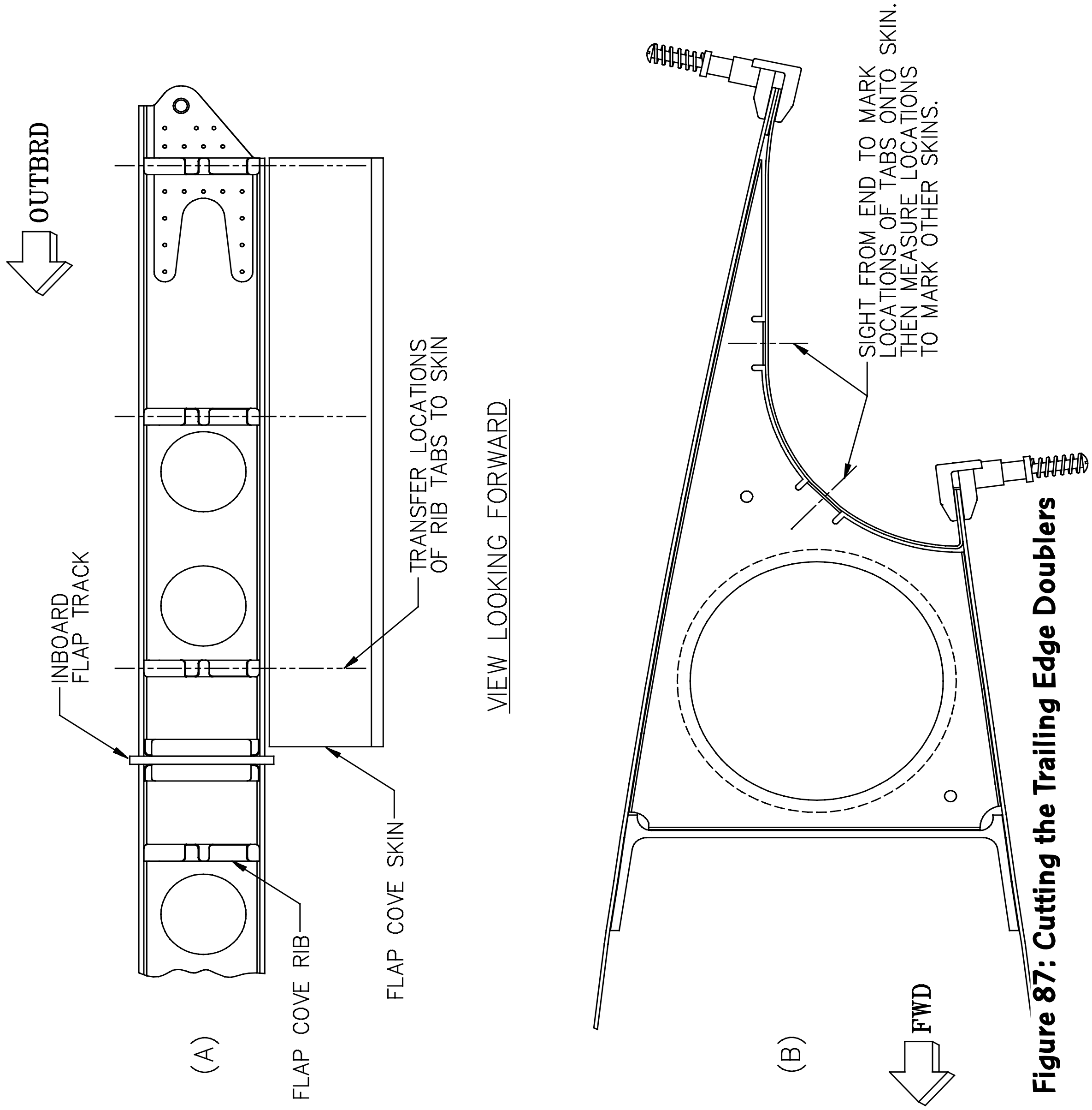

Figure 87: Cutting the Trailing Edge Doublers

Figure 88: Marking Rivet Hole Locations on the Cove Skins

Use the marked hole locations to drill **#40** rivet holes through the cove skins and the tabs on the aileron and flap cove ribs, as shown in Figure 89a. Insert Clecos into these holes as you go. Next, as shown in Figure 89b, lay out rivet holes along the trailing edge of the upper skins every **2"** along the length of the wing and **3/8"** forward of the trailing edge. Drill through the upper skin trailing edges, the trailing edge doublers, and the flap and aileron cove skins at each of these locations with a **#40** bit. Insert Clecos into every third-to-fifth hole after drilling. Similarly, lay out hole locations on the lower skins. These should also be on a line **3/8"** forward of the lower trailing edge but on **1-7/8"** centers. Keep this rivet line in as tight as possible to the radius to the cover skin. Trimming of the lower trailing edge may be necessary. Drill **#40** rivet holes through the lower wing skins and flap and aileron cove skins at these locations, Clecoing as you go.

> **Note** Figure 89 shows the innermost flap cove skin, but the drilling procedures are identical for all the skins.

If the edges of the wing and cove skins are not even (i.e., one of them extends aft of the other), mark the longer skin for trimming even with the edge of the shorter skin. Do this for both the upper and the lower skins. Remove the cove skins and trim the longer skin to the mark. Deburr the cut edges and also deburr the rivet holes.

In order to prevent interference with the wing control surfaces, the **upper** wing skins will be riveted to the cove skins and trailing edge doubler with **flush rivets** installed with the **heads down** toward the control surfaces. Therefore, the cove skins, trailing edge doublers and upper wing skins must all be dimpled on the lower sides, as indicated in Figure 89a, to allow installation of the rivets. Use your **3/32"** dimple dies to dimple all the rivet holes for the upper wing skins.

> **Note** Make sure you dimple the cove skins, the trailing edge doublers and the wing skins from the **lower** sides so that the rivets can properly be installed with the heads down (see Figure 90). The cove skins will be riveted to the **lower** wing skins with **universal-head** rivets, so no dimpling is required for these unless you chose to do so.

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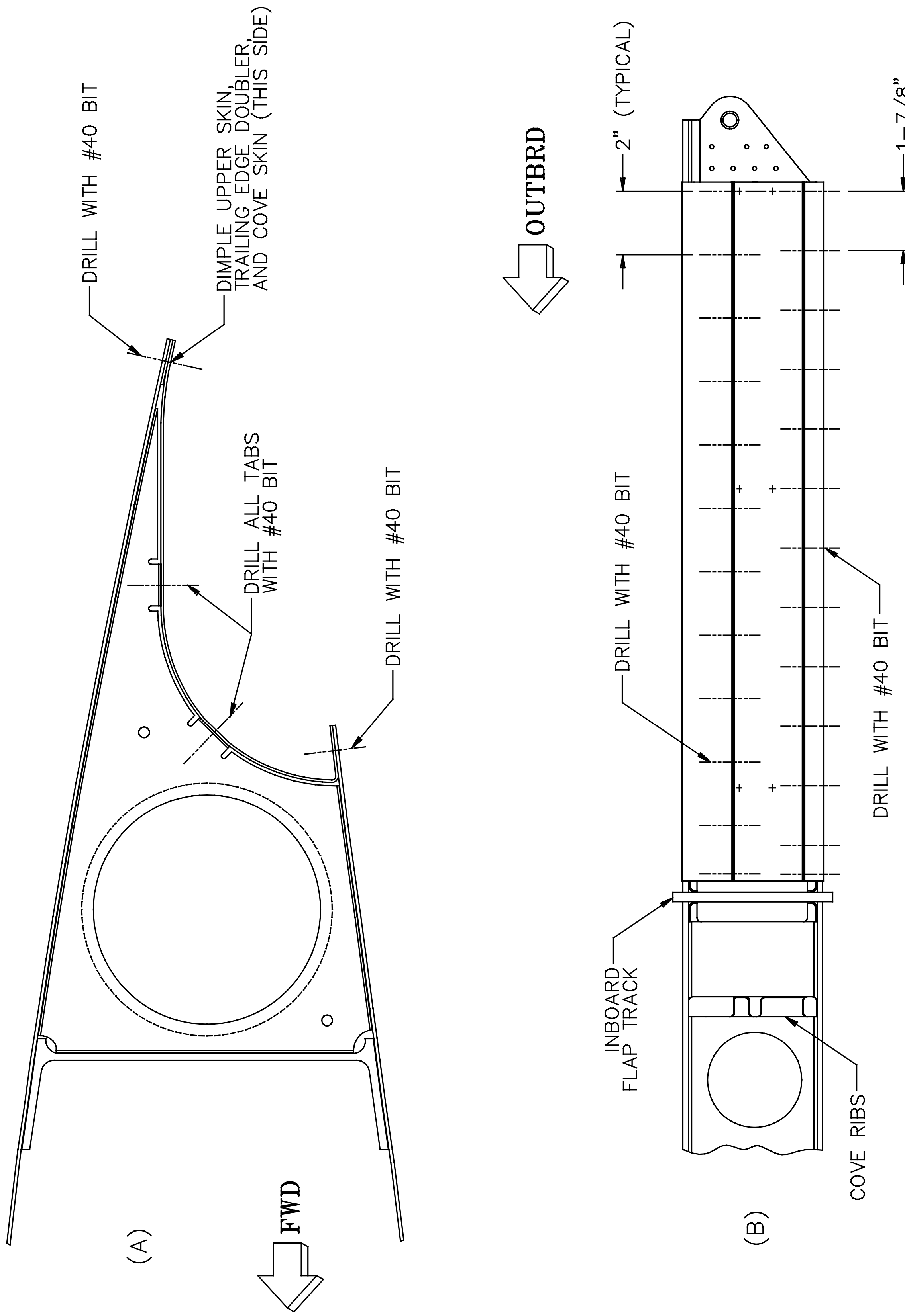

Figure 89: Drilling the Cove Skins and Trailing Edge Doublers

Step 82: Rivet the Cove Skins and Trailing Edge Doublers

Note Before riveting the cove skins, make sure that all the control cables, cable pulleys, cable guards, cable guides, electrical wiring, pitot/static lines and other equipment and hardware that occupy space aft of the aft spar are properly installed and safetied and that none of the systems interferes with the control cables. Verify that the control cables are untwisted and are free to move without interference. We recommend devising some kind of support for the control cables where they exit the inboard end of the wing to hold them in an untwisted condition until the wing is remounted to the fuselage and the final cable connections can be made. This support could consist of a couple of tongue depressors (with notches cut into them for the cables) duct-taped together and then temporarily fastened to the wing structure.

Alternatively, wait until the wings have been mounted to the fuselage for the final time and all the cable connections have been finalized before riveting the cove skins.

Note The flap is extremely tight in the flap cove area. It is recommended that you dimple the cove rib tabs and skin and use the 3/32 universal rivets described here. These are non-structural rivets since the cove skin is held along the upper and lower edges.

Cleco the cove skins and trailing edge doublers in place on the wing. Rivet the cove skins to the tabs on the aft ends of the cove ribs with **3/32" aluminum blind rivets** [104], as shown in Figure 90. Then rivet the cove skins to the lower wing skins with 3/32" AN470AD3 universal-head rivets, installed with the heads on the lower side (outside) of the lower wing skins. Finally, rivet the cove skins and the trailing edge doublers to the upper wing skins with 1/8" AN426AD3 flush-head rivets, installed with the heads down. Be sure to observe proper sequencing while driving these long rows of rivets.

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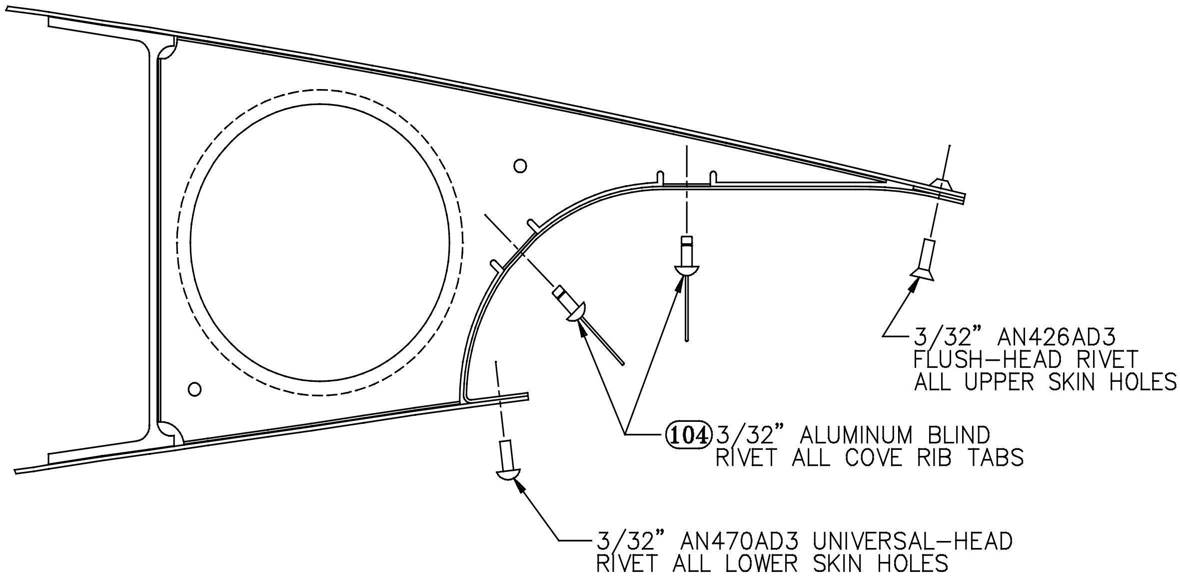
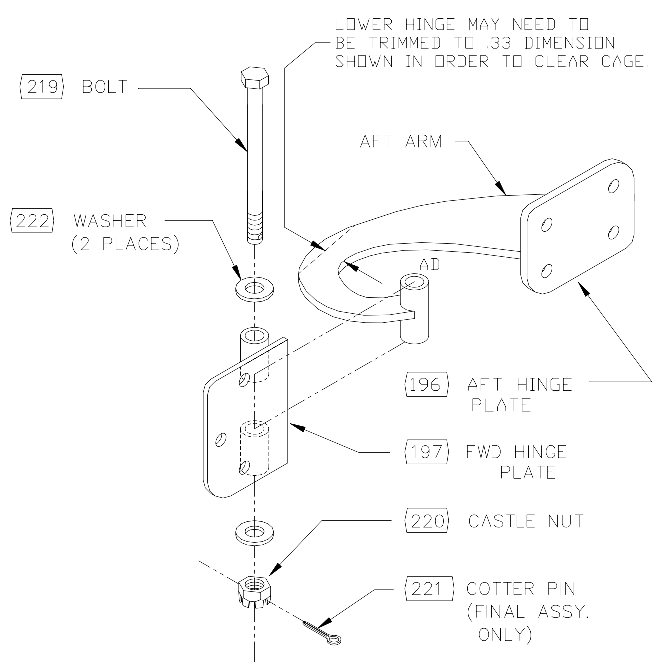


Figure 90: Riveting the Cove Skins and Trailing Edge Doublers

Page 168:

Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.



Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Step 83: Install the Main Fuel Line Fittings and Hose

Rigid tubing fuel lines will be installed inside the cabin of the Sportsman, but to accommodate the folding wing feature, the lines from the tanks into the cabin must be of flexible hose. In this step, you will install the tank fittings and this short length of hose.

Begin, as shown in Figure 91, by threading a **finger screen** [97] into the main fuel line boss of the tank. This screen will ensure that no major junk ever gets into your fuel line from the tank. Next thread an AN844-6D **45° aluminum elbow** [142] into the screen. Thread the elbow into the screen fitting until it's good and snug, with the unthreaded nipple of the elbow **pointing aft**, as shown in Figure 91. We recommend the use of a thread sealant on both the screen and the elbow.

Next, use a utility knife to cut a length of the **5/8" rubber hose** [77] 18" long. **Also reference the parts list in Step 106 in the Systems Installation**. Slide a **7/32"–5/8" hose clamp** [99] over one end of this hose, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly **5/8"** from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Note It's just as bad to overtighten a hose clamp as to undertighten it. As the clamp tightens, it will tend to push the rubber out from underneath it, and this movement will be easily visible at the end of the hose. You should tighten the clamp until the end of the hose **just begins** to move.

Hint To ease installation of the hose, very lightly grease the fitting first.

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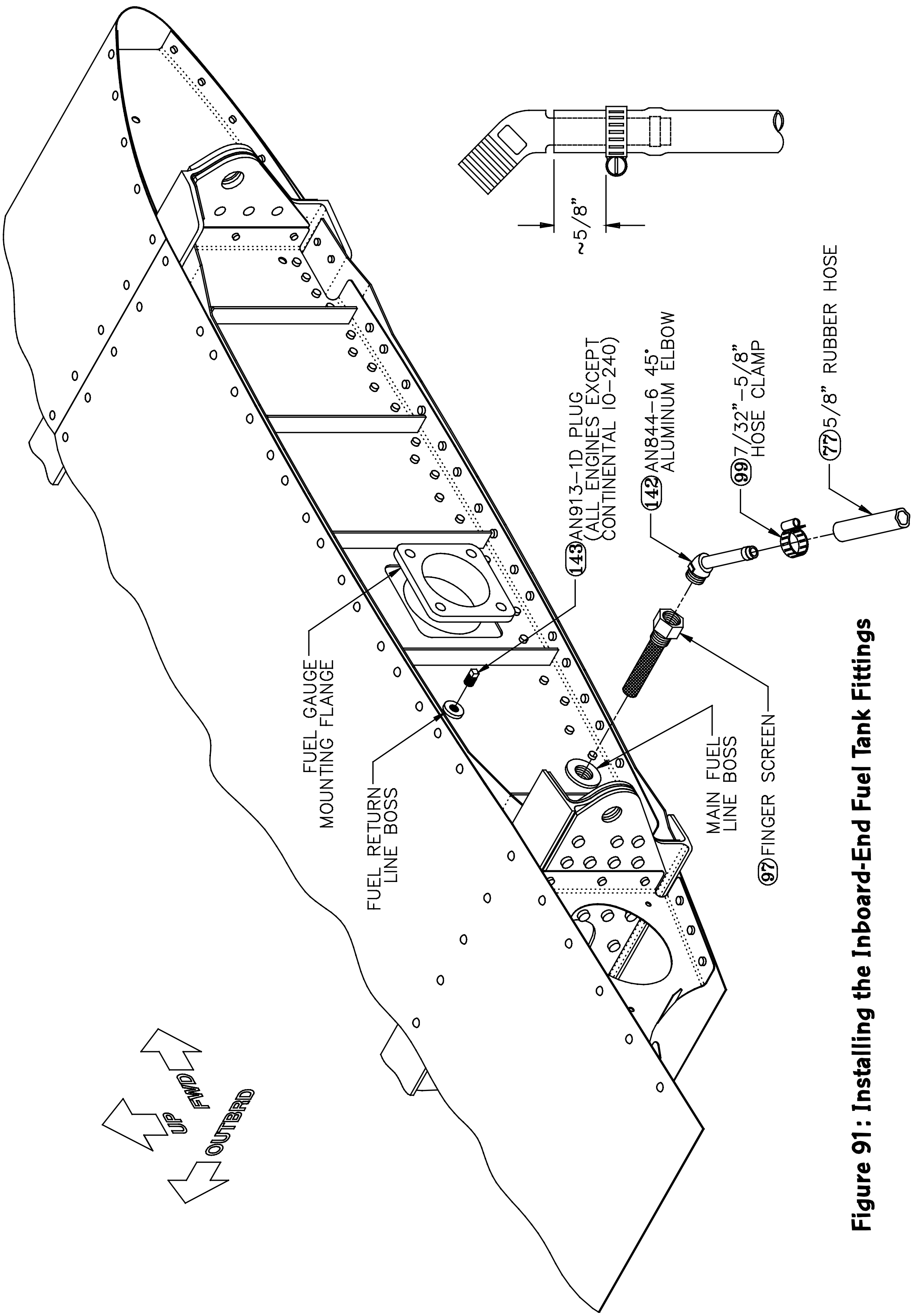

Figure 91: Installing the Inboard-End Fuel Tank Fittings

Step 84: Install the Header Tank Vent Line in the Fuel Return Line Boss

The header tanks are vented into the return line boss on the inboard end of the main tank, as shown in Figure 91.1. **Refer to Step 106 in Systems Installation**. The plug in Figure 91 is no longer used. Thread in the 45 degree elbow AN844-4D into the fuel return line boss as shown in Figure 91. Cut a 21" piece of the 1/4" ID rubber hose (083-00002-01) and insert a hose clamp (450-0190-004) over the end tighten onto the elbow. Insert a second hose clamp and clamp the end over the appropriate fitting in the header tank. There should be no hose kinking nor undue fitting stress during wing fold.

Clearance will have to be provided at the wing root on the fuselage shell for the hoses during wing fold. Add tie wraps or spiral wrap as needed to prevent hoses from chafing or rubbing.

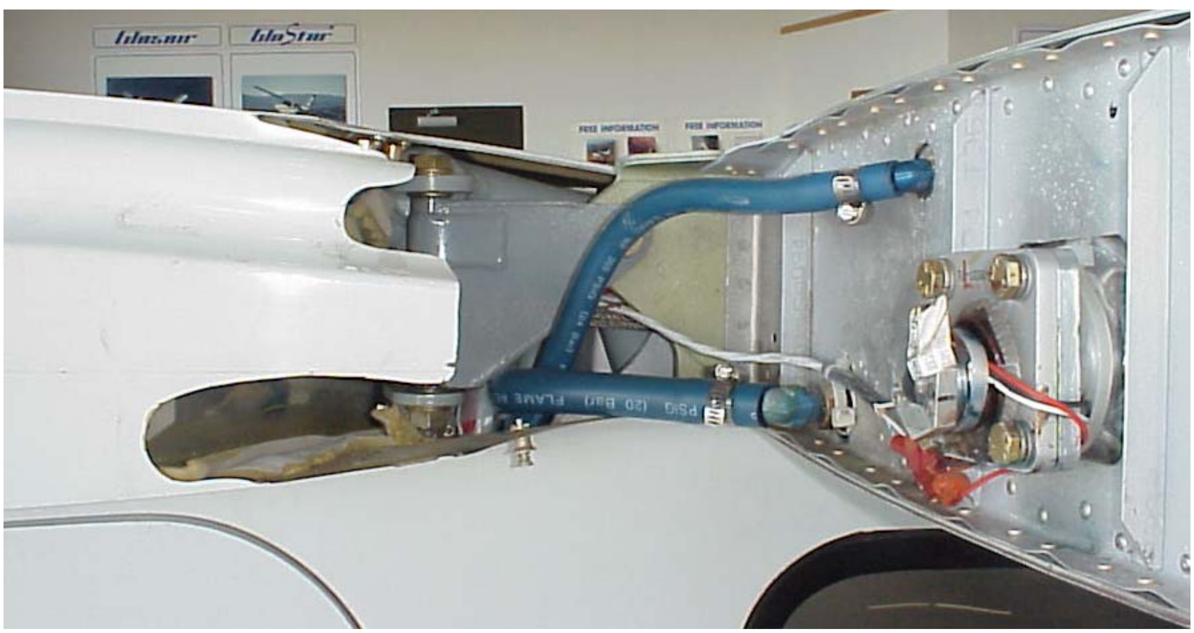

Figure 91.1 Wing Root Details of the Fuel Lines

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Step 85: Install the Fuel Tank Sump Drain Valve

Install a **drain valve** [96] in the sump drain boss at the bottom of each tank. Remove the plug from the boss and use a wrench to thread the valve all the way into the boss, but be careful not to over-torque the relatively fine threads. As with the other metal fittings, use of a thread sealant is recommended.

Completed: Left [ ] Right [ ]

Step 86: Cut Out the Components of the Delta Wings

Small delta wing-shaped vortex generators are installed on the upper surfaces of the Sportsman wing leading edges to enhance the aircraft's handling characteristics during extreme aft-loaded, high angle-of-attack, power-on stalls. These delta wings can be made of bent sheet-metal construction or made from a composite laminate for a more finished product. Both methods will be described for you.

Full-sized templates for the **sheet metal** version of the wing, the outboard supports and the inboard supports, respectively, are given in Figures 92, 93a and 93b. Use these templates to lay out **four** caps, **two** outboard supports and **two** inboard supports on the supplied **.032" X 16" X 16" aluminum sheet** [69]. We recommend laying out all eight parts before cutting any of them, since the 16" X 16" sheet leaves very little excess material.

Use a bandsaw, scroll saw and/or snips to cut the parts out. On the supports, first cut the basic shapes (as indicated by the solid lines on the templates) and then drill at each of the marked locations with a **#10** or **3/16"** bit. Finally, cut tangent to each hole (as indicated by the dashed lines on the templates) to complete the parts.

Sand all the cut edges smooth and radius all sharp corners.

Full size templates for the **composite** wing, web and base are given in Figures 92, 94a and 94b. Use these templates to lay out **four** caps, **two** outboard bases, **two** outboard web supports and **two** inboard supports.

The composite cap and base components are best if layed up on the wing itself as this gives the approximate shape of the delta wing. We do not recommend using wax on the wing, because if you decide to paint later on, the wax will never completely come off the surface. The two web supports shown in Figure 94b can be done on a flat surface and are made from a five-layer laminate of 7781 cloth. The ply orientation is not critical. Once cured, trim the laminate to the shapes given in Figure 94b, remembering to do two of each. Drill a series of 1/16" diameter holes along the upper and lower edges. These holes will aid adhesion when bonding the pieces together.

Tape a piece of mylar, wax paper or plastic down over the leading edge section of the wing and stretch it tight. Do a five-layer laminate over the wing surface in the area of the forward spar rivet lines and forward toward the leading edge. (The base will be installed on the wing by riveting to a hole common to the most forward of the spar rivet lines as shown in Figure 94c, so your laminate should be in this area.

Once the laminate has reached green cure, trim the cap and the base from the laminate to the shapes given in Figure 92 and Figure 94a.

If doing the composite delta wings, skip to Step 92.

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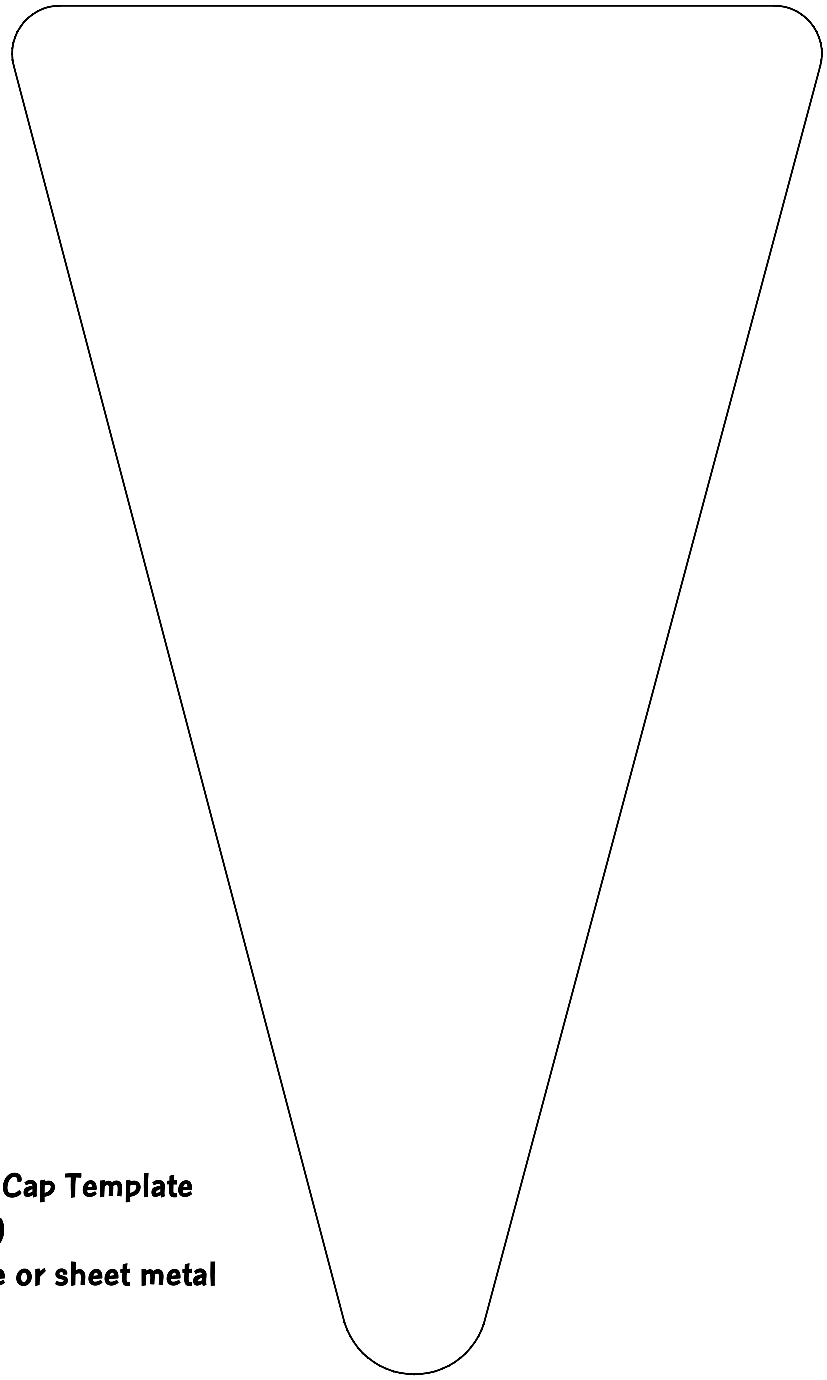

Figure 92: Delta Wing Cap Template
(Full Size)
Good for both composite or sheet metal

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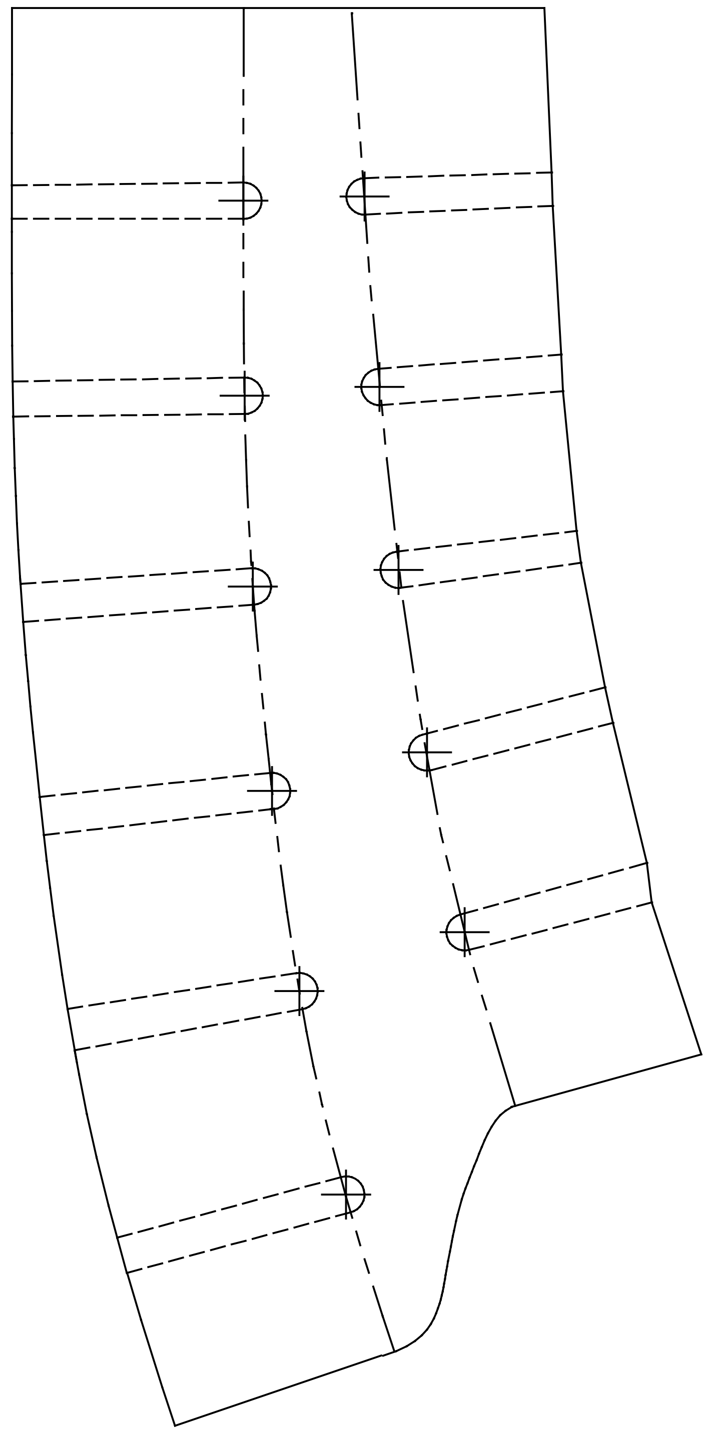

Figure 93a: Outboard Delta Wing Support Template (Full Size)

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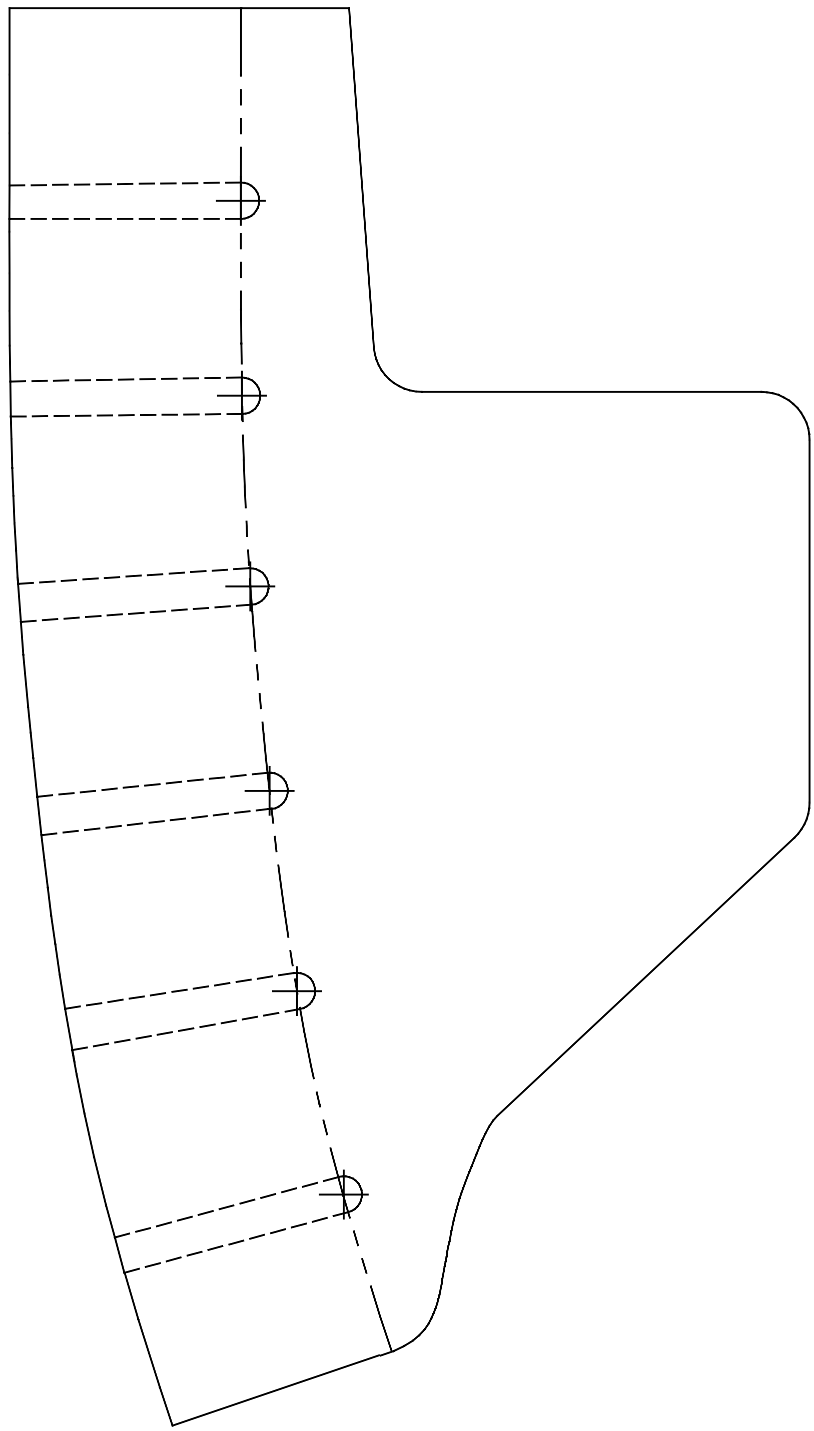

Figure 93b: Inboard Delta Wing Support Template (Full Size)

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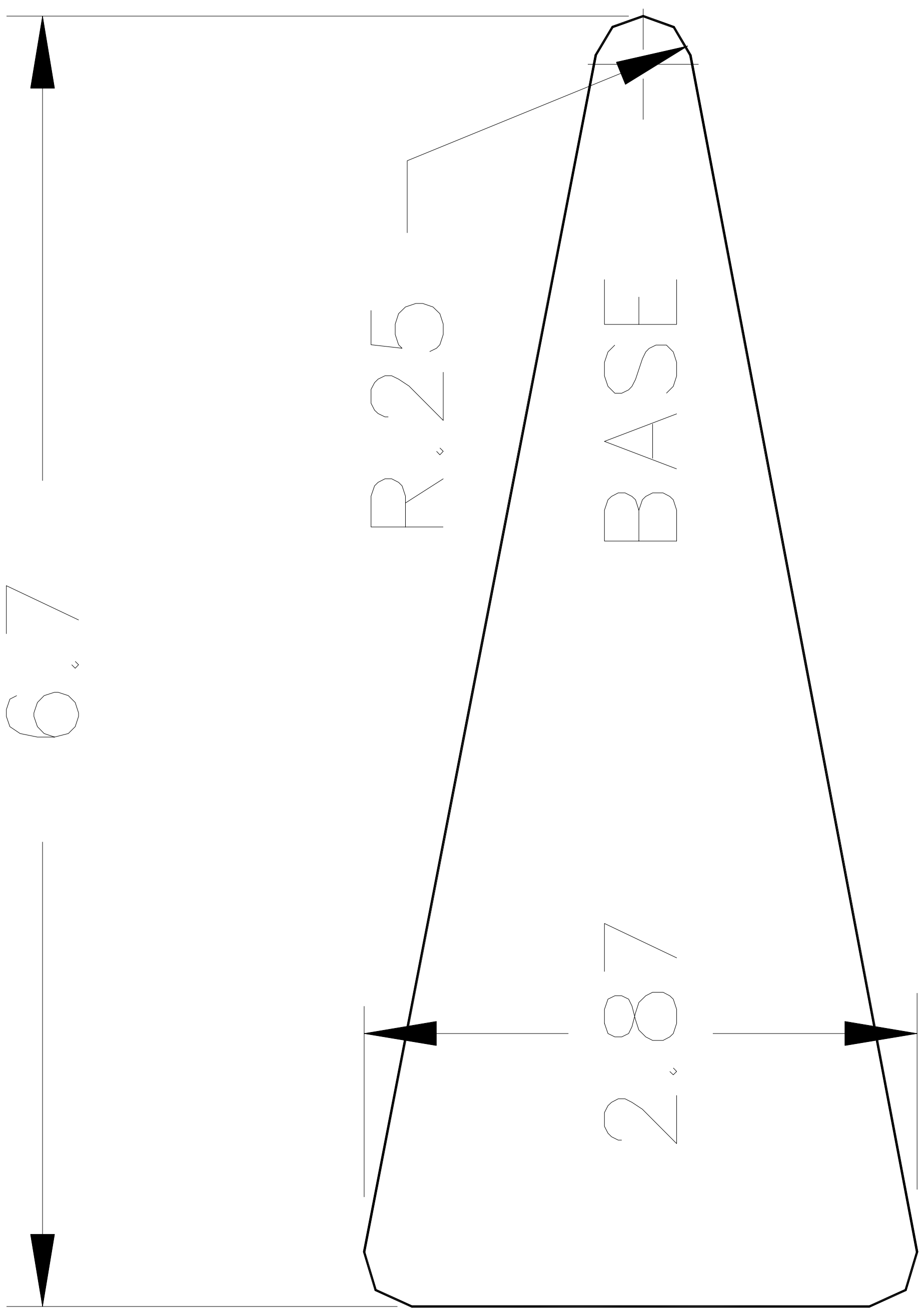

Figure 94a: Composite Delta Wing Base (full scale)

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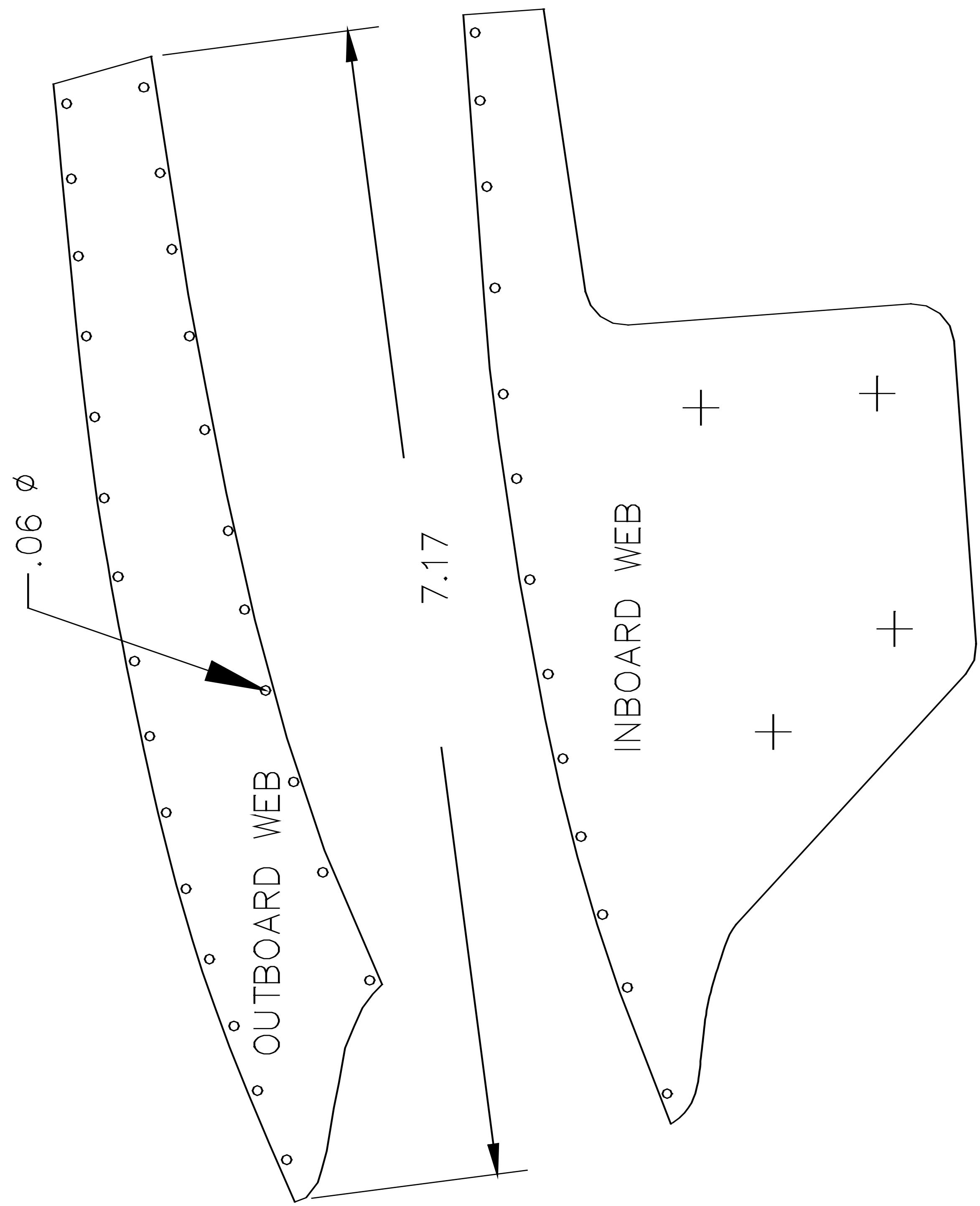

Figure 94b: Composite Delta Wing Webs (full scale)

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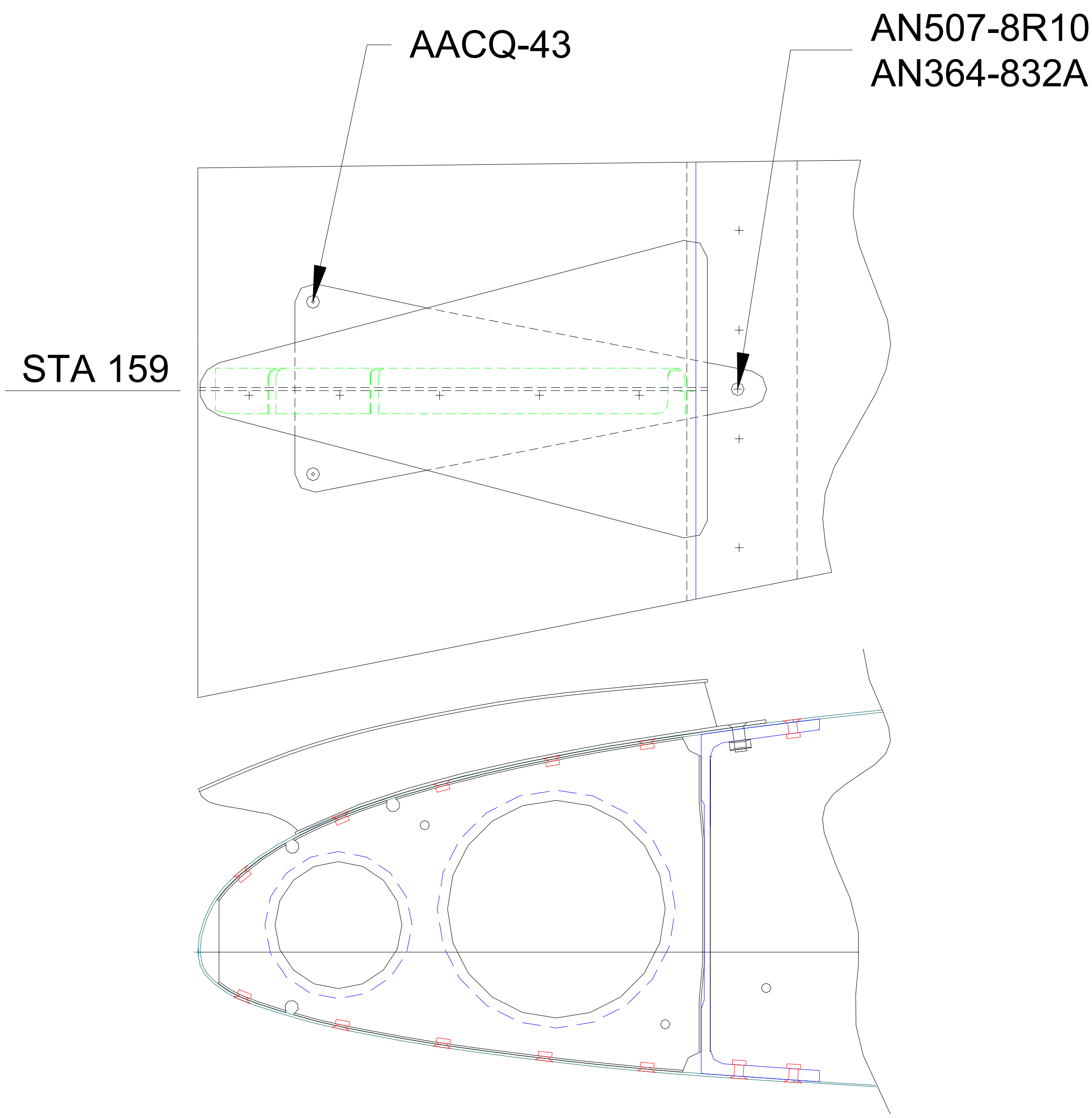

Figure 94c: Installed Location for the Outboard Composite Delta Wing

Step 87: Bend the Outboard Delta Wing Supports

The flat shape of the aluminum outboard delta wing supports consists of a central vane with rows of tabs along the upper and lower edges. When bent at right angles to the vane, these tabs become mounting tabs. The lower tabs are riveted to the leading edge skin of the wing and the upper tabs are riveted to the delta wing cap. The two panels of Figure 95 show how the tabs should be bent.

As Figure 95a shows, alternate tabs are bent in opposite directions, with the centerline of the bend going through the center of the hole at the base of each slot. These bends can be made with a pair of duckbill pliers. Try to keep the radius of the bend in the neighborhood of **1/8"**, but don't worry too much about this—it's not critical.

Figure 95b illustrates the completed support.

> **Note** For simplicity's sake, we recommend bending both supports according to the directions on the tabs in Figure 95a. Two identical supports will result, and they will be perfectly functional. However, if you prefer perfect symmetry, you can bend one support according to the bend directions shown and the other with the tabs bent in the **opposite** directions.

Completed: [ ]

Step 88: Bend the Inboard Delta Wing Supports

The inboard supports of the aluminum delta wing function just the same way, except that because they are placed at the fuselage/wing junction, they can be riveted directly to the vertical wing-root area of the fuselage shell (as illustrated in Figure 97). Thus, they only need bent mounting tabs on the top where they attach to the delta wing caps. Use the same procedures you just used on the outboard supports to bend these upper tabs.

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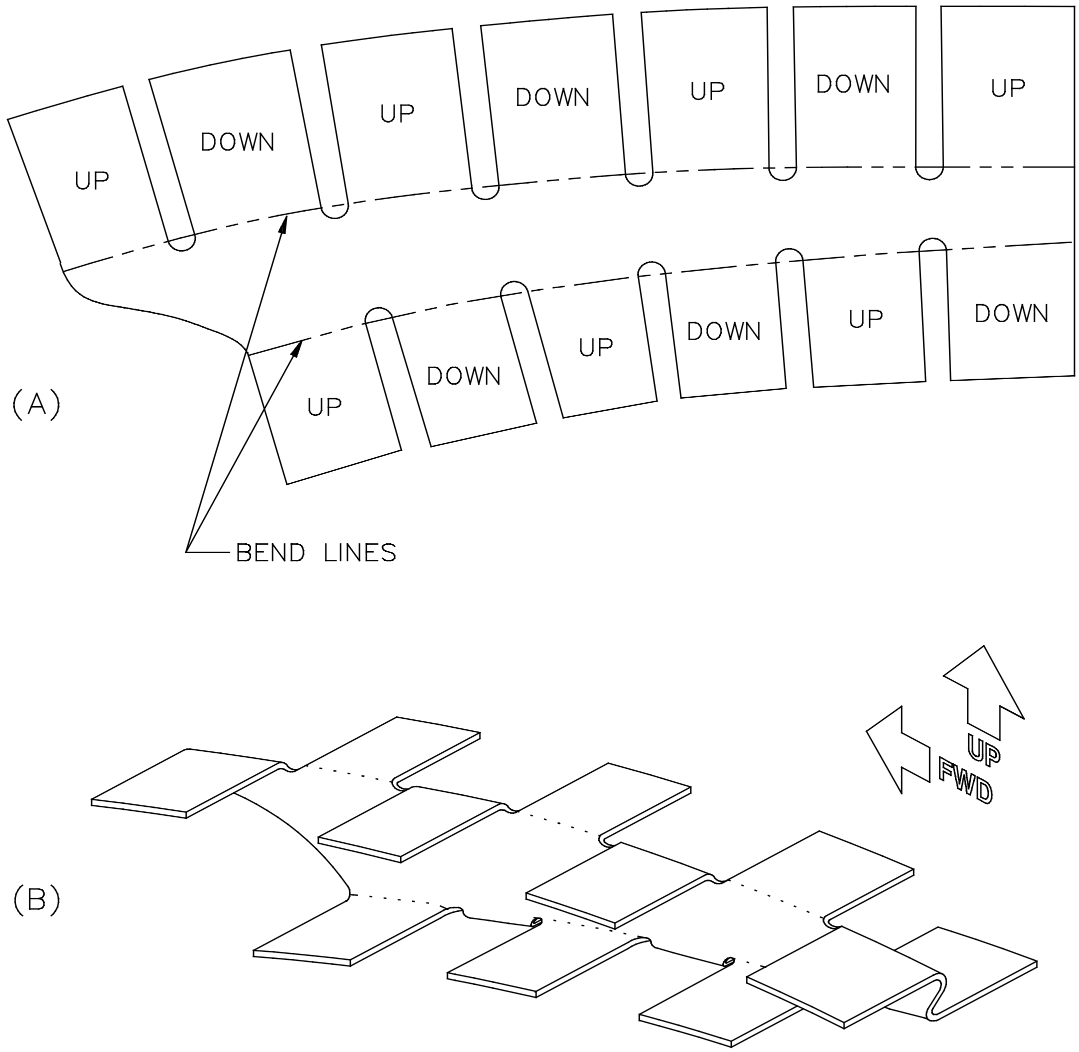

Figure 95: Bending the Outboard Delta Wing Supports

Step 89: Drill the Delta Wing Caps and Upper Support Tabs

Now that you have all four aluminum delta wing supports bent to shape, you can drill the holes for the rivets that will attach the caps to the upper tabs of each support. Begin by marking a longitudinal centerline on one side of each cap.

Lay a cap flat on the bench with this centerline up. Position a delta wing support on top of the cap with its vertical vane centered on the centerline and its forward-most upper tab flat against the cap, as shown in Figure 96a. While holding the support in this position, drill a **#40** hole through the forward-most upper tab and the cap.

> **Note** In general, drill about **1/4"** inboard of the end of the tab or the edge of the cap, whichever is closer to the support centerline. The tabs that extend past the cap edges will be trimmed later. In a fore-and-aft direction, center the holes on each tab; eyeball accuracy is fine for judging this.

After drilling the first hole, insert a Cleco. Then, as shown in Figure 96b, rock the support backward, bending the cap to match the curvature of the support, until the second tab is flat against the cap. Drill and Cleco that tab, and proceed in this manner until all the tabs have been drilled and the cap is held tightly against the support along its entire length. Then mark each cap and support so that they can be reunited later and mark any tabs that need trimming to match the cap. Remove the Clecos, deburr all the holes and trim the tabs as necessary.

> **Note** Figure 96 shows an inboard support because it allows a clearer illustration, but the outboard supports and caps should be drilled in exactly the same way.

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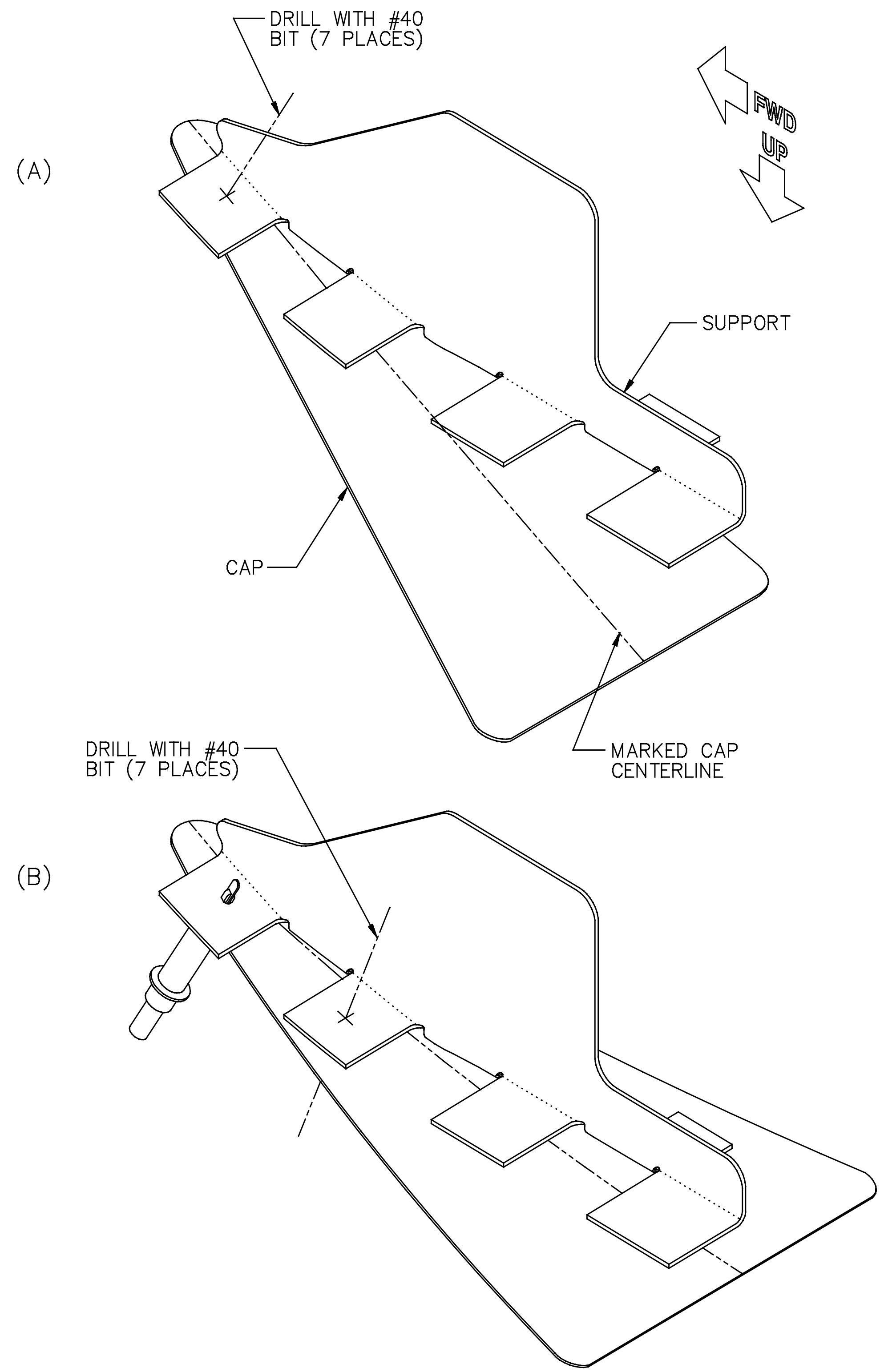

Figure 96: Drilling the Delta Wing Caps and Upper Support Tabs

Step 90: Position the Supports on the Airframe and Drill the Lower Tabs

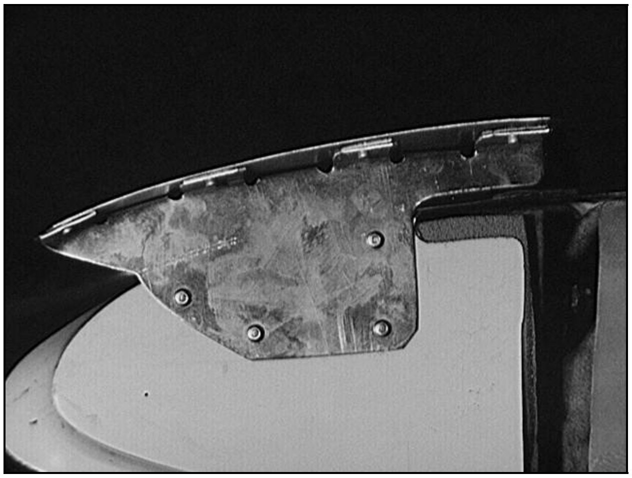

Figure 97: Inboard Delta Wing Installation

The next step is to drill the rivet holes through the lower support tabs and the underlying airframe structures to which the delta wings attach.

Begin with the inboard supports. As Figure 97 shows, these are riveted directly to the vertical portion of the fuselage shell wing-root area. Figure 98 shows how the supports should be positioned relative to the wing-root area. The leading edge of the support should be positioned even with the leading edge of the airfoil shape. Vertically, the upper support tabs should be **1-1/4"** above the airfoil surface at the forward end and **11/16"** above the surface at the aft end (both distances measured perpendicular to the surface).

With the support held in position, drill four **#30** rivet holes through the tab of the support and the fuselage shell. The location of the holes isn't critical—just follow the example of Figures 97 and 98.

> **Hint** Because the top deck hasn't yet been installed, the fuselage wing-root areas are still quite flexible. You may find it worthwhile to have an assistant hold a scrap wood block on the inboard side of the wing root while you drill these holes.

The outboard supports are riveted directly to the leading edge wing skin. They are centered over **Nose Rib 14**, approximately **135"** outboard of the inboard edge of the inboard leading edge skin, as shown in Figure 98b. Because the lower tabs fix the vertical position of the supports, you only need to make sure that, as with the inboard supports, the leading edges of the outboard supports are even with the leading edges of the wing.

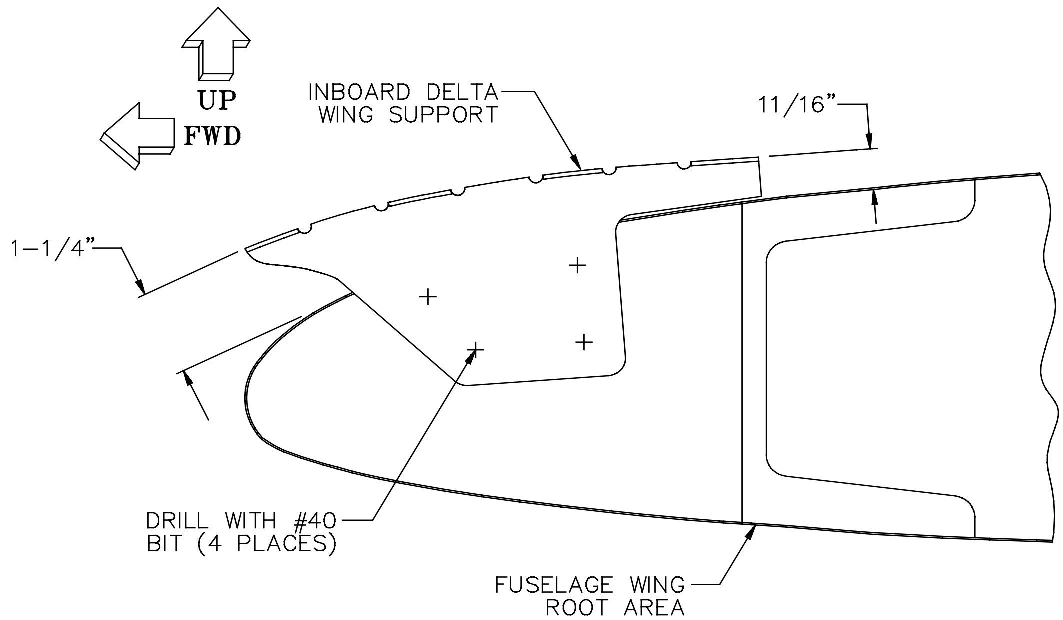

Figure 98a: Positioning and Drilling the Inboard Supports

VIEW LOOKING INBOARD

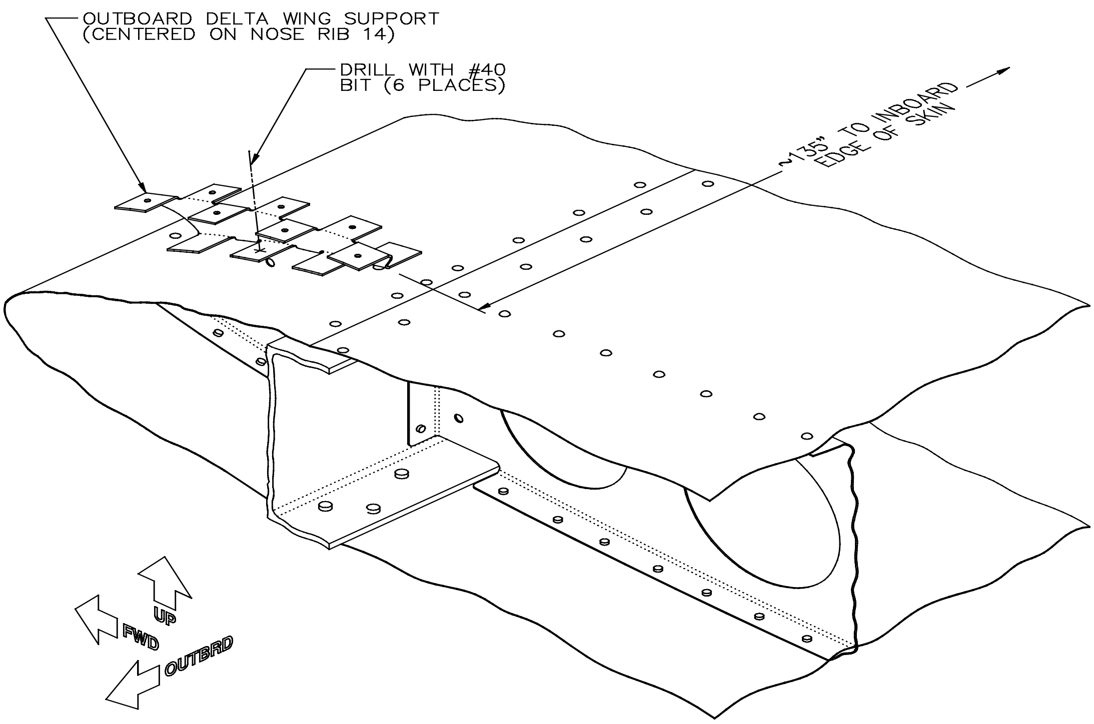

Figure 98b: Positioning and Drilling the Outboard Supports

Holding the supports in position, drill a **#30** hole through the center of each tab and the underlying leading edge skin. Insert Clecos as you go. After drilling, deburr all the holes in the supports and the leading edge skins.

Completed: Left [ ] Right [ ]

Step 91: Corrosion-Proof the Delta Wing Components

The delta wings are now completed, but we recommend not riveting them together or installing them until the "Miscellaneous Final Assembly Details" sub-section below. This will give you a chance to paint your wings and fuselage without having to work around the delta wings. However, now is a good time to apply the anti-corrosion protection of your choice to the delta wing components.

Completed: [ ]

Step 92: Bond the Composite Delta Wing Components

The bonding of the composite delta wing parts is done by applying a thick resin, milled fiber and q-cell mixture into the fillets between the web, cap and the base as seen in Figure 99. The bonding of the outboard delta wing is best done on the wing itself. The inboard wing can be done anywhere.

Center the base about wing station 159 +/- 1 inch and drill a #20 hole (for a number 8 screw) thru the aft end of the base and into the wing skin and spar between two existing rivets as shown in Figure 94c. Then drill two #30 holes through the base and the skin on the forward end as shown in the figure and cleco them in position. These will be held on with AACQ-43 flush blind rivets.

Center and secure the web over the base and apply a 1/8" fillet of a very thick mixture of q-cell, milled fiber and resin into the corner between the two parts on both sides squeezing it into the holes in the web. Try to get a good clean fillet to minimize any bodywork later. Allow the parts to cure.

Position the cap of the wing over the web and apply the adhesive in the same manner as the base. Bonding the cap can be done off the wing because the web and the base assembly will hold the shape. The position of the cap relative to the leading edge of the wing can be seen in Figure 94c and 98a.

Bond the inboard cap to the inboard support base in similar manner as described above. This can be done on or off the airplane at your discretion. The positioning of the inboard delta wing is the same as shown in Figure 98a.

After all the composite delta wings have been bonded, sand fill and prime the assemblies for the paining of your choice.

Installation of the assemblies should be done after the wings are finished to prevent from damaging.

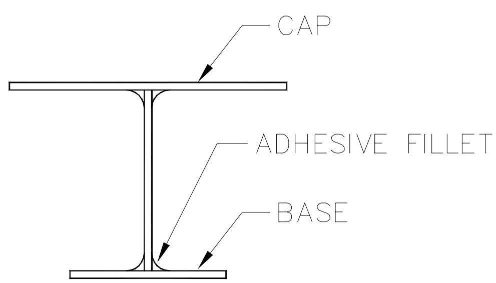

Figure 99: Bonding the Composite Delta Wings Together.

Completed: Left [ ] Right [ ]

Step 93: Prepare the Wing-Root Areas of the Fuselage Shell for Final Wing Installation

It's almost time to hang the wings on the fuselage once again, but first, you have to provide a couple more cutouts in the wing-root areas of the fuselage shells—for the fuel gauge mounting flanges on the inboard ends of the fuel tanks and for the blue rubber fuel lines and fittings. For each wing root, measure the locations of the fuel gauge mounting flange and the main fuel line boss relative to the wing spar ends. Transfer these dimensions to the wing root area of the fuselage shell on each side, measuring from the wing attach lugs on the cage.

Use drills, hole cutters, files and/or a saber saw with a carbide grit blade to make cutouts in the shell matching those in the root ribs. In the case of the fuel lines/ fittings, the cutout should start at the location corresponding to the main fuel line boss and extend aft as a slot all the way to the aft spar cutout.

Hint All the cutouts may have to be extended or adjusted during the process of hanging the wings, so keep your cutting tools handy as you move on to the next step.

Completed: Left [ ] Right [ ]

Step 94: Install the Wings on the Fuselage

It's time to install the wings on the fuselage for the final time! To do this, you'll want to use essentially the same procedures you used in "SECTION IX: SYSTEMS INSTALLATION," but there are a few differences.

First, you will probably find it easier to install the wing this time if the wing strut is already bolted to the strut attach arm at its outboard end before you start. Second, the fuselage is on its gear now, so of course you'll need to raise the wing higher. However, assuming that you have an adequate number of helpers (three others is probably about optimal), you may still want to keep those padded support stands handy and use them for security.

Bring the wing into position and secure the spar roots to the cage attach lugs, using the hardware specified in SECTION IX (see Figures 61 and 62 for the forward and aft spars, respectively). Unlike the initial wing installation, go ahead and install all the specified washers and safety pins at this time.

With the spar attach points taken care of, position the fuselage wing strut attach fitting around the fuselage strut attach lug and secure it there with the hardware called out in Figure 63 of SECTION IX.

Completed: Left [ ] Right [ ]

Step 95: Complete the Fuel Tank Vent Line Installation at the Wingtip

In the Systems Installation (Step 60), you routed the main tank vent line out to the tip through the leading edge section of the wing and installed the vent fitting in the aux tank. Now you will finalize the vent lines for both tanks and secure them to the tip.

From the supplied **1/4" O.D. nylon tubing**, cut an **18"** length for the aux vent. Insert a **nylon tubing connector insert** [320-0259-001 from Systems Installation] into one end of the tubing, slide the nut and sleeve from the male connector over the other end, and then tighten the nut on the connector body on the aux tank.

Drill a **1/4"** pass-through hole through the lower outboard wing skin and the lower flange of tip rib. As Figure 100 shows, this hole should be about **11-1/4" forward** of the trailing edge of the lower wing skin and centered from side-to-side on the rib flange. This hole location can be adjusted as necessary to clear any rivets, rib flange flutes or nut plates for the wing tip fairings.

Pass the vent line through the hole and secure it with a **1/4" nylon loop clamp** [450-0006-250] located on the rib web just above the lower flange. However, with the aux tank now in place, you no longer have any access to the inboard face of the rib web, so a **1/8" X 1/4" large-head blind rivet** [700-0004-004] must be used, as shown in Figure 100, Detail B. Position the loop clamp and drill a **#30** hole to accommodate the rivet.

Rout the main tank vent line in similar fashion and pass it through a hole drill in the rib flange approximately 5" aft of the front spar, again clearing any rivets, flutes or nutplates. Secure it to the rib using the same 1/4" nylon loop clamp and 1/8" rivet.

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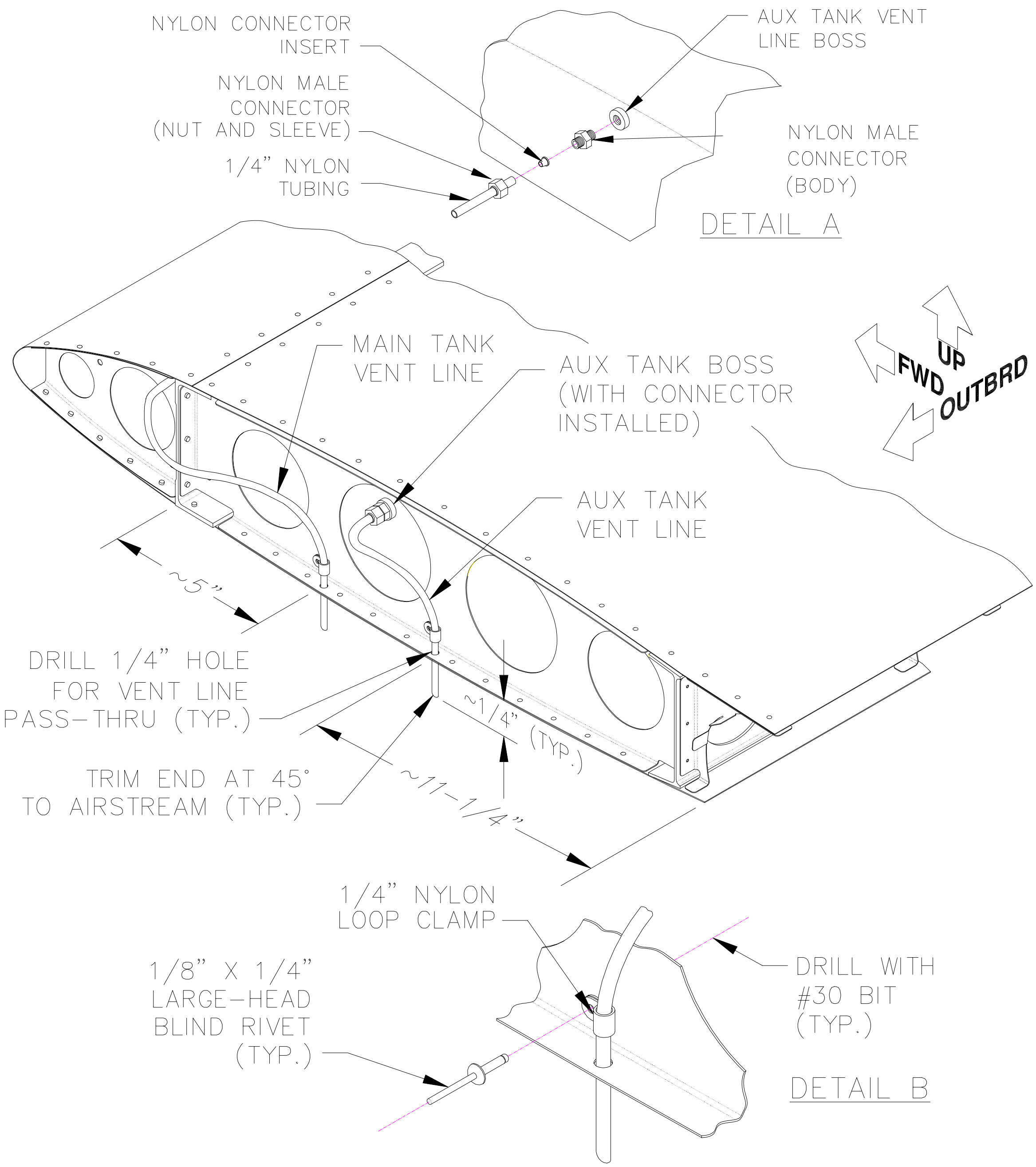


Figure 100: Securing the Vent Lines at the Wing Tip.

Step 96: Complete the Wing-to-Fuselage Fuel System Connections

Slip a 7/32"–5/8" hose clamp over the rubber hose; then very lightly grease the tubing end and push the hose over the header tank inlet until it's well past the bead. Move the hose clamp into position below the bead and tighten it.

Completed: Left [ ] Right [ ]

Step 97: Seam the Wingtip Fairing Halves Together

The fiberglass wingtip fairings consist of upper and lower halves which are seamed together with strips of fiberglass cloth. Use the procedures described in Step 1 of "SECTION VIII: FUSELAGE ASSEMBLY" to remove the mold lip along the edges of the **left** and **right upper** [40 and 41] and **left** and **right lower wingtip fairing halves** [38 and 39]. Sand just until the mold lip disappears.

Tape the upper and lower tip fairing halves of each pair together by stretching masking tape across their mating edges. Initially tape only from the trailing edges of the fairing halves to the aft end of the flat surface provided for the navigation light assembly on the upper half. To keep resin from leaking out, cover the entire length of this aft part of the seam with masking tape without leaving any gaps. **Don't apply any tape forward of the nav light mounting surface yet**. Use the masking tape as a hinge to fold the two fairing halves apart like opening a book; this will provide access for applying laminates to the narrow trailing edge portion of the seam on the inside of the fairing.

For each wingtip fairing, cut two pieces of bi-directional cloth on the 45° bias, one **1" X 54"** and one **1-1/2" X 54"**. Mix a batch of resin and laminate the 1"-wide ply first and then the 1-1/2"-wide ply in the taped area of the seam. Once the aft part of the seam has been saturated and while the laminates are still wet, carefully fold the two fairing halves closed and tape the rest of the seam with masking tape applied on the outside. Finish laminating the leading edge portion of the seam on the inside.

When the laminates reach the green cure condition, use a utility knife to trim them even with the ends of the fairing halves. Let the seam final-cure and then sand any remaining roughness at the trimmed ends.

Note Do not bond together the curved trailing edge portion at the aft end of the fairing at this time. By leaving this section unbonded, the aft end of the fairing can be adjusted up or down slightly to align with the aileron trailing edge. The fairing trailing edge will be bonded after establishing its proper position relative to the aileron.

Completed: Left [ ] Right [ ]

Step 98: Trim the Wingtip Fairings to Clear the Ailerons

As shown in Figure 101, scribe lines are molded into the tip fairing as guides for trimming clearance slots for the aileron (on both the upper and lower surfaces) and for the aileron counterweight (on the lower surface only). In this step, the fairings will be trimmed to clear the ailerons so they can be mounted on the wing.

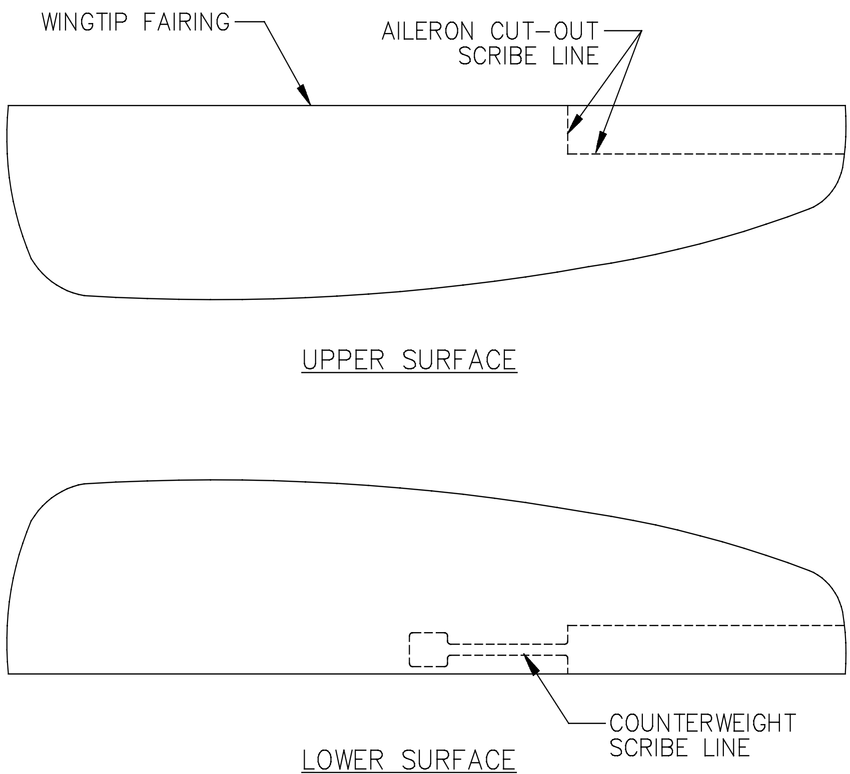
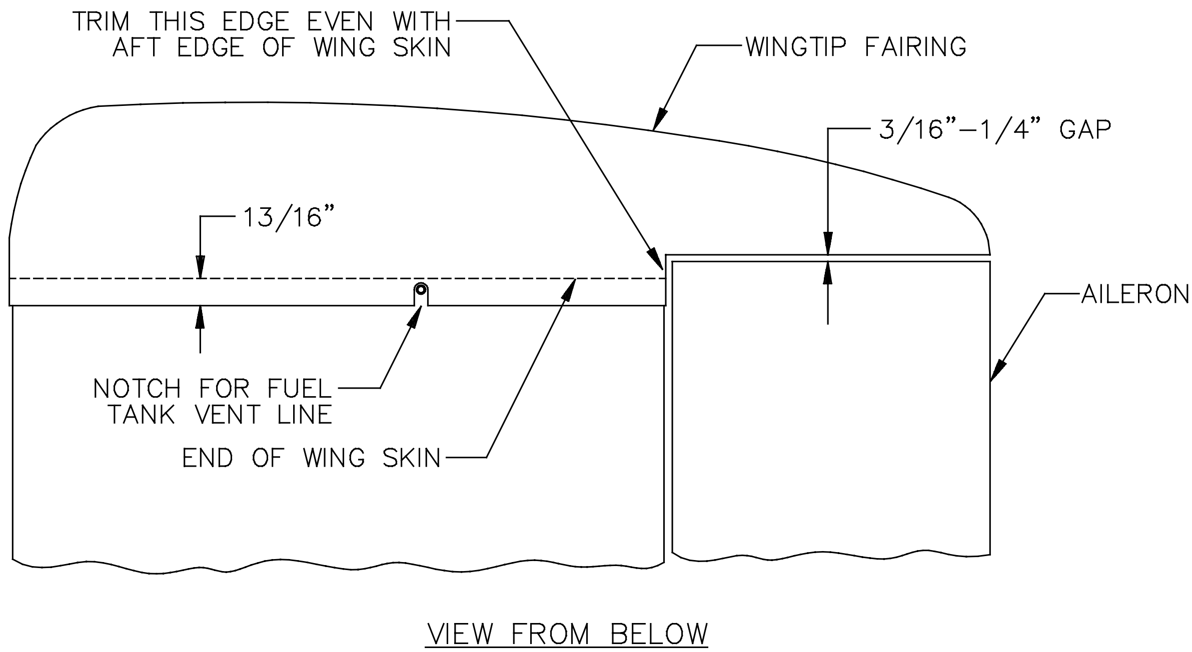


Figure 101: Wingtip Fairing Scribe Lines

The counterweight slots will be cut in a later step. As shown in Figure 102, mark lines on both the upper and lower surfaces of the wing parallel to and **13/16"** inboard of the outboard ends of the skins. Then, using the scribe lines as an initial, rough guide, open up the aileron cutouts until the fairing can be slid onto the end of the wing to the 13/16" line while maintaining a clearance from the end of the aileron of between **3/16"** and **1/4"**, as shown in Figure 102. At the same time, trim the forward ends of the cutouts until they're even with the aft edges of the wing skins on both the upper and lower surfaces, as shown. You'll also have to cut a notch in the lower inboard edge of the fairing to clear the fuel tank vent line; make the notch **3/8"** wide to provide 1/16" clearance all around the vent line. Remove the fairing when satisfied with its fit.

Completed: Left [ ] Right [ ]



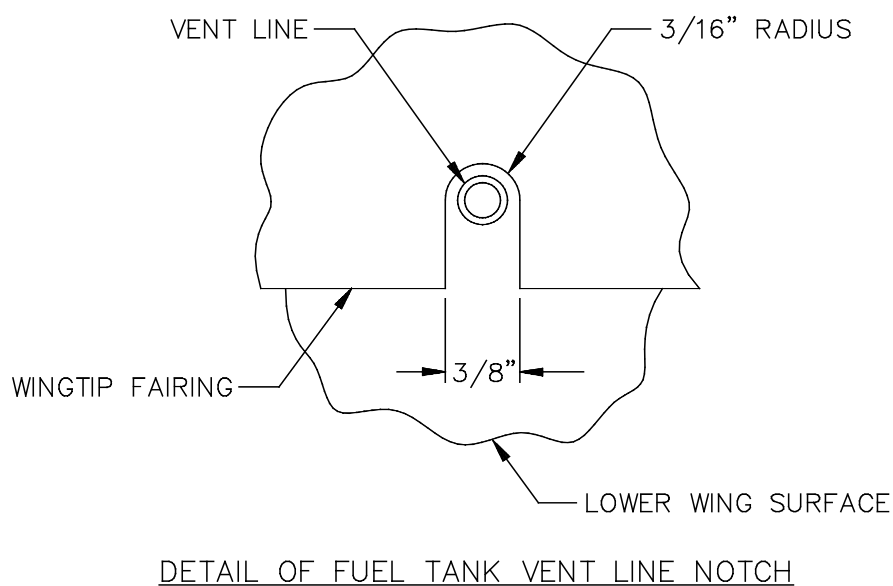


Figure 102: Trimming the Wingtip Fairing to Clear the Aileron and Fuel Tank Vent Line

Step 99: Install the Fairing Mounting Nutplates

Each wingtip fairing will be fastened to the end of the wing with ten AN526-8R7 round-head machine screws threaded into K1000-08 nutplates. Five fasteners will be used on the upper surface and five on the lower surface of each wingtip.

The holes for the fairing mounting screws will be centered on the Main Rib 6 rivet lines. Use a felt-tip pen to mark these lines on the outsides of the **wing skins**, top and bottom. Lay out five fairing mounting hole locations on each side along the lines just marked, positioned **approximately** as shown in Figure 103a: the forward-most locations are about **3"** forward of the split line between the leading edge and main skins, and the rest are spaced about **6"** apart, except for the aft-most ones, which are spaced about **4-1/2"** on the upper surface and about **3-1/2"** on the lower surface from the next ones forward. Position the hole locations so that the nutplates, when installed, will not interfere with existing wing skin rivets, rib flutes or spar flanges. (Since the nutplates are about 1" long, the hole locations must be spaced a minimum of 1/2" from any obstruction.) Make the hole location marks long enough (continuing them inboard past the 13/16" fairing edge line) so that they will be visible when the tip fairing is installed.

Next, on the **wing**, measure the distance from the 13/16" fairing edge line to the Main Rib 6 rivet line, labeled "X" in Figure 103b. Mark lines on the **tip fairing** this same distance from the inboard edge on both the top and the bottom surfaces; these lines will be the centerlines of the fastener holes. (The lines will be about 1/2" outboard of the fairing's inboard edges, but measure as instructed, just to be certain).

Install the fairing on the end of the wing with its inboard edges on the 13/16" reference lines on the wing. Push aft on the leading edge of the fairing to get a good, close fit. (You may find it necessary to grind down the seam laminates slightly at the leading edge of the fairing to help get a good fit). When satisfied, tape the fairing securely to the wing top and bottom. Transfer the hole location marks on the wing to the fastener centerlines on the fairing and drill through the fairing, wing skin and rib flange at each location with a **#19** bit. Insert 5/32" Clecos as you go to keep the fairing tight against the wing.

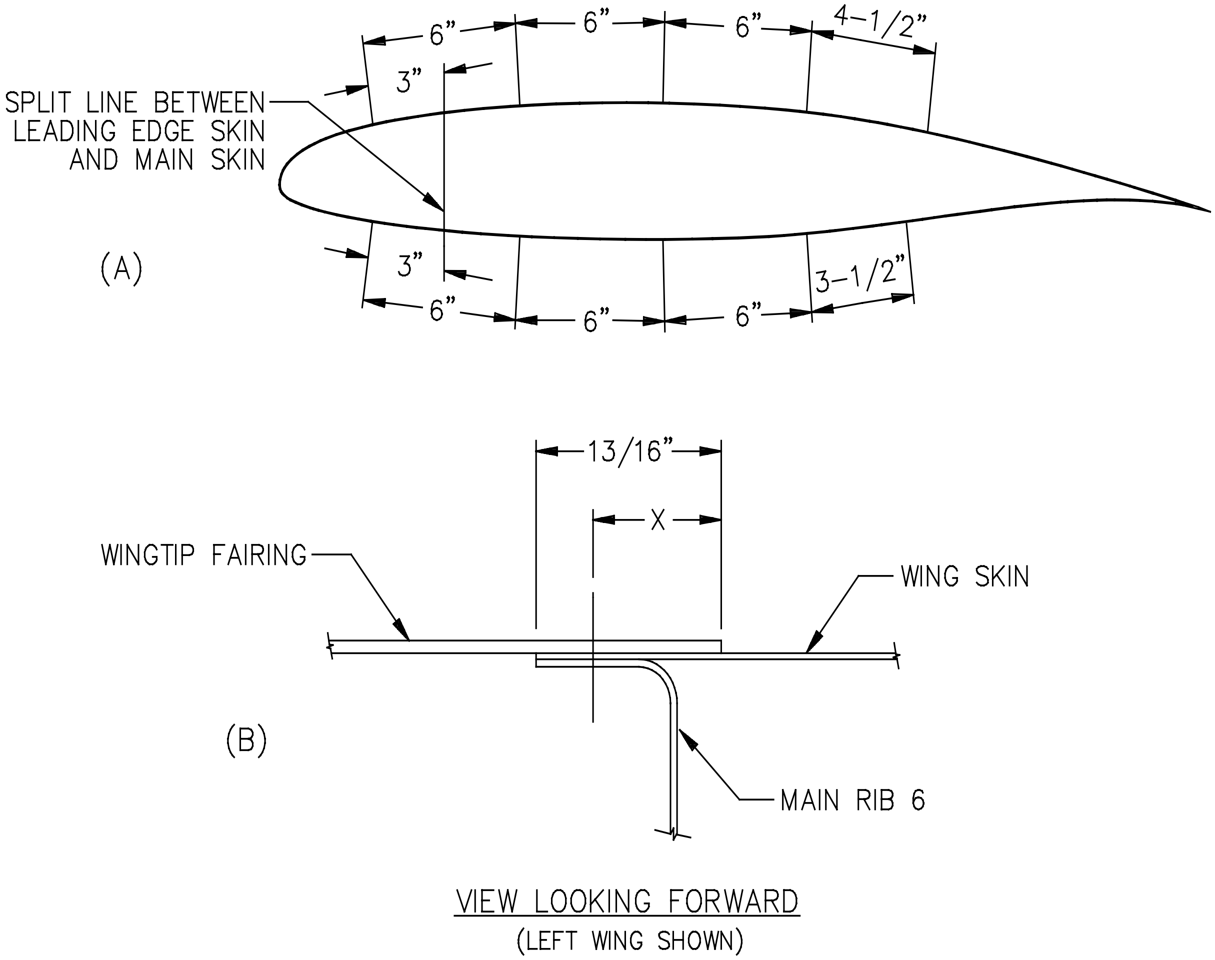


Figure 103: Marking the Fairing Mounting Screw Hole Locations

Remove the fairing and drill and deburr **#40** holes for the nutplate rivets in the wing skins and rib flanges, and then dimple the holes to accommodate 3/32" AN426AD3 flush-head rivets. The dimple die will easily dimple both the rib flange and the skin at the same time. For best results, you can also dimple the K1000-08 nutplates themselves, but you will probably have to grind one side of the female die to provide clearance for the nutplate centers.

Rivet the nutplates to the wing, and install the fairing temporarily with AN526-8R7 screws.

Completed: Left [ ] Right [ ]

Nav/Strobe Light Option Kit A mounting surface has been provided on the outboard side of the tip fairing for the Whelen 3-way wingtip light assembly supplied with Glasair Aviation, LLC's Nav/Strobe Light Option Kit. If you are installing the Nav/Strobe Light Option, you can mount the light assemblies at this time and complete the routing of the wiring to the wingtip. **Turn to the option instructions now.** Return to Step 102 of this *Assembly Manual* when the specified option steps have been completed.

☞

Step 100: Bond the Trailing Edges of the Fairings Together

Now it's time to finish the wingtip fairings by bonding their trailing edges together. Prepare by setting the ailerons in their neutral position, with their trailing edges even with the flap trailing edges. Then mix a small batch of thick resin/mill fiber mixture to bond the curved portion of the tip fairing trailing edge together. Pry the trailing edge of the fairing apart (removing one or two mounting screws to permit this, if necessary) and apply a small bead of the mill fiber mixture between the surfaces at the trailing edge. Place the fairing trailing edges back together and adjust them up or down to align with the aileron trailing edge. Drill a **#40** hole or two through both fairing halves near the inboard end of the trailing edge and insert Clecos to help hold the trailing edge in position relative to the aileron. Elsewhere, use masking tape to hold the fairing trailing edge together while the mill fiber mixture cures, or use very light clamping pressure with Cleco side-grip clamps or small C-clamps.

After the trailing-edge bonds have cured, remove the wingtip fairings and set them aside. You'll further trim them for final installation in the "CONTROL SURFACE BALANCING AND FAIRING INSTALLATION" sub-section when you install the aileron counterweights. If you wish, you can fill any Cleco holes now with body filler and sand smooth.

Completed: Left [ ] Right [ ]

Door Installation

In this sub-section, you will mount both the cabin doors and the baggage door. Since the fiberglass fuselage shell flexes slightly when the fuselage is under load, we recommend waiting until the engine and wings are mounted on the fuselage and on its gear before fitting the doors. Otherwise, you might fit the doors precisely to the shell only to find that gaps open up around the doors or—even worse—that the doors won't close properly when the airplane is completed.

Procedures for mounting the **left** [13] and **right cabin doors** [14] are identical. Unless otherwise specified, the following text and illustrations refer to the left door.

Step 101: Mark Reference Lines on the Fuselage Shell and Cabin Door

The first step in installing the cabin door is to mark the hinge line on the fuselage shell. As shown in Figure 104, this line should be marked parallel to and about **1/8 to 1/4"** forward of the forward edge of the door cutout. Use a straightedge to mark the line.

Mark on the outside of the shell the outlines of the two steel hinge-mounting plates on the fuselage cage. Be as accurate as possible since miss drilling a hole may make it difficult or impossible to install the nuts. They are approximately 10" apart. Mark also the outline of the tubes that are in the vicinity.

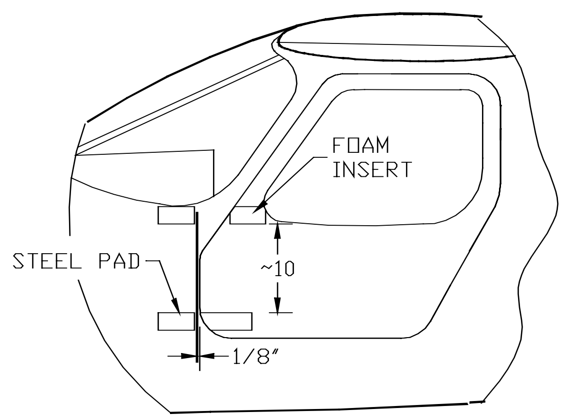


Figure 104: Main Door Hinge Locations

Finally, use the same informal technique to mark the outlines of the foam hinge-mounting hardpoints on the outside of the door.

Completed: Left [ ] Right [ ]

Step 102: Install the Door Seal

The rubber **door seal** [102] requires clearance all the way around the door between the flange of the fuselage door cutout and the inside edge of the door frame. The door cutout flange is factory trimmed at 1/2" in height. This clearance gap can acceptably be anywhere from **1/8"** to **1/4"** wide, but **3/16"** is optimal, as shown in Figure 105.

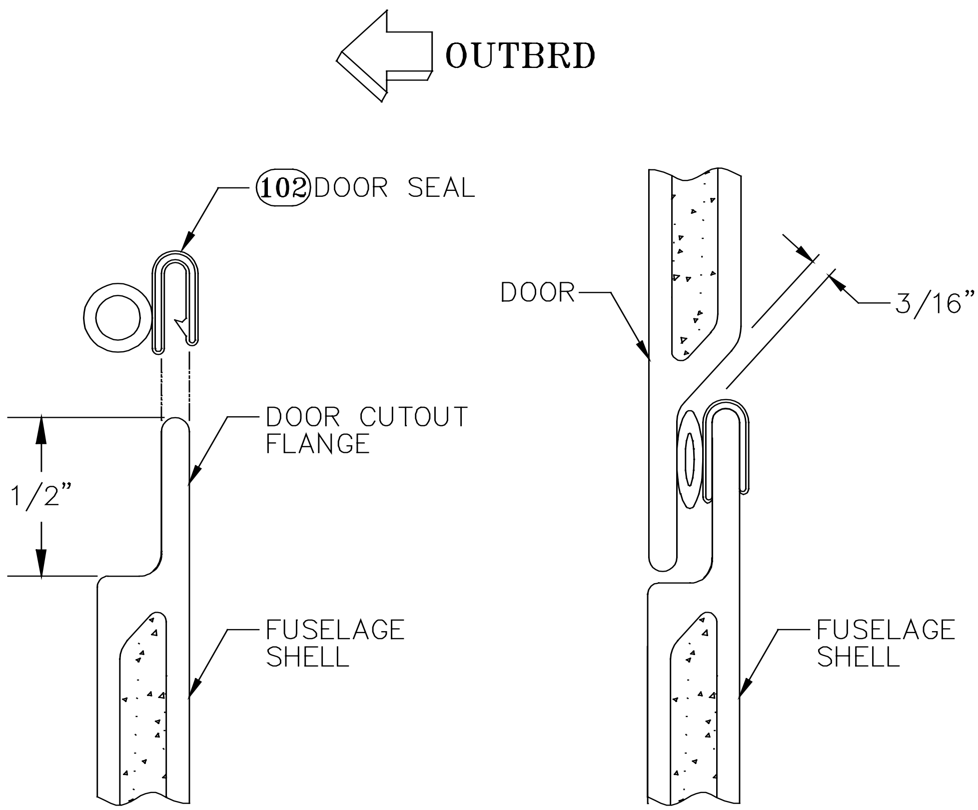


Figure 105: Installing the Door Seal

The door seal is very flexible and can be stretched or compressed significantly during installation. The idea is to compress the seal as much as you can during installation so that a gap won't open up should the seal contract later.

Cut the supplied door seal into two **10'** lengths and one **8'-7"** length for the cabin doors and the baggage door, respectively. Starting at the **bottom, aft corner** of the cabin door cutout, press the seal over the cutout flange, as shown in Figure 105.

Work the seal onto the flange all the way around the cutout, all the while compressing the seal **lengthwise** as much as you can. (It doesn't matter whether you go forward or aft from your starting point.) When you've installed the seal all the way around the door, let the end hang loose inside the fuselage and trial fit the door. If there are areas where the seal interferes with the door, remove the door, pull the seal away and sand the fuselage flange as necessary until the door fits cleanly with the seal in place. An additional 1/16" can be sanded from the flange around the circumference if necessary. It is ideal to have a slight gap around both sides of the bulb to allow for compression.

When you're satisfied, you can cut off the excess seal, However, do **not** cut the seal right at the point where the ends appear to meet. Instead, cut it off about **2" longer** than seems necessary. Then, go around the perimeter of the door again, seating the seal down onto the flange and compressing it lengthwise as you did in the initial installation until the excess length is taken up and the two ends fit snugly together. Our experience has been that if this extra round of compressing is omitted, a gap will inevitably appear later between the ends of the seal, even if they seemed to fit perfectly on initial installation. Pay particular attention to the corners of the door, where it's easy to inadvertently pull the seal away from the flange. If you get to a point where you absolutely cannot compress the seal any further and some excess length remains, go ahead and trim that off, but **compress it as much as possible** first!

> **Note** When the airplane is finished and painted, you can secure the seal to the flange with Silpruf or other similar adhesive.
>
> If you happen to cut the door seal short, stretch it out between two people with a firm pull. A permanent set in the seal can be made which will stretch the length a considerable amount.

Completed: Left [ ] Right [ ]

Step 103: Fit the Door to the Cutout and Temporarily Secure It in Place

The cabin doors are trimmed slightly oversize at the factory. However, final sanding of the door to achieve the precision of fit you want is best left until after the hinges and latches have been installed. For now, simply overlap the edges of the doors onto the exterior of the fuselage shell.

Position the doors in the cutouts so that any gaps between the edges of the doors and the edges of the seals are equalized all the way around, and then tape them securely in place on the exterior with wide masking tape. Apply the tape around the entire perimeter of the door, except for the forward edge where the hinges will be mounted. Extend the WL 100 line across the door to aid in marking the hinge locations parallel to waterline.

Completed: Left [ ] Right [ ]

Step 104: Assemble the Hinges

Each door has an upper and a lower hinge consisting of a forward and an aft half. The first step in assembling the hinges is to press NAS75-3-004 **plain steel bushings** [169] into the pivot holes of **all** the **door hinge halves**: the **aft lower left** [15] and **right** [16], the **aft upper left** [17] and **right** [18], and the **forward left** [19] and **right** [20].

Next, pair the hinge halves off as shown in Figure 106. Note that the aft **upper** halves (Figure 106a) are longer than the aft **lower** halves (Figure 106b), while the two forward halves are identical. Also note that the left and right are distinguished by the off-center positions of the horizontal flanges—**high** on the **aft** halves and **low** on the **forward** halves. Take care to ensure that you have paired all the halves correctly.

Both hinges are assembled with identical hardware, which is shown in Figure 105a; insert a **small nylon washer** [80] between the halves and secure the parts with an AN3-6A **bolt** [115], an AN364-1032A nylon self-locking nut and an AN960D10 **aluminum washer** [152] under both the bolt head and the nut. Tighten the nut until the hinge halves snug down against the nylon washer but **not** to the point that the washer is compressed between the halves.

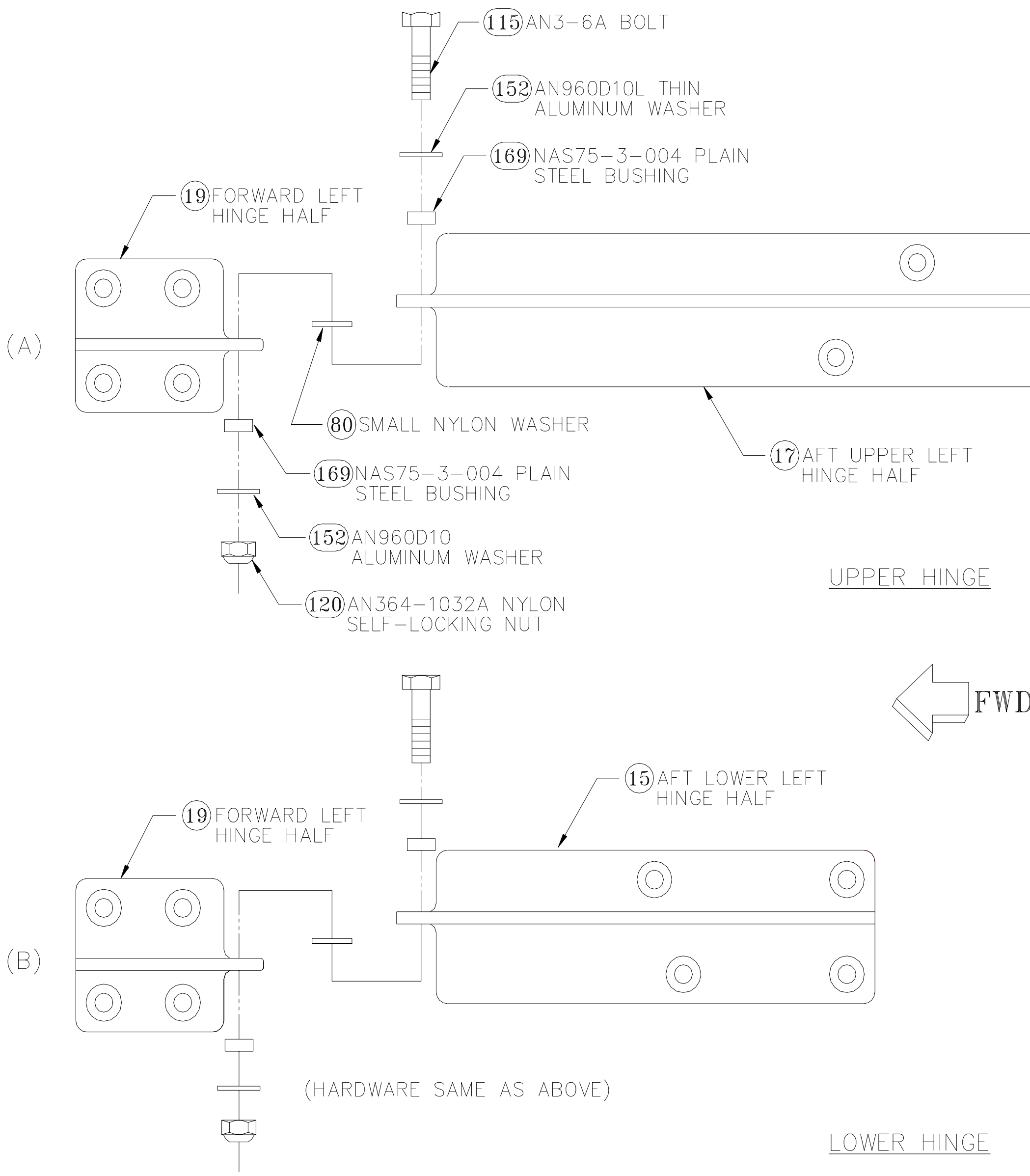


Figure 106: Assembling the Hinges, Left Hand Shown

Step 105: Position and Drill the Hinges

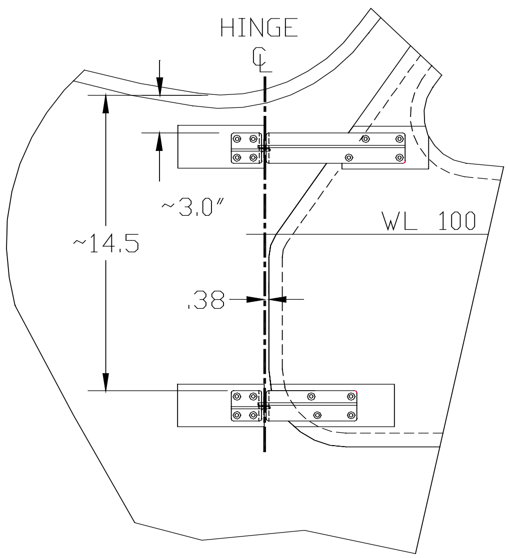


Figure 107: Locating the Hinges

As shown in Figure 107, the hinges are positioned with reference to the marked hinge line, measuring to make sure they are parallel to waterline. Hold the upper hinge against the door and fuselage roughly centered in the mounting area outlines you marked earlier and with the hinge bolt centered over the hinge line. When properly positioned, the forward, upper corner of the hinge should be about **3"** below the edge of the windshield flange in the shell, as shown in the figure. Verify you location by measuring down from the flange edge to the steel backup plates on the inside. When you're satisfied, mark along the upper edge of the hinge assembly onto the outside of both the door and the fuselage. Verify your screw positions are in good locations. The hinge centerline ideally is located approximately 3/8" forward of the door opening edge.

Repeat the process to mark the location of the lower hinge. This time mark along the lower edge of the hinge assembly, being sure to mark both the fuselage and the door.

Note: Position the hinge so you get the best fit on the hinge plates. It may have occurred to you that the pivot axes of the two hinges will not be perfectly aligned when the hinges are mounted flat on the fuselage sides, because the sides of the fuselage aren't strictly flat. However, the misalignment involved is quite minor, and the hinges can tolerate it without any binding. Try to center the hole location of the upper, aft hinge half in relation to the beveled foam edge on the door interior. If you wish, measure and make the foam outline with a dotted line as shown. The fit will be very tight and the hinge can only be lowered so far, otherwise the forward, upper hinge bolt will miss the steel back-up plate.

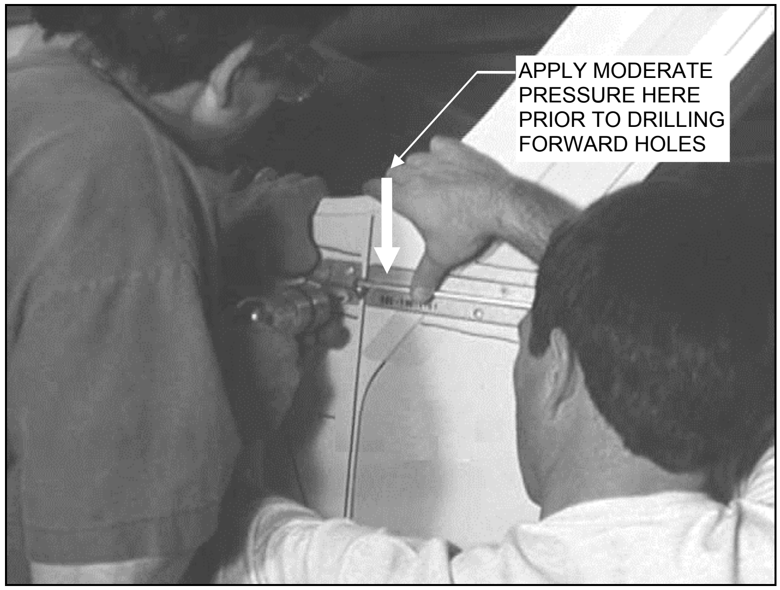


Figure 108: Drilling the Hinge Mounting Holes

As Figure 108 shows, it's a good idea to have a helper assist you in holding the hinges in position while drilling the mounting holes. Be careful, as always, to drill square to the mounting surface. For each hinge, begin with a couple holes through the **aft** hinge half into the door. Drill these holes **all the way through the door** with a **#10** bit, and then insert AN509-10R20 **flush-head machine screws** [136]. Temporarily secure these screws with AN960-10L thin washers and AN315-3R **jam nuts** [117].

Next, drill a couple **#10** holes through the forward half of each hinge, the fuselage shell and each cage mounting plate. Insert AN509-10R18 **flush-head machine screws** [135] in these holes and temporarily secure them just as you did the aft pair.

Caution When drilling these holes, take great care to hold the drill steady. It's easy to inadvertently enlarge the holes through the fiberglass while drilling through the steel mounting plates. Install a metal backup plate to keep from inadvertently drilling through the upper hinge plate and into a cage tube.

Hint Before drilling these holes, apply moderate **downward** pressure on the forward hinge half as indicated by the bold arrow in Figure 102. This slight "pre-load" will help offset sagging over time from the weight of the door.

Note There is a gap between the fuselage shell and the mounting plates that you will fill shortly with resin/Q-cell mixture. For now, avoid tightening the nuts on the temporary screws through the forward hinge halves more than finger tight; over-tightening them risks permanently deforming the shell.

With two holes and two screws in each half of each hinge, go ahead and drill the remaining holes in all four hinge halves.

Warning When drilling the **aft** two holes through the **forward** half of the **lower** hinge, be very careful that your drill bit doesn't contact the cage tube that lies behind the mounting plate. If it is nicked, its structural integrity could be compromised. Use a drill stop or place a block of wood inside the mounting plate to prevent this.

After the holes have been drilled, label each half of both hinges so that they can be reunited with their mates after disassembly. Then remove the hinges from the fuselage and the door and separate the halves. On all kits shipped through December 2004, the internal nuts for the door hinges use 061-00001-01 Acorn Nuts [64] and AN936A10 lock washers [144] described on page 227. On kits shipped after January 2005, the hinge bolts are secured with Shur-Lok nuts potted inside the door frame. Step 110.1 describes this procedure on page 220.

Completed: Left [ ] Right [ ]

Step 106: Install the Forward Hinge Halves

You can now fill the gap between the fuselage shell and the upper and lower cage mounting plates with thick-mix Q-cell. Apply masking tape across the gap along the side and bottom of each plate to help retain the mixture while it cures. Mix up a very thick batch of Q-cell and pack it into the spaces between the shell and the plates. Clean up any excess Q-cell, leaving a nice fillet along the top edge of each plate.

After the Q-cell is in place but before it starts to cure, replace the forward hinge halves, inserting their mounting screws through the Q-cell. Clean up excess Q-cell that is displaced inboard of the plates by the screws, and then secure them permanently with the washers you used before and AN364-1032A nylon self-locking nuts. Just tighten the nuts until they are snug against the plates. After the Q-cell has cured completely, tighten the nuts firmly.

Completed: Left [ ] Right [ ]

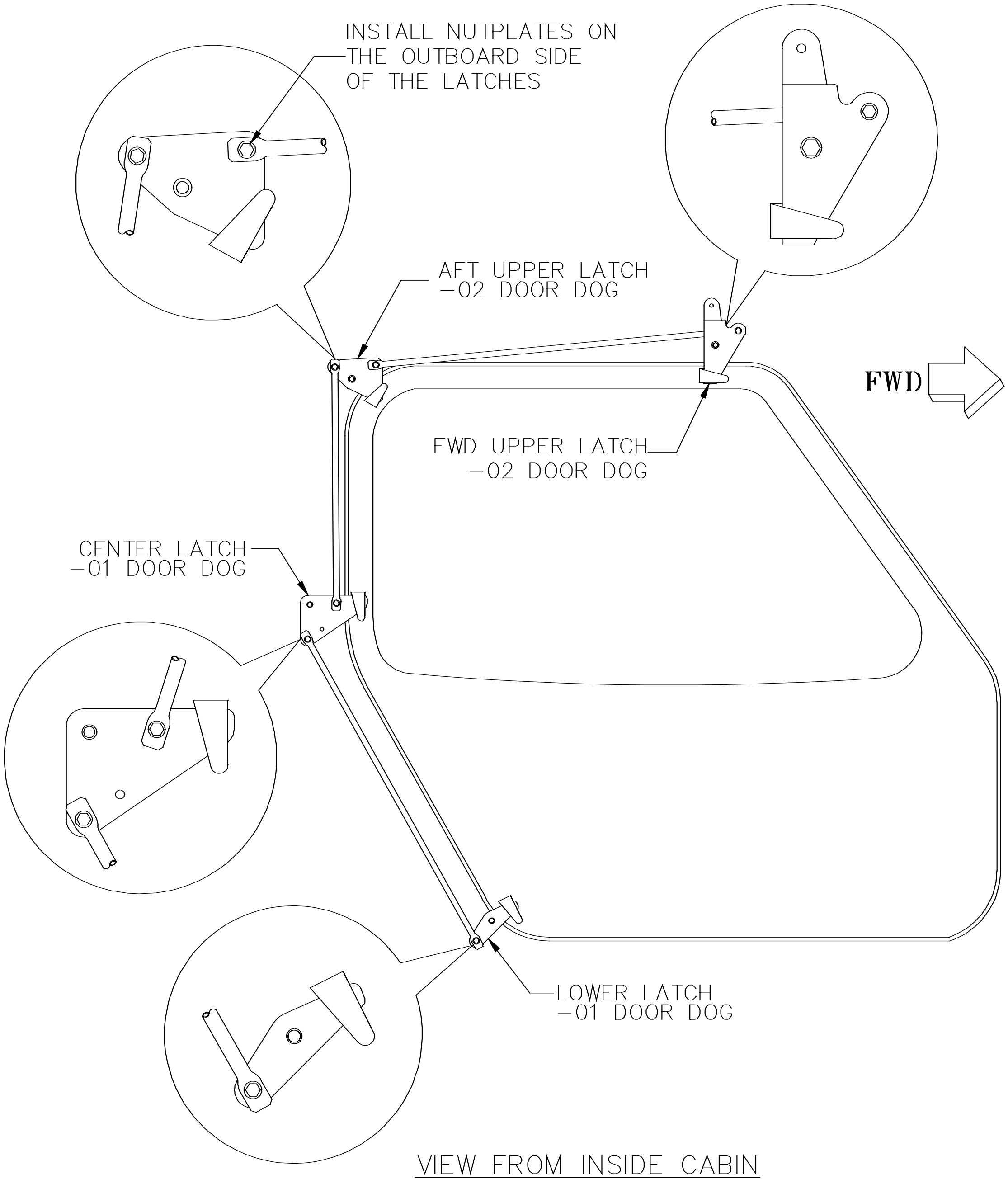


Figure 109: Door Latch and Pushrod Layout. Nutplates are installed on the outboard side of the three aft latches where each pushrod attaches.

Step 107: Fabricate the Door Latches and Dogs

The door latch system in the Sportsman consists of four latch plates attached to each side of the cage. Interconnected by pushrods, these latches engage four dogs that are attached to each door. Figure 109 shows the general arrangement of the latches and pushrods.

Because they are somewhat more complex parts, the **left** [27] and **right forward upper** [28] and **left** [29] and **right center door latches** [30] have been manufactured for you. The upper aft and lower forward latches, however, are simple aluminum shapes, and are therefore left to you to fabricate. Likewise, the eight door dogs must also be cut from sheet metal—stainless steel in this case.

Full-sized templates for each of these builder-fabricated parts are given in Figure 110. Cut **two aft upper** and **two lower** door latches from the **.12" X 3" X 10" aluminum sheet** [71] and cut **eight** dogs from the **.090" X 3/4" X 24" stainless steel sheet** [74]. Although the left- and right-hand parts will be distinguished later, they are identical at this stage. Use a bandsaw or scroll saw to cut out the shapes, and then files and/or a belt sander to smooth the cut edges.

> **Note** The stainless will require a fine-toothed, metal-cutting blade. The 1/4" diameter pivot holes should ideally be drilled undersize and reamed to .250" to minimize wobble.

Using a center punch driven through the templates, mark the holes locations shown on one of the upper aft and one of the lower forward latches. Then stack the latches of each type together in pairs and drill all the holes, using the bit sizes specified on the templates. Deburr all the holes thoroughly.

Fabricate a 1.0-1.25 diameter round or octagonal shape 1/4" thick doubler from scrap material to rivet to the upper door latch on the **inside face**. The extra thickness offers more bearing surface and tends to make the latch stiffer thus eliminating wobble.

The door dogs also require some holes. With a #30 bit, drill six holes in the square end of each dog. The spacing of these holes is not critical—their purpose is simply to aid in bonding the dogs to the door frame. **Complete: [ ]**

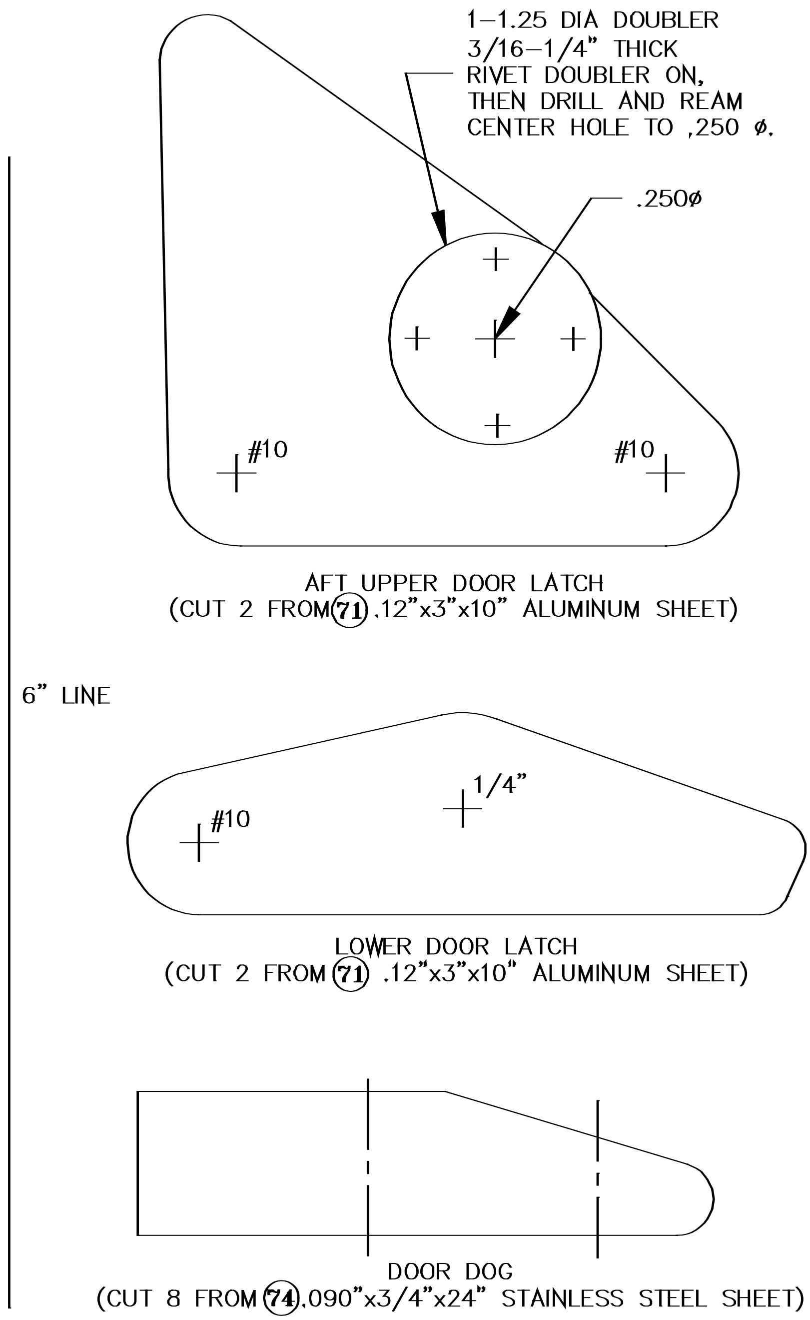


Figure 110: Templates for the Builder-Fabricated Door Latches and Dogs (Full Size)

Step 108: Install Shoes on the Ends of the Latches and Rivet the Upper Latch Doubler.

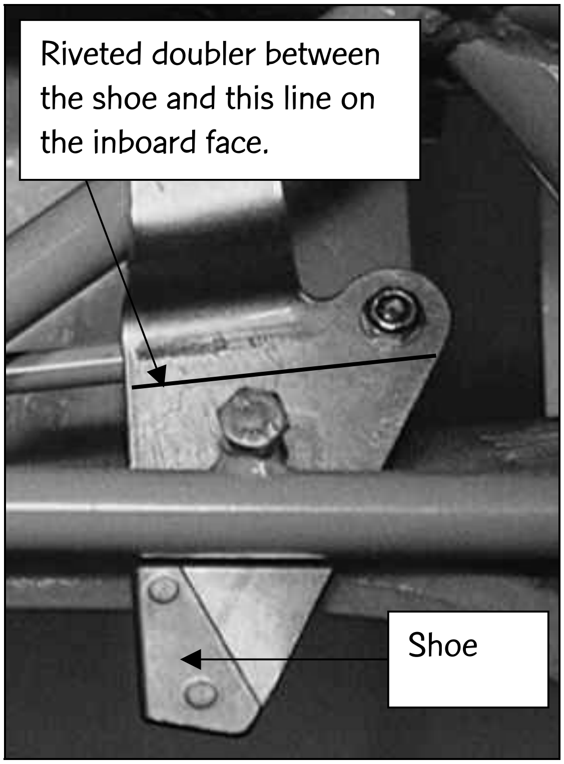


Figure 111: Door Latch Shoe

As mentioned previously, the latches engage dogs to secure the doors. Three of the latches—both uppers and the lower—are aluminum, and over time, these latches will wear somewhat against the stainless steel dogs. It is recommended to provide extra wear protection to these parts in the form of small shoes of a more durable material riveted onto the bearing surfaces of the latches.

Figure 111 shows the approach to this problem employed by most GlaStar builders. Small scraps of leftover .016"-thick stainless from the firewall were trimmed and bent to go around the engagement edge of the latch.

The latch was then countersunk and the shoe dimpled **on both sides** for a pair of flush-head rivets. The double countersink allows the rivets to be set essentially flush on both sides of the latch. Use shorter than standard rivet lengths for these. Refer to Figure 109 to determine which edge the shoe should be placed on.

The upper forward latches [27 & 28 shown in Figure 111] function best if a doubler is riveted to them on the **inboard face of the latch**. This will increase the thickness of the latch from the area of the shoe up to a point above the pivot bolt. Use any .06 aluminum remnant and rivet it to the upper latch. Make note of where the shoe will be riveted to the latch and incorporate those two holes into the rivet pattern. Three rivets across the top and three below the pivot bolt (counting the two in the shoe) will be plenty. Take care to trial fit the shoes to the latches, and deburr before riveting.

Completed: Left [ ] Right [ ]

Step 109: Install Pushrod Nutplates on the Latches

As shown in Figure 109, three aluminum pushrods connect the four latches so they all move together. These push rods are connected to the latches with bolts that are fixed to **single lug nutplates** [195]. A total of six nutplates are used per each side and are installed on the outboard faces of the three aft latches. One nutplate is used on the inboard face of the upper forward latch. The other five are attached to the outboard faces of the latches at the appropriate locations shown in the enlarged details in Figure 109.

Install the nutplates at this time as shown in Figure 121. Make sure you countersink and use flush head rivets on the side where the pushrods go.

Completed: Left [ ] Right [ ]

Note Figure 112 deleted.

Step 110: Install the Latches on the Cage

The two upper latches and the lower latch are all installed with AN4 bolts inserted through steel bushings that are welded to the fuselage cage. Refer to Figure 113 for the locations of these bushings.

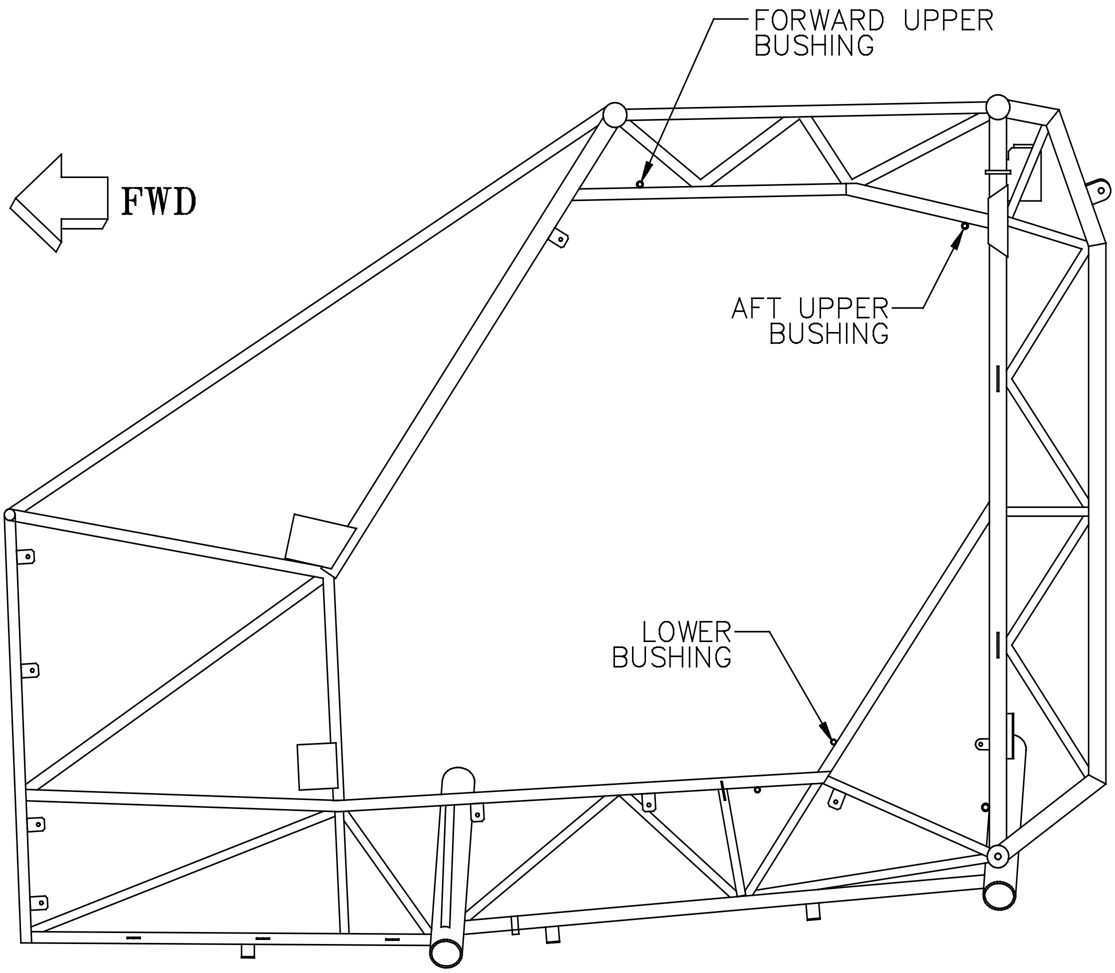


Figure 113: Locations of the Door Latch Bushings

Figure 114 shows the general installation method for all three of these latches. (The center latch is handled somewhat differently, as detailed below.) Each latch is installed **outboard** of its respective cage bushing, with the bolt inserted from the **inboard** side. One or more washers are used between the bushing and the latch to position it the proper distance from the door seal; aim for a gap of about **1/8"**, as shown in Figure 114.

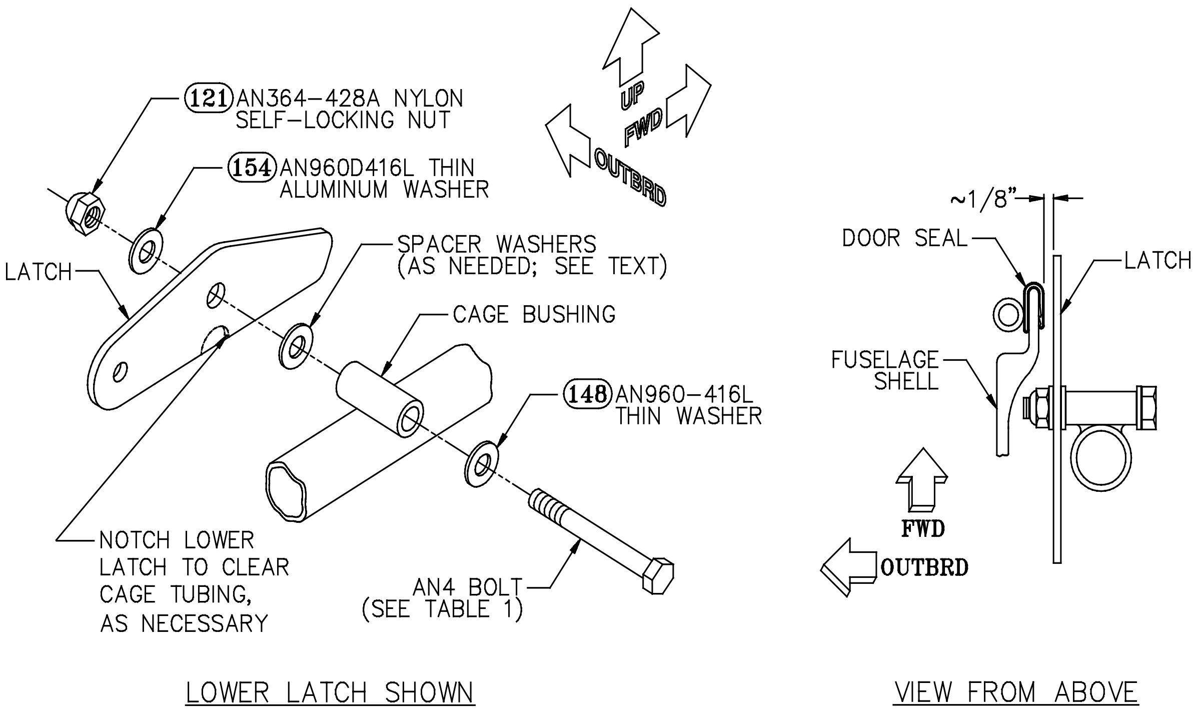


Figure 114: A Typical Latch Installation

Because of variations in the relative positions of cages and fuselage shells, it's impossible to specify the exact washer stack-up you will need between the outboard end of the bushing and the latch in order to achieve this spacing. You can use any combination of thick and thin washers, and you can use a mix of aluminum and steel washers, as necessary. However, there are a couple general principles to observe in any case. First, you must use **at least** one **steel** washer against the cage bushing, be it an AN960-416, standard-thickness washer or a
-416L thin washer. Second, if you need more than one washer, it's more desirable to use **aluminum washers**—either AN960D416 standard [153] or D416L **thin** [154]—outboard of the first steel washer. Experiment with different combinations as necessary to achieve the desired 1/8" gap for each individual latch. Finally, it may be necessary in some cases to **remove** material from the outboard end of the bushing; these cases still require a steel washer between bushing and latch, however.

Before you install the **lower latch**, notch its lower edge as necessary to clear the fuselage cage tubing, as shown in Figure 114. To determine how big a notch to cut, look ahead to Figures 117 and 125, which show the latch's latched position and which way it rotates.

Because the bushings are not all the same length and because of the variations mentioned above in cage-to-shell relationships, each latch will require a different length bolt. Table 1 gives the anticipated best size for each latch; however, it's possible that you will need to use bolts a size or two longer or shorter for one or more or your latches.

LATCH POSITION	BOLT
Forward upper	AN4-14A
Aft upper	AN4-26A
Lower	AN4-12A

Table 1: Latch Bolt Lengths

When you've determined your optimal washer stack-up and bolt length, mount the latches as shown in Figure 114. Apply a modest amount of axle grease to the bolts and the bearing surfaces of the washers and latches before assembly. Use AN364-428A nylon self-locking nuts to secure all the bolts. Tighten these nuts firmly, and then back them off about a quarter-turn to allow free rotation of the latches.

Figure 115 shows the proper orientations of the (a) forward upper, (b) aft upper and (c) lower latches, respectively, relative to the door cutout and cage structure. Refer to these photographs carefully to make sure you orient your latches properly.

> **Note** Figure 115 shows the left-hand latches; the right-hand are mirror images.

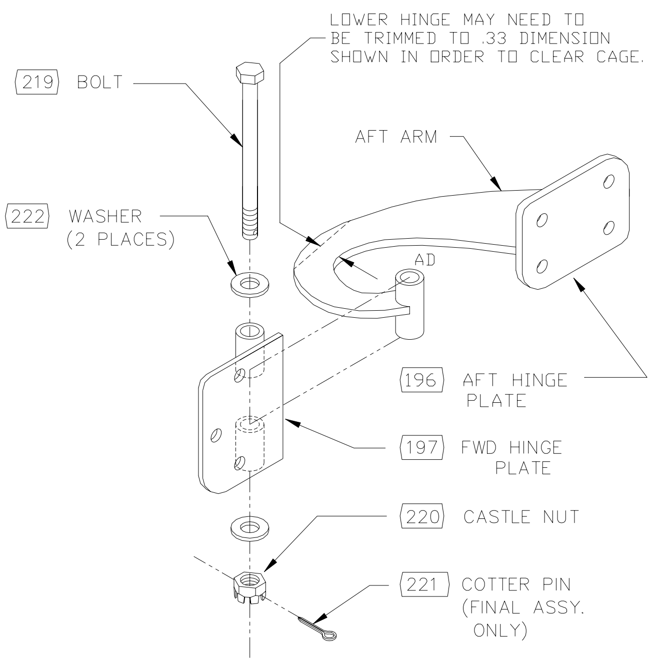
Now it's time to install the final latch—the center latch. This latch comes with a shaft welded to it that penetrates the fuselage side through the bushing you pressed into the upper shell attach fitting way back in "SECTION VIII: FUSELAGE ASSEMBLY." This shaft will be drilled to accommodate the exterior door handle in a subsequent step. Figure 116 shows the orientation of the left-hand lower aft latch; the right-hand latch is mirror image.

As with the other latches, shim washers must be inserted between the bushing and the latch to produce a gap of about **1/8"** between the outboard face of the latch and the door seal. In this case, however, **nylon** washers should be used. You should have an ample supply of these in both thin and thick varieties left over from shimming between the fuselage shell and the cage. In order to use these washers with the latch, you'll have to ream them with a **5/16**" drill bit. (Step 110 is continued on page 221)

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Page 220:

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.



Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Step 110.1: Installing Shur-Lok Nuts in the Doors

On kits shipped after January 2005, the main cabin aft door hinges are secured to the door using **Shur-Lok Nuts** [232] which are potted inside the door frame using a thick structural fill. Early kit owners may order these through Glasair Aviation.

1/2" to 9/16" diameter holes need to be counterbored from the **inside** of the door. The counterbore should extend right down to the exterior ply, so the Shur-Lok rests flush against the exterior plies. Be careful not to cut into the exterior plies. Use a 1/4" diameter die grinder and grind out the interior ply to the 1/2" diameter so the nut can pass through. The foam can be routed out to a larger diameter because it will be filled with the structural fill as shown in Figure 114.1.

Once all the holes are counterbored, insert the Shur-Loks and attach the door hinges to the exterior of the door and tighten the nuts just enough to keep them secure and tight against the exterior plies. Mix a thick batch of resin/cobosil/milled fiber and press the mixture into each hole filling all the voids. Allow the mixture to fully cure before removing the hinges.

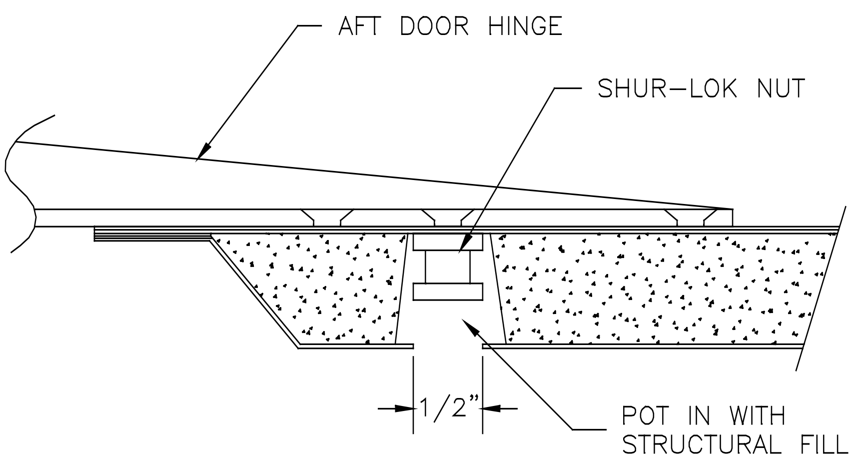
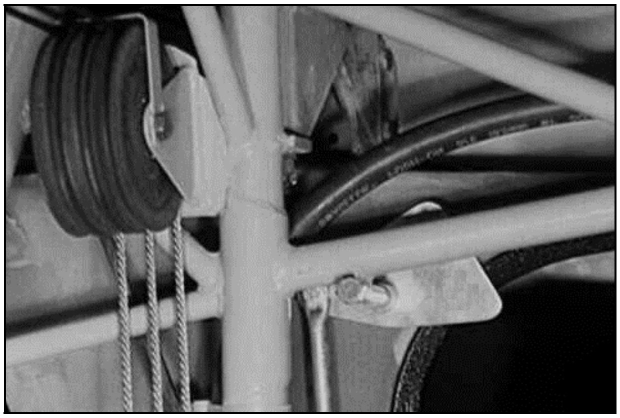
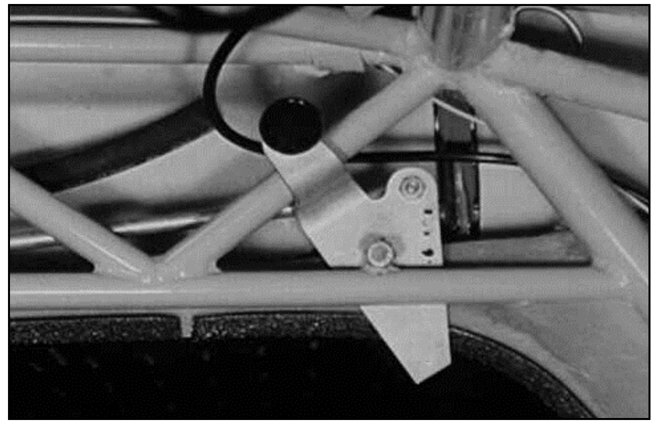


Figure 114.1: Installing the Shur-Lok Nuts in the Doors

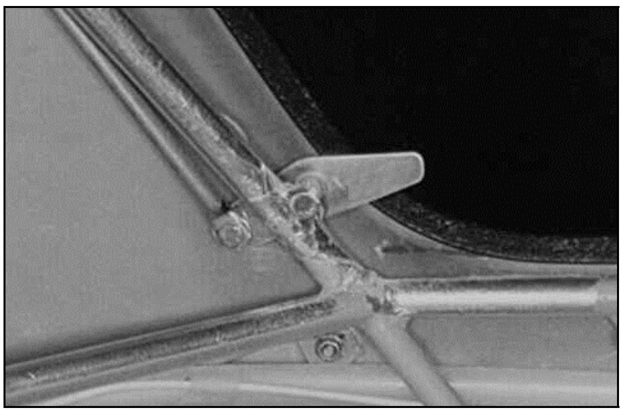
Step 110.1 Completed: Left [ ] Right [ ]



(b)



(a)



(c)

FWD ➡

Figure 115: Orientations of the Forward Upper, Aft Upper and Lower Door Latches

After you have inserted the shaft of the lower aft latch through the requisite number of washers and the upper shell attach fitting bushing, grab the end of the shaft outside the fuselage shell with a pair of vise-grip pliers to hold the latch tightly in place temporarily.

Completed: Left [ ] Right [ ]

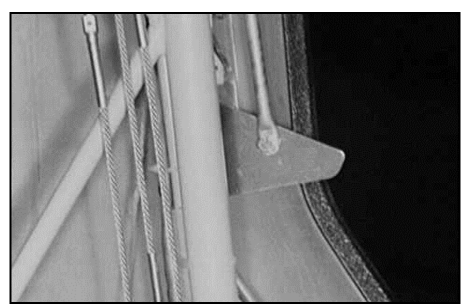


Figure 116: Orientation of the Center Door Latch

Step 111: Fabricate the Door Latch Pushrods

With all the latches in place, you can now make the pushrod linkages between them. These rods are made from **3/8" 6061-T6 aluminum tubing** [110], cut to the proper length and flattened on each end to accept a bolt. The first step, therefore is to determine the proper tubing lengths. This must be done for each pushrod individually. There are simply too many possible variations for us to successfully prescribe a rod length ahead of time, and in fact, you may find that—for instance—your left upper rod needs to be a slightly different length than your right upper rod. So don't take anything for granted; measure the required rod length for each of the six locations!

Prior to measuring, you need to position all the latches properly relative to one another. Figure 117 shows these orientations for the left-hand latches, using the edges of the door as references. There's no need to go to elaborate lengths in measuring these angles; since you'll locate the door dogs to match the latch positions, you can simply eyeball the latter with fine results. Secure the latches in position either with tape or by temporarily tightening the nuts on the pivot bolts.

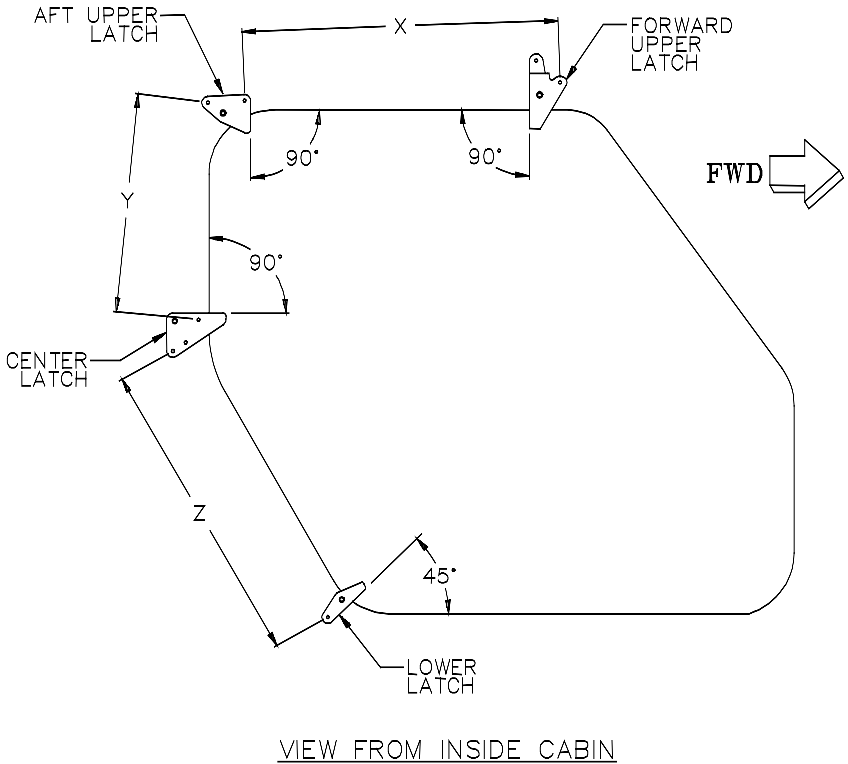


Figure 117: Measuring the Latch Pushrod Lengths

Now measure the straight-line distances between the centers of the pushrod holes on each latch, as indicated by Lines X, Y and Z in Figure 117. Take care to make sure you're using the proper holes for each rod.

Once you've determined X, Y and Z, **add 5/8" to each dimension to get the actual pushrod length**. Remember, you measured center-to-center distance; if you cut your rods to this length, you'll be embarrassed when it comes time to drill the bolt holes in the rods! (We've provided approximately 40" more tubing than is required, so you're allowed one such mistake, but not more!)

Hint Cut the longest rod first; that way, if you do make a mistake, you can still use the tubing for one of the shorter rods.

Having cut the rods to length, the next step is to flatten the ends for drilling. This is best done in a bench vise. However, if you use the square-edged jaws of a standard vise for this purpose, the jaws will bite into the tubing, perhaps to the point of cutting the end right off rather than simply flattening it as desired. To prevent this, make a pair of "soft" jaws like those shown in Figure 118. Simply sand or file a **1/8" radius** into the ends of a couple pieces of scrap aluminum angle. Tape these in place inside the jaws of your vise, and insert the tubing to be flattened into the rounded ends of the new jaws, as shown in the photograph. This will produce a nicely radiused, gradual bend in the tubing.

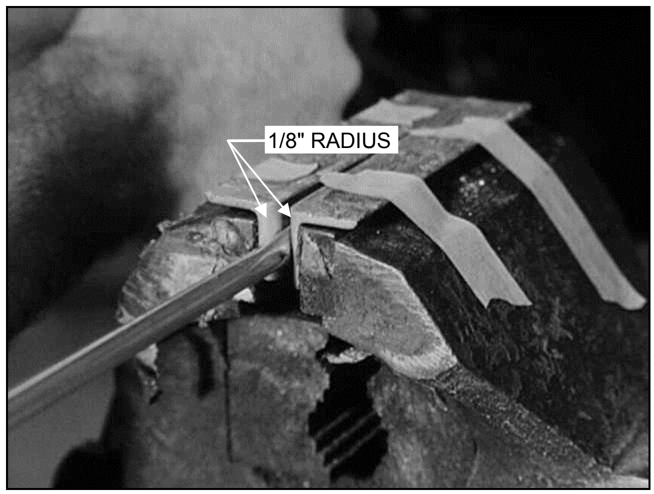


Figure 118: "Soft" Vise Jaws for Flattening Tubing

As shown in Figure 119, insert the end of a rod to be flattened **7/8"** beyond the **square** end of the jaws. This will produce a flat area about **3/4"** long. Tighten the vise until the tubing is completely collapsed.

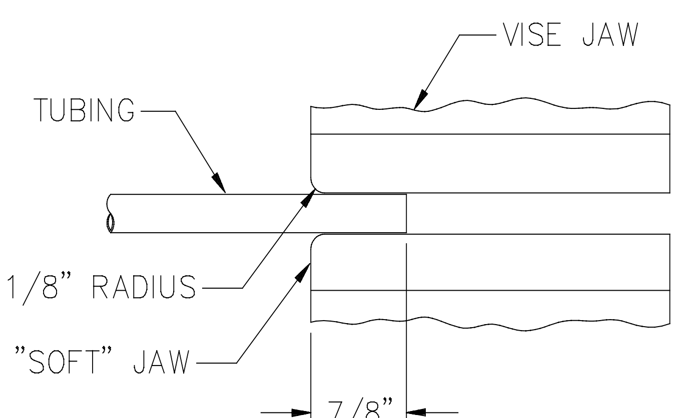
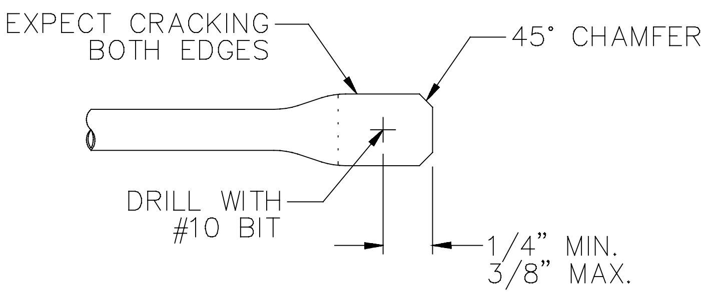


Figure 119: Flattening the Tubing

Note Flattening the first end of each rod is easy, but be absolutely certain that you flatten the other end **in the same plane** as the first one! In other words, make sure the already flattened end is **vertical** when you place the other end in the vise.

Note When you remove the flattened end from the vise, you'll probably notice that the edges of the flattened area have cracked slightly (see Figure 120). Don't worry about this. It's unavoidable and will not affect the strength or utility of the pushrods.

Once the rod ends are flattened, chamfer the corners at about 45° and smooth the cut ends, as shown in Figure 120. Then, using a **#10** bit, drill the bolt holes the ends of the rods, using the X, Y and Z dimensions measured earlier to determine the exact placement. As Figure 120 shows, be sure place the holes so as to maintain the proper edge distance specified in the figure.



Mark each pushrod as it's completed to make sure you can return it to its original position.

Completed: Left [ ]
Right [ ]

Figure 120: Finishing the Latch Pushrod Ends

Step 112: Install the Latch Pushrods

Install the pushrods between the latches using the hardware shown in Figure 121a: by inserting the AN3-4A bolts into the washers, pushrod and latch as shown. Be sure to use the thicker washer between the latch and the pushrod, and then check the final result to see that there is a minimum gap of about **1/16"** between the rod and the latch, as shown in Figure 121b. If necessary, use additional thin aluminum washers to shim the rod away from the latch.

As with the installation of the latches themselves, lightly grease the bearing surfaces of all the parts prior to assembly.

Note All the pushrods go on the **inboard** side of the latches, as shown in Figure 121, with the exception of the upper pushrod where it attaches to the forward upper latch; **only** this end should be secured **outboard** of the latch.

Completed: Left [ ] Right [ ]

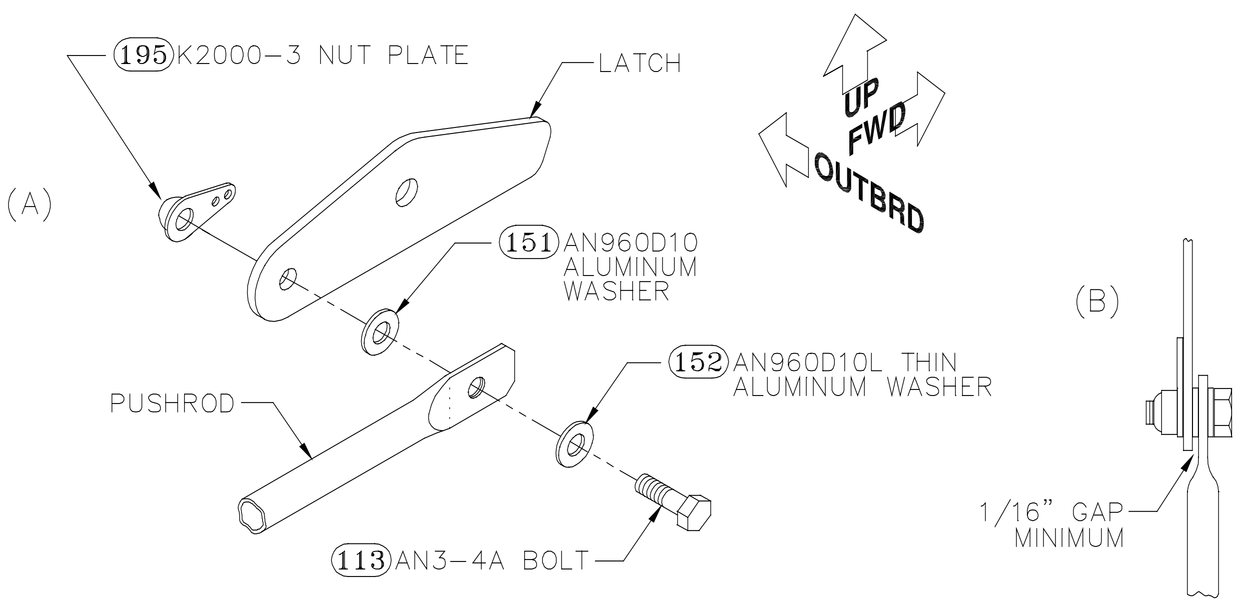


Figure 121: A Typical Pushrod Installation

Step 113: Bend the Door Dogs

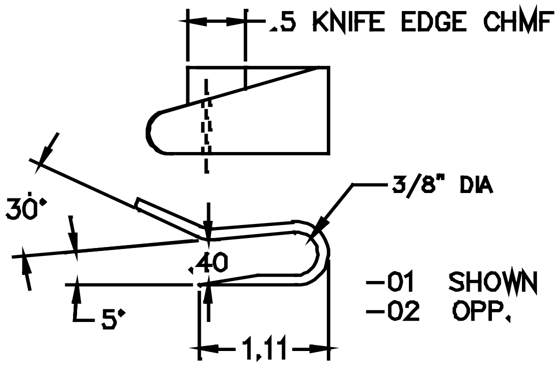


Figure 122: Dog Specifications

Now it's time to return to the stainless steel door dogs. As shown in Figure 122, the flat shapes you cut out earlier must be bent over on themselves to form catches that will capture the latches when they are rotated by the door handle. The bent dogs are then bonded to the door frame.

As shown in the figure, the dog blanks should be bent over a **3/16"**-radius just over **180°**. Then, the last **5/8"** or so of the narrow end should be bent back away from the square end at about a **30°** angle to provide a ramp to capture the latch. (Note the bend lines in Fig. 110)

Bending stainless—especially small, relatively thick pieces like the dogs—can be a real challenge. We recommend enlisting the help of a local sheet metal or machine shop with a leaf brake. This will allow you to bend the dogs to about 45° or so. From that point you can finish the bends by clamping the dogs in a vise around a **3/8"**-diameter rod. Don't insert the dogs too far down into the vise, or else the legs will bend into a curved shape, as shown in Figure 123a. Instead, you want to continue the 3/16"-radius bend begun in the brake. This requires putting just a bit of the part into the vise, as shown in Figure 123b. To prevent the vise from spitting the part out, apply downward pressure to the 3/8"-diameter rod while slowly tightening the vise until the desired bend is achieved. To finish the bend the last bit beyond 180°, turn the assembly over and tighten the vise, as shown in Figure 123c. Then, reposition the dog in the vise as shown in Figure 123d and use a block of wood and a hammer to bend the ramp section on the narrow leg of the dog. Make this last bend around a piece of angle with a 1/8"-radius, as shown.

Note In bending the dogs, be sure to bend four in one direction and four in the other; the left and right doors require **mirror-imaged sets**.

Completed: Left [ ] Right [ ]

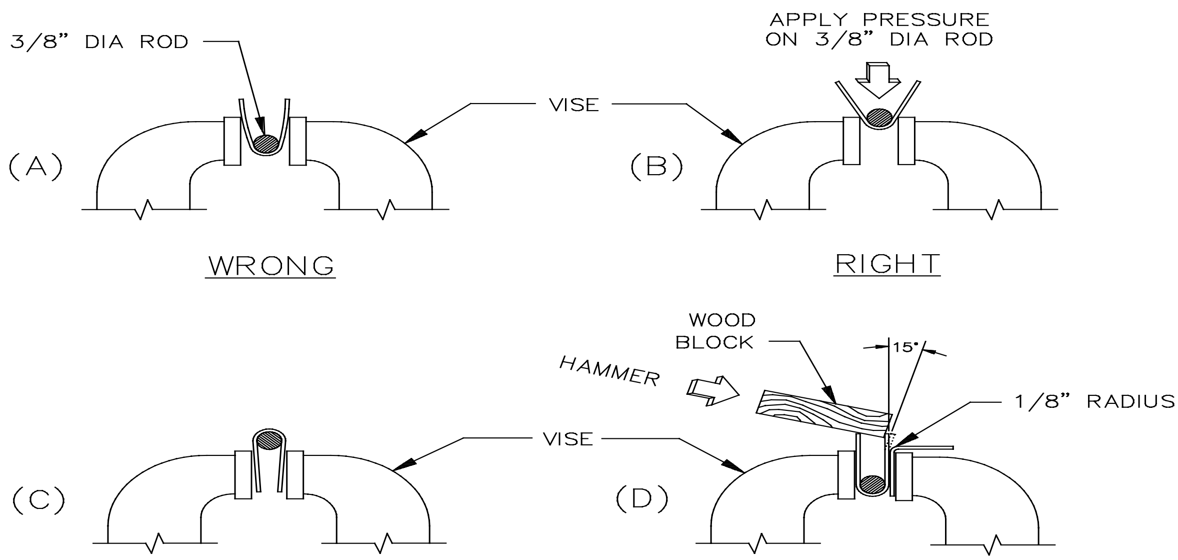


Figure 123: Bending Techniques for Finishing the Dogs

Step 114: Install the Dogs on the Doors

In order to position the dogs properly, it's necessary first to re-hang the doors. Before doing that, however, use coarse sandpaper to roughen a few square inches on the inside of each door frame where the dogs will be mounted.

Next, re-bolt the aft hinge halves to the door, again using the temporary AN315-3R jam nuts. (Ultimately, the aft hinge halves will be secured with more aesthetic **acorn nuts** [64] and AN936A10 **lock washers** [144], but this should await whatever upholstery or interior finish you intend to put on your door panels.) Then reassemble the hinges. Close the door tightly, compressing the door seal until the exterior surface of the door is flush with the exterior surface of the fuselage shell. Use tape or, if necessary, clamps through the door windows to hold the door in tightly against the seal.

Figure 125 shows how the dogs are positioned relative to the latches. Note first that the angled edge of each dog faces inward toward the center of the door. The forward upper dog opens forward, the aft upper opens forward and upward, the center opens downward and the lower opens forward and downward. The upper three dogs are all roughly centered on the width of the door frame, and the lower dog is spaced an equivalent distance inward from the edge of the door.

Check to see that all four latches are still secured in their closed positions—that is, the positions you placed them in Step 112—and then one by one, position the dogs as shown in the figure. Slide each dog against the engaging edge of its respective latch until the latch makes firm contact with the inside of the dog. **Make sure that the end of each latch protrudes slightly beyond it's dog, as shown.** Then, holding the dog in that position, trace around its base with a marking pen. After marking the position of each dog, mark the dog itself so you can be sure to return it to its original position later.

Repeat the process for all the dogs, and then remove the door from the fuselage and lay it inner side up on a bench.

The dogs are first bonded to the door frames with a mill fiber/resin mixture, and then two patches of bi-directional cloth are laminated over the bases of the dogs to provide extra strength. Begin by mixing a small batch of very thick mill fiber/resin mixture, and apply it liberally to the back of the dog. Then position the dog inside the outline on the door frame, pressing it down firmly so that the mill fiber oozes out the bonding holes. Spread this excess over the inside surface of the base, and shape a fillet around the perimeter of the base.

Note In some instances, it may be necessary to recess into the door frame in order to get the dog in to position. This can be determined by closing the door and determining the lateral (side to side) position of the dogs with the latches closed. If this is the case on your installation, grind away the inner door skin (avoid breathing carbon fiber dust) before installing the dog. Be sure to hollow out the foam to a depth of at least 1/4" and replace with a thick Q-cell potting mixture. Then glass over the dog as called out in the rest of the instructions.

Figure 125: Positioning the Dogs

After you have smoothed down the mill fiber and removed any excess (especially where it oozes through the bonding holes), you can apply the bi-directional laminates. There's no need to wait for the mill fiber mixture to cure, but make sure the dogs do not shift position. For each dog, cut two **2"-square** pieces of cloth on the 45° bias. As shown in Figure 126, laminate these pieces over the base of the dog, lapping down around the door frame evenly on both sides. However, don't allow the laminates to lap over onto either the inside or outside flanges.

Let the mill fiber and the cloth laminates cure fully. Then sand any rough edges smooth. Be careful when sanding not to sand through to the cloth, especially the exterior layer of cloth on the door itself.

Completed: Left [ ] Right [ ]

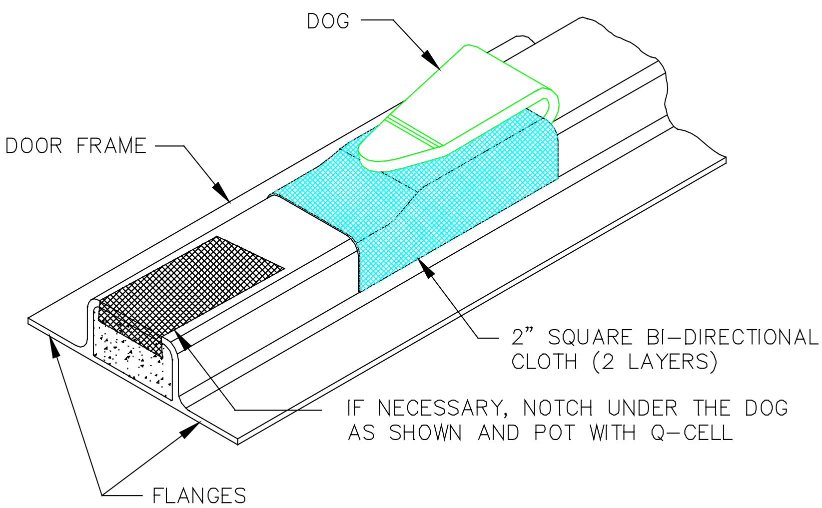


Figure 126: Applying Bi-Directional Laminates to the Dogs

Step 115: Drill the Exterior Door Handle

Re-mount the doors on their hinges, close them tightly against the door seal and move the latches to their fully closed positions. Lock them in place by torquing the nut on one of the pivot bolts. Double check the center latches for proper shimming away from the door seal. Once the **exterior door handle** [31] is drilled, there will be no possibility of adding or removing nylon washers from the latch shaft, so it's got to be right now.

You'll want to drill the exterior handle so that, when the latches are fully closed, it's in its "flying" position—that is, parallel longitudinally with the aircraft waterline. However, you'll be removing the handle and latch shaft from the airplane for drilling, so you need to reference the position of the handle to the latch plate itself. If nothing has changed since your initial set-up of the latches, the upper edge of the center latch plate should be perpendicular to the aft edge of the door cutout, and this is, for all practical purposes, parallel to the waterline (see Figures 117 and 125). Double check now to see that the latch is still in this position. If it has moved a bit, make note of the direction and amount of the change so that you can adjust the relative position of the door handle accordingly.

Next, slide the door handle over the latch shaft and assess the length of the shaft. When the shaft is bottomed out in the handle, the inboard face of the handle should ride on the outboard end of the door latch bushing. You may find it necessary to trim the end of the shaft to achieve this.

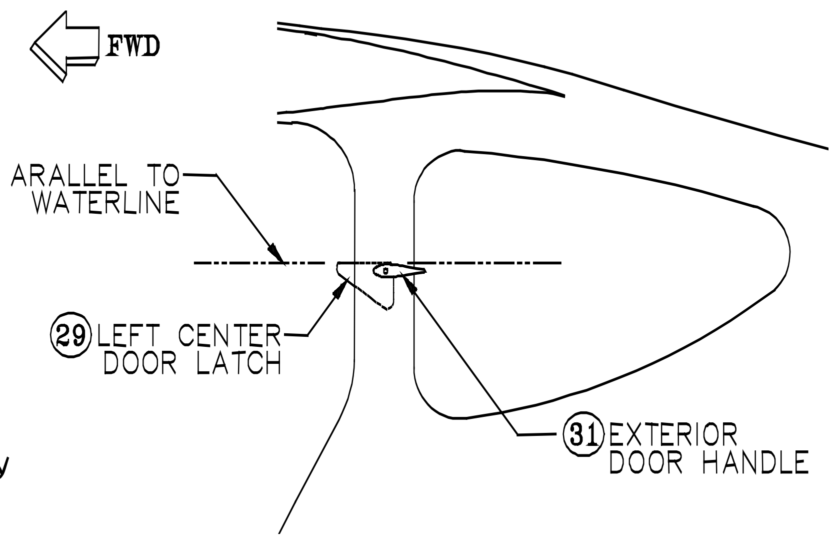


Figure 127: Aligning the Exterior Door Handle

Then have an assistant climb into the cabin and apply firm pressure in the **outboard** direction on the center latch plate. While s/he is doing that, use a sharp scriber to mark the latch shaft where it emerges from the door handle bushing. Mark around the entire circumference of the shaft.

Once the shaft has been marked, unlatch the door and remove the center latch from the fuselage. Leave all the other latches and the pushrods in place.

To drill the latch and handle assembly, use a stack of steel washers on the latch shaft to space the handle the proper distance from the latch plate, as determined by the scribed line indicating where the shaft emerged from the door handle bushing. Use whatever combination of washers is necessary to hold the handle on the scribed line.

Hint Actually, you may want to shim the handle about **1/64"** further **outboard** than the scribed line, just to provide a little extra clearance. Also, be sure **not** to use nylon washers in your temporary shim stack-up; they can be compressed in the vise.

Orient the latch and handle properly relative to one another, and clamp the entire assembly in a vise, as shown in the figure. The latch and handle should be **upside down** so that you'll be drilling into the bottom of the handle.

Note It's easy (but embarrassing) to mistakenly orient the handle 180° off its proper position—that is, with its sharply pointed end forward. Take one more look to make sure this doesn't happen to you!

When clamped in place, the longitudinal axes of both the handle and the shaft should be parallel to the base of the vise. As discussed above, if there was any discrepancy in the position of your latches when you scribed the latch shaft, adjust the vise so that the same **relative position** between the handle and the latch is maintained. The handle is secured on the shaft by means of a small roll pin. To accommodate this pin, you must drill a hole all the way through the handle and the shaft. Center punch a hole location on the bottom of the handle that is centered over the shaft and **1/4" outboard** of the **inboard** edge of the handle. Drill through the handle and shaft at this location with a sharp **1/8"** bit.

Note Use of a drill press and drill press vise is **strongly** recommended for this procedure. Although it would be possible to drill the hole successfully with a hand-held drill, it would be extremely difficult, and the odds are good that you'd miss the center of the shaft and/or elongate the hole.

After the hole has been drilled, disassemble the parts and deburr the holes. Mark the handle to distinguish the left-hand one from the right. If you wish, the handles can now be polished with sandpaper of progressively finer grits or with a non-metallic buffing wheel.

Note Do **not** use steel wool on the aluminum handles. Dissimilar-metals corrosion will result from the steel wool residue left on the part.

Completed: Left [ ] Right [ ]

Step 116: Install the Forward Over-Center Spring

A **forward door latch over-center spring** [75.1] installed between the center latch and the upper shell attach fitting, as shown in Figure 129, insures that the doors latch positively. The spring is inserted at its upper end through a small hole drilled in the shell attach fitting; at its lower end it is secured with a bolt. In addition, an **aft door latch over-center spring** [75] will be installed in Step 129 when the shell attach fitting is fastened to the cage tab.

Figure 129: Forward Over-Center Spring

As Figure 130a shows, the **#40** hole for the upper end of the spring is drilled **1/4" outboard** of the **inboard** edge of the upper shell attach fitting. Vertically, the hole should be located as high as possible on the fitting flange while remaining below the cage attach tab. This will provide the maximum spring tension for the most positive over-center effect. Deburr the hole after drilling it.

Figure 130b shows the installation of an AN3-10A **bolt** [111] in the forward-most open hole in the center latch plate. The goal here is to install the bolt so that it sticks out as far inboard as possible. Insert the bolt through two AN960-10 washers, and then thread an AN315-3R jam nut onto the bolt as far as it will go. Next, insert the bolt through the latch plate from the inboard side until the jam nut contacts the plate. Secure the bolt with an AN364-1032A nylon self-locking nut and an AN960-10L thin washer on the outboard side of the latch plate. Thread the locking nut onto the bolt just until the end of the bolt emerges from the nut. Then tighten the jam nut down on the plate from the inboard side.

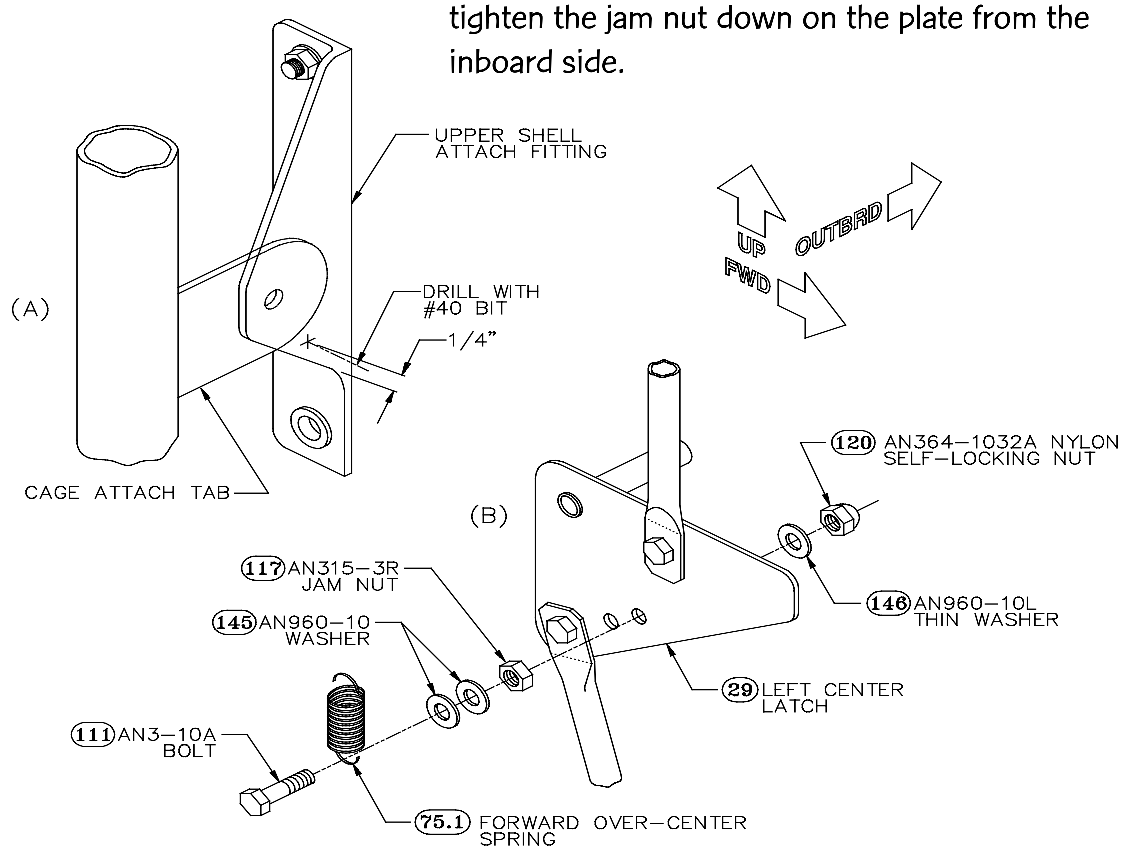


Figure 130: Securing the Ends of the Forward Over-Center Spring

Replace the center latch along with its original stack-up of nylon washers and reconnect the latch pushrods. Install the over-center spring with a pair of needle-nose pliers. At the lower end, the two spacer washers on the AN3 bolt should be **outboard** of the spring. Check to see that they are sufficient to hold the spring clear of the latch when the latch is rotated.

Completed: Left [ ] Right [ ]

Step 117: Final-Adjust the Latches

Re-mount the doors on the hinges for the final time. From inside the cabin, pull the door closed and engage the latches. Push out on the door and check each latch to see if it remains tightly engaged against its dog without tending to back off. If necessary, the latches can be adjusted slightly for better engagement by bending their tips inward or outward.

Completed: Left [ ] Right [ ]

Step 118: Install the Exterior Door Handle and Interior Knob

If you choose to find sand and polish the exterior handle, do so now. Slide the exterior door handle over the center latch shaft and line up the holes in the two parts. Drive a **1/8" X 5/8" roll pin** [98] into the hole. There are two methods for doing this. The easiest is probably to use a large pair of channel-lock pliers to mash the pin into the hole. Alternatively, you can use a light hammer and a bucking bar. Hold the bucking bar under the handle and use the hammer to drive the pin.

Finally, install the black plastic **knob** [103] on the inboard side of the forward upper latch. Secure it with an NAS603-7P round-head machine screw; use AN936A10 lock washers under both the screw head and the knob. You have to use either an offset or a stubby screwdriver to gain access to the outboard side of the latch.

Completed: Left [ ] Right [ ]

Step 119: Install the Cabin Door Locks (Optional)

Door Lock/Key Ignition Option Glasair Aviation offers a complete door lock and keyed ignition switch option kit that includes two custom-designed cabin door locks, two baggage door locks and a standard five-position aircraft ignition switch, all of which use the same key. The kit also includes all installation hardware (excluding electrical supplies), two duplicate keys and detailed instructions. Order P/N 921-03000-01.

Completed: Left [ ] Right [ ]

Step 120: Drill the Shell Fitting and Install the Over-center Springs

With the doors in position closed, pass drill through the shell attach fitting and cage and install the AN4-11 bolts as shown in Figures 130 and 13. Install the aft door latch over-center spring attach hardware in the center door latch plate, as shown in Figure 134.1 and as described previously in Step 117 for the forward spring. Install the aft spring between the two bolts.

Completed: Left [ ] Right [ ]

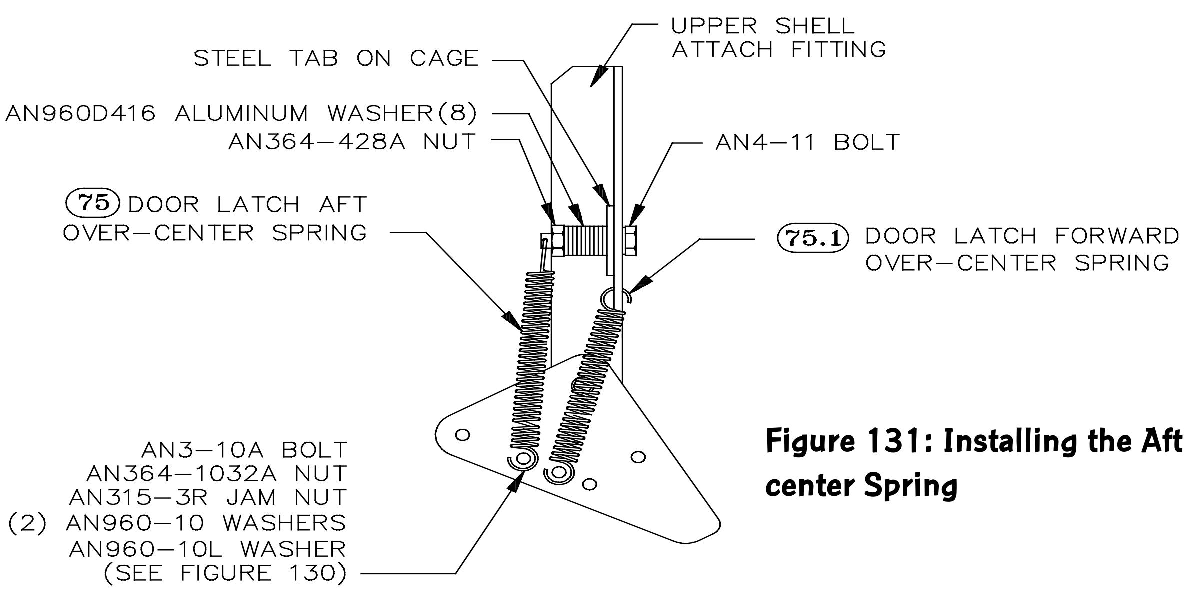


Figure 131: Installing the Aft Over-center Spring

Step 121: Installing and Fitting the Baggage Door

The Sportsman is equipped with an oversized baggage door that allows easy access to the baggage area or optional rear seats. In this section, you will mount the baggage door. **It is best not the have the fuel header tanks installed at this time, since access to the hinges is tight.**

The **baggage door [6]** is trimmed at the factory slightly oversize, so it should fit the door cutout fairly closely "right out of the box." However, final sanding of the door to achieve the precision fit you want is best left until after the hinges have been installed. For now, overlap the door edges onto the outside of the fuselage. This is best done with the rubber **door seal** [102] in place. Install the seal in the same manner as was done on the main cabin doors, making sure you compress the seal tightly into position, so shrinkage will not cause any gaps in the seal later

Position the door [6] in the cutout so that the gap between the edges of the foam core and the edges of the cutout (seal flange) are equalized all the way around on the inside.

Complete [ ]

Step 122: Assemble the Hinges

Once the door is secured on the exterior with 2" masking tape, assemble the **fwd hinge** [197] and **aft hinge** [196] together with hinge bolt **AN4-25** [219], and two **AN960-416L** washers [222], secured loosely with a castle nut [220] as shown in Figure 132. It might be necessary to run a ream or 1/4" drill through the hinges to eliminate any powder coat finish inside the hinge bushings. Because of the buildup of powder coat paint, it may be necessary to sand away the pain on the ends of the bushings. Do not cotter pin at this time, since future disassembly of the hinge bolt will be necessary. Secure the plates together so that they are on opposite sides of the hinge bolt. Repeat this process for both top and bottom hinge assemblies. Use a dab of wheel bearing grease on the bolts prior to assembly. The upper hinge assembly needs the bolt installed upside down, or else you can't remove the bolt and door once the hinge-half is installed.

Complete [ ]

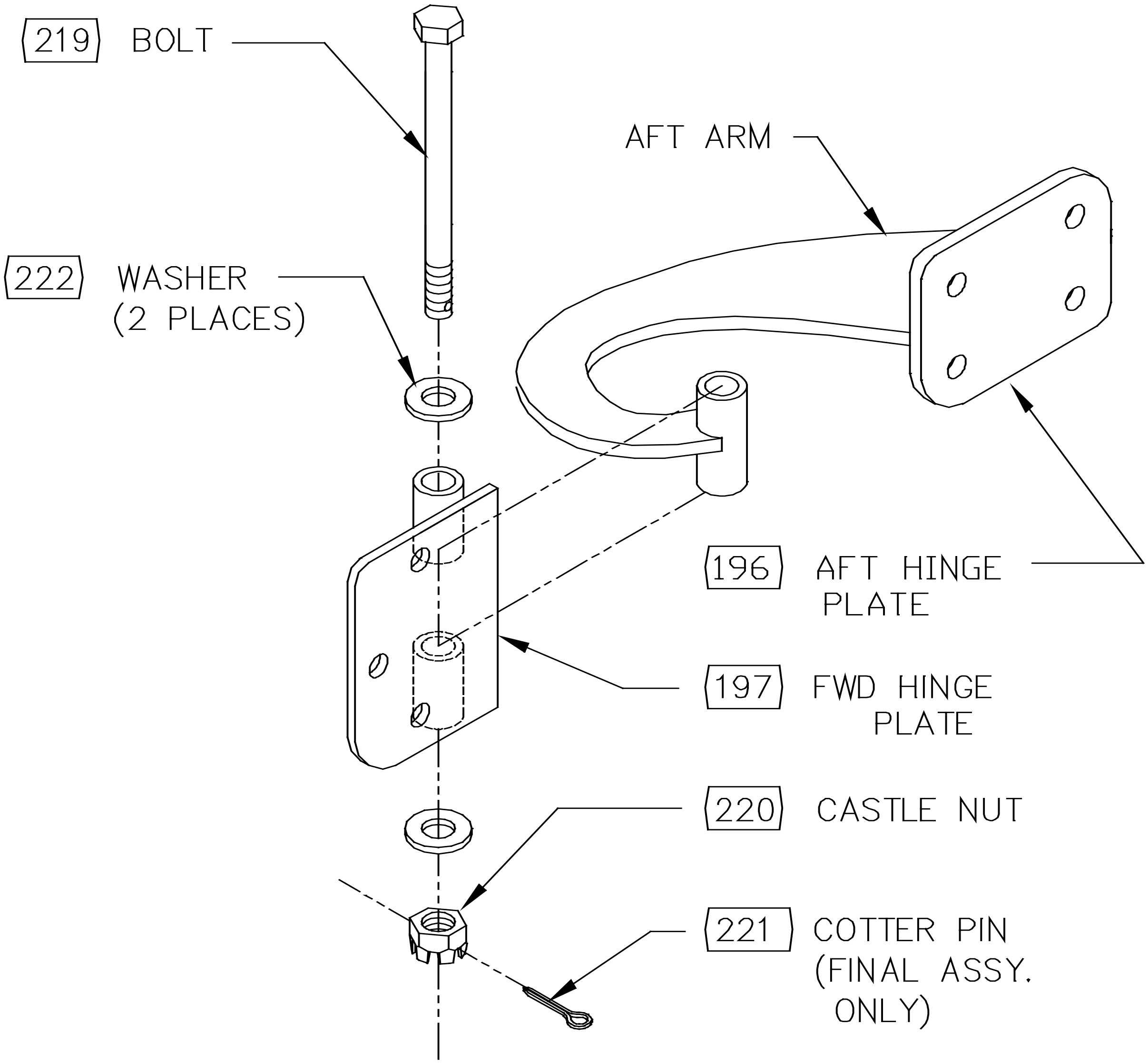


Figure: 132 Baggage Door Hinge Assembly

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: [redacted]

Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Step 123: Rig the Baggage Door Hinges

The hinges are located in the center of the opposing foam recesses on both the door and the fuselage shells. Like all doors, the two hinges should form a single line through the hinge pins. This requires them to be mounted on flat and parallel surfaces, the hinge arms must be parallel and the hinge bolts concentric. The foam recesses have been leveled at the factory during fabrication, so they should be **fairly flat** and parallel with each other. **Shimming may still be required**. (On earlier kits, these recesses were not leveled at the factory and you will have to apply a liquid shim to level the mounting pads.)

One good aid in the assembly process is to insert a 24" long 1/4" diameter threaded rod through both the upper and lower hinges (remove the bolts). Use nuts to secure and adjust the hinge vertical position so the arms are approximately 18" apart and will be centered in the foam recess. This keeps the two hinges in position and in line with one another. Verify that you have positive clearance between the hinge arm and the lower vertical truss tubes. It is important to keep the forward hinge plate as close as possible to the dimensions given in Figure 133.1. This will allow the door to open up the maximum amount (slightly over 90 degrees.)

When you have the optimum position for the hinge, mark the outline with a pencil.

Complete [ ]

Figure 133: An installed Hinge Assembly

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 1 5.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 5 , not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bi Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #1 b

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

Step 124: Drill the Hinges Plates Through the Fuselage and Door

First you will drill the forward hinge plates to the fuselage per the dimensions in Figure 133.1, then you will drill the aft door hinge. All drilling is done from the inside of the airplane. **You must attempt to drill perpendicular to the outer shell surface, not drill perpendicular to the hinge plates**. This will ensure the screw heads are flush with the outside surface.

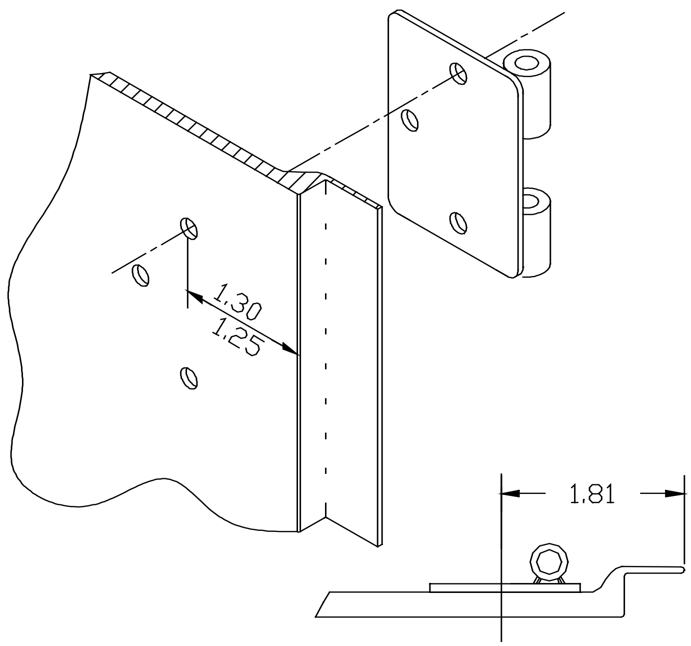


Figure 133.1: Location of the Forward Hinge Half on the Fuselage

It is best to work with a good 90° drill with short #10 bits. But great care must be taken to make sure the hinges do not shift. Keep them connected to each other with the 24" rod. The important dimension is the 1.30/1.25, but since you must drill from the inside you must measure from the edge of the 1/2" flange, resulting in a 1.8" dimension. While holding the drill perpendicular to the **outer surface** of the shell, drill the 6 holes common to the two forward hinges with a #10 or 3/16" drill bit. Temporarily insert an AN509 screw into each hole as you go. Then re-drill the external side of the holes with a **#3/16 - 100° micro-stop counter sink**. Reinstall the AN509 screws into the hinges and tighten only enough so they cannot shift and just begin to contact the shell.

Now drill from the inside through the aft hinges and through the door. Once again, keep the drill perpendicular to the outer surface. Then re-drill the external side of the holes with a **#3/16" 100° micro-stop counter sink**.

Remove the door from the fuselage, but keep the forward hinge in place. If necessary, relieve the flange on the fuselage in the area right under the forward hinge as shown in figure 135. This will allow the hinge to rotate freely to it's maximum open position. Then reinstall the door to the aft hinge and snug up on all the hardware, but do not over tighten. Just make sure the door hinges cannot wiggle in their attachment with the door and fuselage.

When both hinges are temporarily installed (but securely) to the fuselage and door, now is the time to trim the door so it fits inside the door opening with a constant gap of 1/16". The forward, door/fuselage gap may be widened to a maximum of 3/16" at your option. This allows the door to open a little wider. Begin at the forward edge of the door because this edge will keep you from opening the door very far, as it will contact the out surface of the fuselage. Work your way around the perimeter until the door has a consistent gap. Before you can tighten down on the hardware a shim must be made to keep the hinges level and in line. This shim will also serve to adjust the forward edge of the door for a flush fit with the outer surface of the fuselage.

A liquid shim can be made by mixing a thick, non-runny resin/milled fiber/Q-cell mixture and setting the hinge in position while the mixture cures. Tape off the back side of the hinge plate to prevent the mixture from oozing through the holes and so it can be removed. Also tape off the area around the hinge for cosmetic appearances. Alternatively, a sheet metal shim can be fabricated from various pieces of scrap aluminum sheet stock.

In some cases you may need to grind away corner fillets or bridging where the cloth has stretched across the recess. This is acceptable as long as you make a small laminate over the area to replace the inner ply that you removed. Make sure you keep the surface as level as possible.

Complete [ ]

Step 125: Mount the Hinges to the Door and Mount the Door to the Fuselage

Fasten the door with AN509-10R8 **flush sink screws** [214], AN960-10L **washers** [215] below the nuts, and AN364-1032A **self-locking nuts** [210].

Relieve the flange to allow the door to pivot 90 degrees.

Figure 135: Hinge Arm Relief Notch

Complete [ ]

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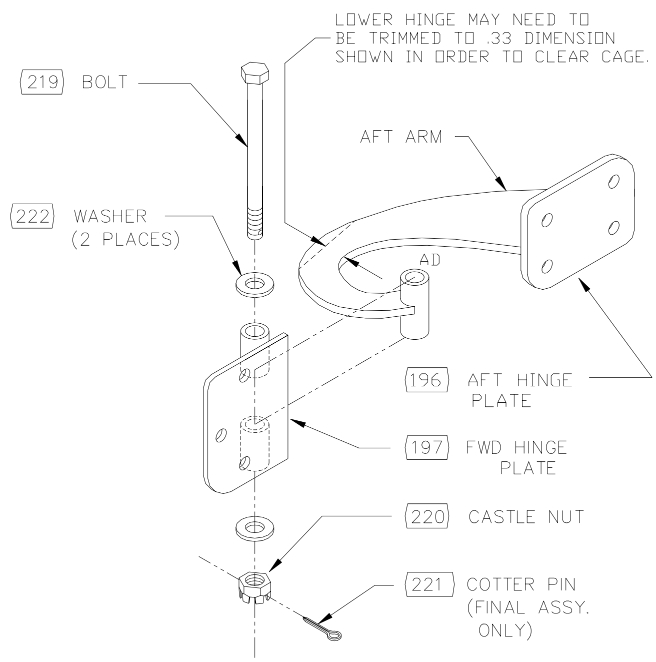
Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.

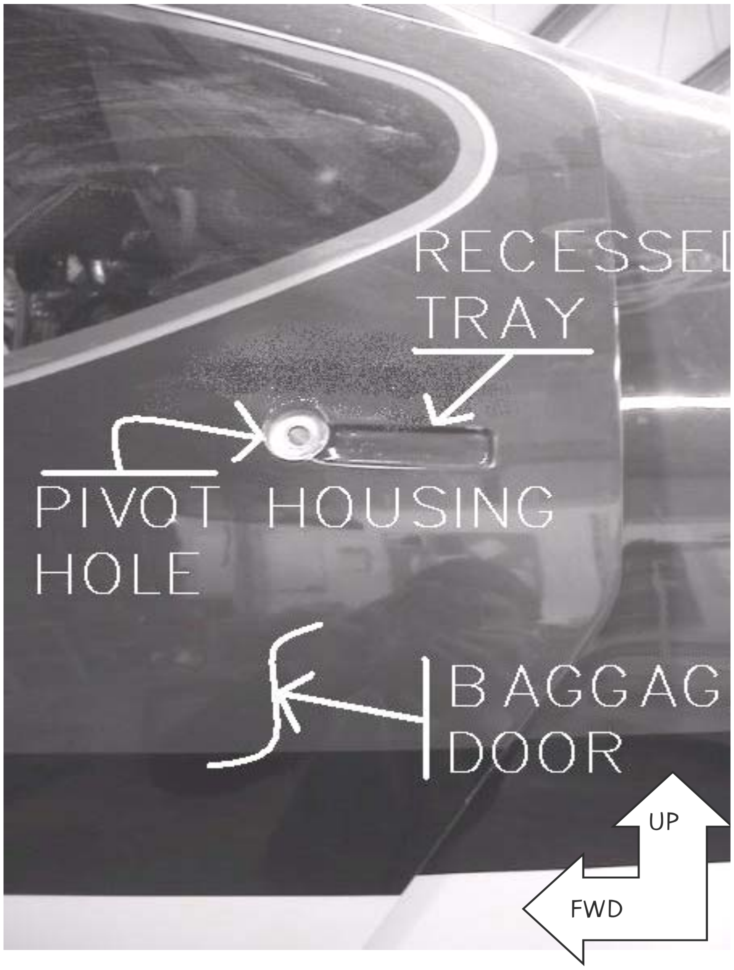


Page 242: [redacted]

Step 126: This Step Has Been Deleted

Step 127: Mount the Rear Door Latch Assembly

The door will arrive from the factory with a recessed "tray" for the external latch handle. However, the door will need to be drilled with a hole saw or die grinder for the pivot housing. At the forward end of the recessed tray, there is a dimple. This dimple will be the center of the pivot-housing hole. Cut the hole with a 1-1/2" hole saw.



Once the hole is drilled, insert the aluminum **pivot housing** [205] bevel side first. Push in the pivot housing until the notched rim is flush with the exterior skin, then align the notch with the recessed tray as shown in Figure 136.

Start by assembling the external handle to the pivot shaft. Place the **spring** [209] into the recessed "U" of the **pivot shaft** [202], followed by the **external door handle** [204].
Secure the handle and spring in place with the **roll pin** [217]. (See Figure 137) Once the roll pin is secured in pivot shaft, round the protruding ends of the pin so that the pivot shaft head is smooth.

Figure 136: Baggage Door Handle External Recess

Note: At this time, the pivot housing [205] will only be temporarily installed. The pivot housing will later be removed and reassembled with adhesive.

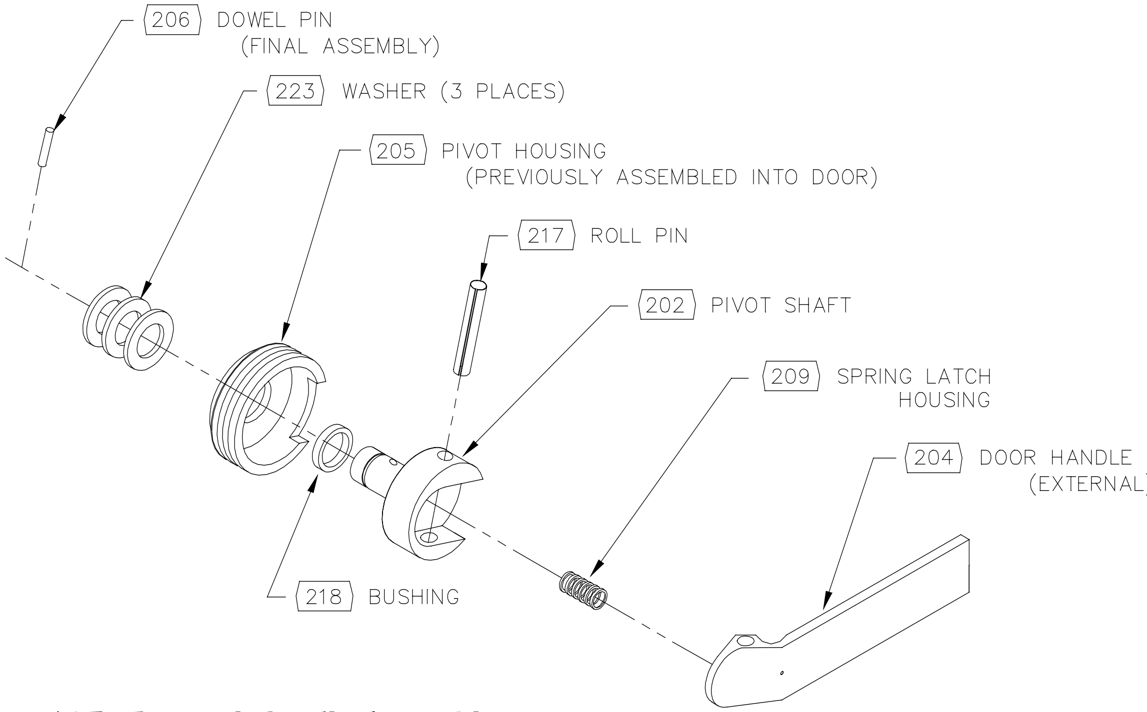


Figure 137: External Handle Assembly

Insert the **NAS75-7-.100 bushing** [218] into the aluminum pivot housing. Next, install the pivot shaft through the pivot housing in the door and align the external handle so that it rests inside the recessed tray. Then install three AN960-716 washers [223] onto the pivot shaft. Finally, install the **internal handle** [198} over the pivot shaft as shown in Figure 138.1.

The foam core is factory recessed for the internal handle. Swing the internal handle to verify it can rotate freely between the 10:00 o'clock and 2:30 o'clock (open and closed) positions as shown in Figure 138.1. Once this has been achieved, remove the internal and external handles from the pivot housing. Position the pivot housing flush with the external door surface keeping the handle slot in line with the recessed tray. Bond the pivot housing in place with a mixture of resin/Q-cell and milled fiber, as shown in Figure 138.2.

Once the adhesive mixture cures, reinsert the external handle assembly into the pivot housing. Replace the three washers onto pivot shaft, then slide the **dowel pin** [206] through the hole in the 7/16" diameter pivot shaft and then slide the **internal door handle** over the **pivot shaft** followed by a AN960-716 washer and secured with a **retainer ring** [224].

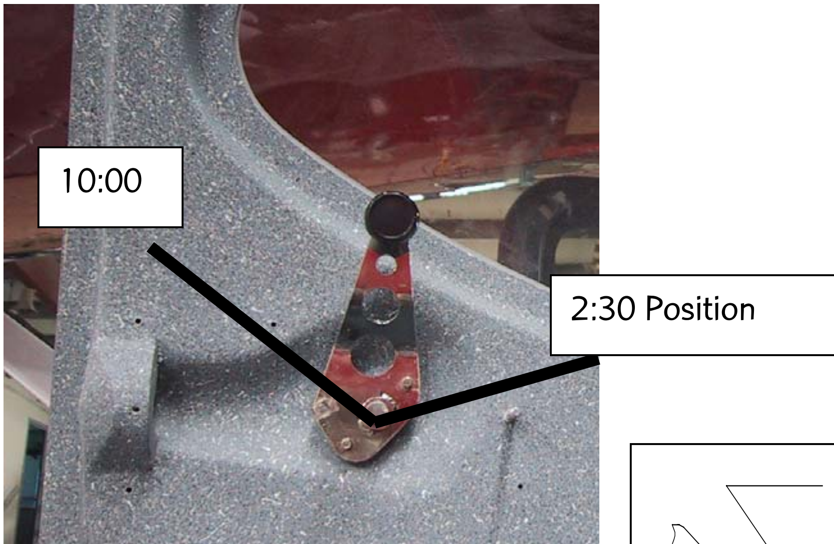
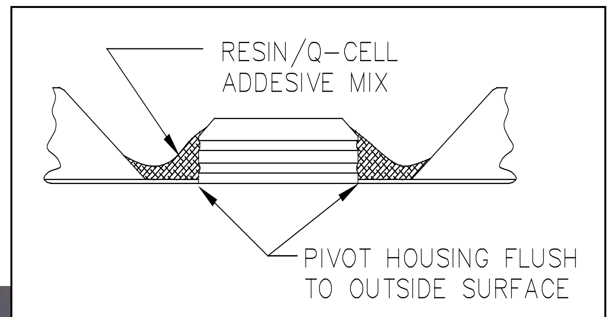


Figure 138.1: Internal handle shown in the 12:00 o'clock position



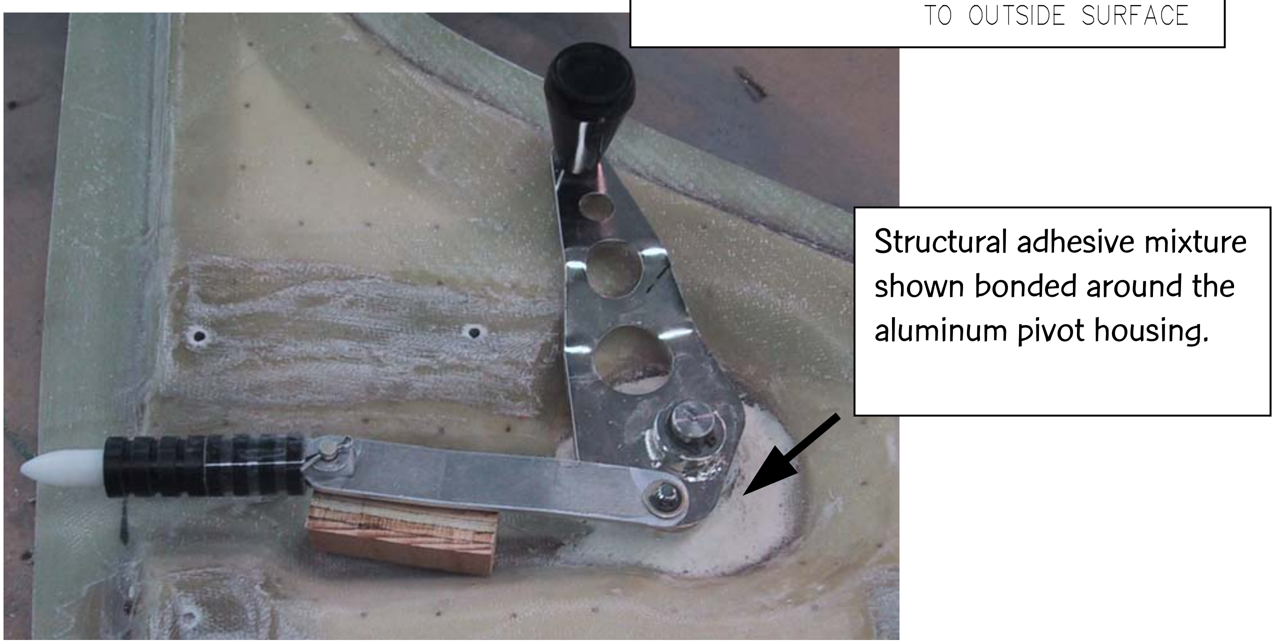


Figure 138.2: Internal latch housing shown bonded into position within the foam core recess.

Drill a #10 hole in the end of the **latch bar** [201] **3.45"** from the other hole, then radius and deburr the end. Attach the **latch pin** [200] to the latch bar with the **clevis pin** [212], followed by an AN960D10L **washer** [216], and secure with a **cotter pin** [211]. Then, insert **bushing** [226] through the fwd latch bar hole, and attach the latch bar to the latch bar stud (on the internal door handle) with the **snap ring** [207] as shown in Figure 138.3.

With the latch pin secured to the door handle, rotate the handle to the 2:30 o'clock position and hold the latch pin level. Hold the pin between your thumb and index finger to simulate the latch guide. Again, rotate the door handle between the 10:00 and 2:30 positions and remove any glass/foam obstructing movement of the pin assembly with a drum sander.

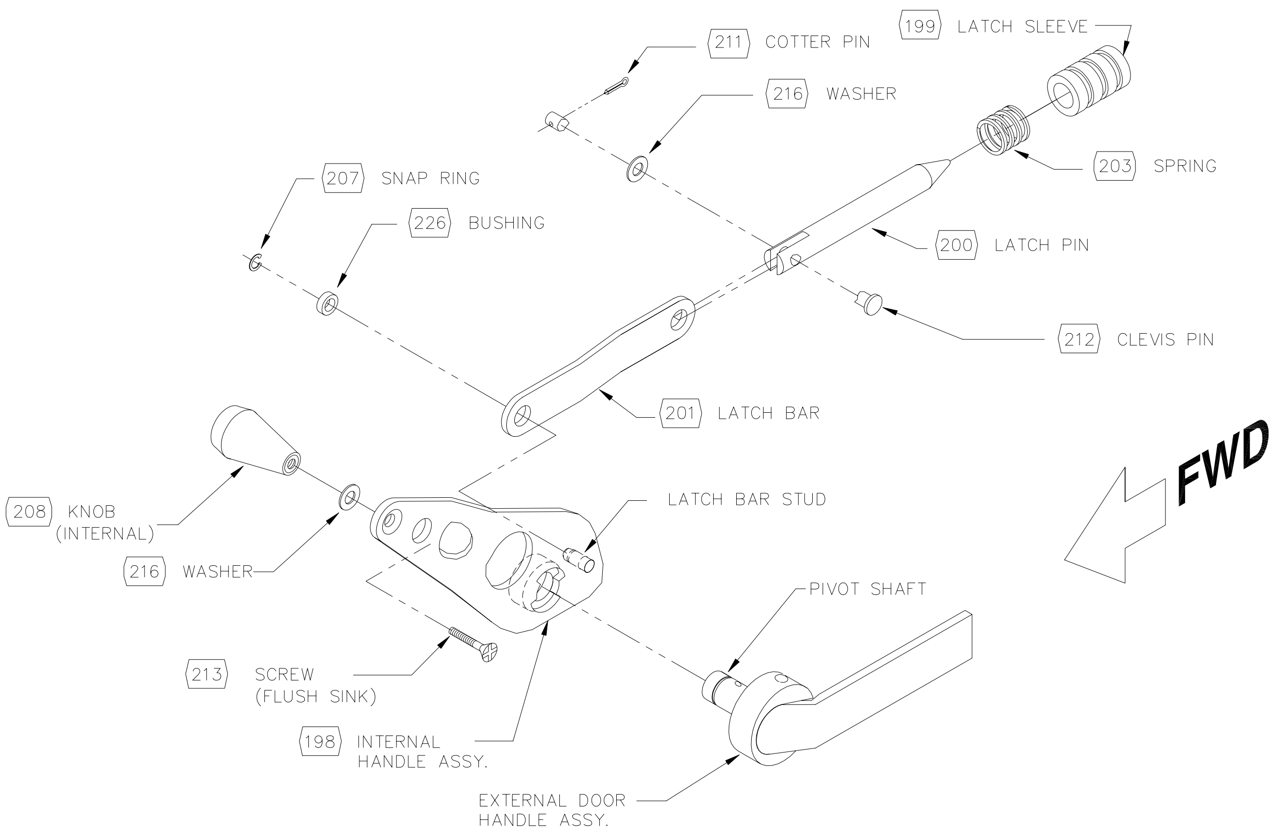


Figure 138.3: Internal Door Handle Assembly

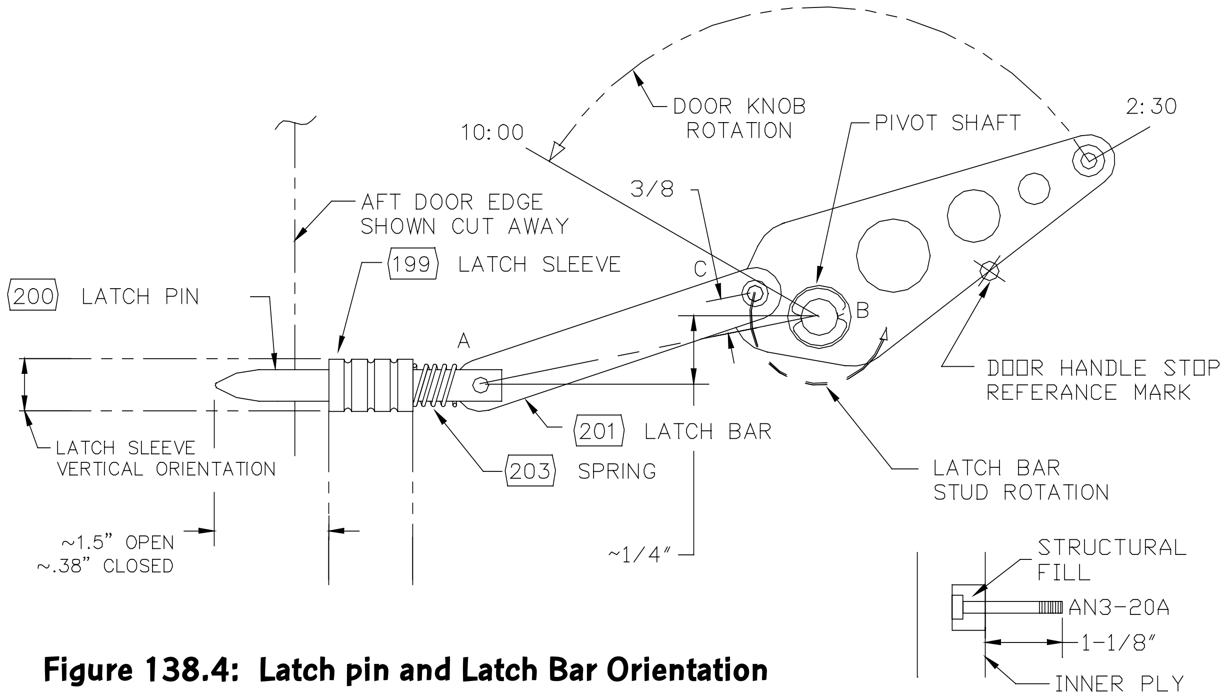


Figure 138.4: Latch pin and Latch Bar Orientation

Now that both the latch bar and the latch pin are installed onto the internal door handle, rotate the handle until the latch bar stud is slightly above (~3/8") the pivot shaft (over-center between points A & B in Figure 138.4). The latch sleeve and pin should be approximately 1/4" below the handle pivot. While holding the assembly in this position, mark a handle stop reference mark along the fwd edge of internal door handle onto the foam core, somewhere in the middle, reference Figure 138.1 and 138.4 for more information. In this position the latch is closed with the latch bar over-center relative to points A & B. This mark will be for the internal handle forward stop. At this mark, drill a 7/16" hole through the inner skin and half way through the foam core (about 3/8" deep). **Do not drill through the exterior plies.** Place an AN3-16A **bolt** [225] into the hole, head first so the threaded end is sticking out approximately 1-1/8" from the inner ply and fill the hole around the head with a thick Q-cell/milled fiber and resin mix. Tape the bolt perpendicular to the skin surface until the resin cures.

With the latch bar rotation overcenter, and the handle against the forward stop, the linear tension created by the latch pin spring will keep the door handle from inadvertently rotating open during flight.

Complete [ ]

Step 128: Bonding and Finishing the Internal Parts

Now the latch pin guide and receiver can be mounted and then the latch finished. The next several paragraphs describe how to locate the sleeves in both the door and the fuselage sill.

Rotate the internal handle to the closed position so that it rests against the forward stop. Then, slide a **latch pin sleeve** [199] over the latch pin. Hold the sleeve so that the latch pin is about **1/4"** below the level of the handle pivot as shown in Figure 138.4. This will be the vertical orientation of the latch sleeve and should be approximately centered in the foam recess. Hold the sleeve in this position against the door, then make a reference mark on the door along the sides of the sleeve. Make a small shim from a piece of scrap wood .45" thick and place it between the outer skin and the pin. This will act as a standoff to space the pin and sleeve the correct distance from the outer skin in the foam recess.

To get the horizontal (fore and aft) location of the latch pin sleeve, rotate the internal door handle assembly to the **open** (10:00) position allowing the latch pin to slide through the sleeve. While in the open position, slide the latch pin sleeve fore and aft until only the tapered portion of the latch pin protrudes. Use the side marks for reference to preserve the vertical orientation of the latch pin guide. Once the vertical and horizontal orientations are determined, tape the latch pin sleeve (and shim) to the door with duct tape.

Next, determine the location of the latch pin receiver in the fuselage side of the door. Rotate the handle to the open position and attempt to close the door. Grind away the door flange where the latch pin strikes the internal flange of the doorframe. Remove just enough material until the receiver can slip over the pin and nest inside the cutout of the fuselage door flange. Note the alignment of the latch bar relative to the internal handle.

> **Note** You want as much pin travel and engagement into the receiver sleeve as possible. The pin should just clear the fuselage and the receiver sleeve when closing.

Once the door flange is cut out, close the door and rotate the handle to the closed position. From inside the aircraft, insert the other latch pin sleeve over the end of the latch pin. (This will be the latch pin receiver.) Hold the sleeve so that the end of the pin is flush to the opposite side. You may need to grind away more of the fuselage door sill. Tape the receiver in this position. Make a final adjustment to the thickness of the wood shim and location of the sleeve to get the orientation you want. Make a second wood shim and space it between the outer skin and the latch bar as shown in Figure 138.5. These two shims will support the pin and bar so the guide sleeve can hang free while being spaced the proper distance off the outer plies and then be bonded in place. This work is best done on a bench. **The fuselage receiver sleeve will be done last** after the door latch sleeve has been permanently bonded.

Remove both sleeves and the door.

The **latch cover plate** [227] must now be fit before the final bonding can be accomplished. The cover is a rolled and formed aluminum part that must be trimmed to allow for clearance as the internal handle rotates. Figures 139 and 139.1 show how the cover is used as a forming mold when bonding the guide sleeve. The full-scale trim template for the cover is given in Figure 138.7. It should be used only as a starting point as trimming will differ significantly from installation to installation.

After the cover has been trimmed, reinforce the inner skin with a two-ply laminate of 7781 cloth under the latch cover flange where the four sheet metal screws will attach the cover to the door. After it has cured, sand any high spots down so the cover sits good and flat.

Take the receiver sleeve and tape the outside with scotch tape and apply a coat of wax on the tape. Slide the taped sleeve over the pin first and butt it up against the latch bar, followed by the guide sleeve and position the guide sleeve back to the position marks on the door as shown in Figure 138.5. The two wood shims should be positioned so the correct standoff spacing is achieved. Reference Figure 138.6 for a typical position of the sleeve and pin the foam core recess. **The second taped receiver sleeve must be removed from the latch assembly once the adhesive has cured enough to allow for trimming. !**

The latch sleeve is bonded in place with a very thick resin, milled fiber, and Q cell mixture. Care must be taken so the adhesive mix does not get inside the sleeves and obstruct the movement of the latch pin. It should stand without flowing.

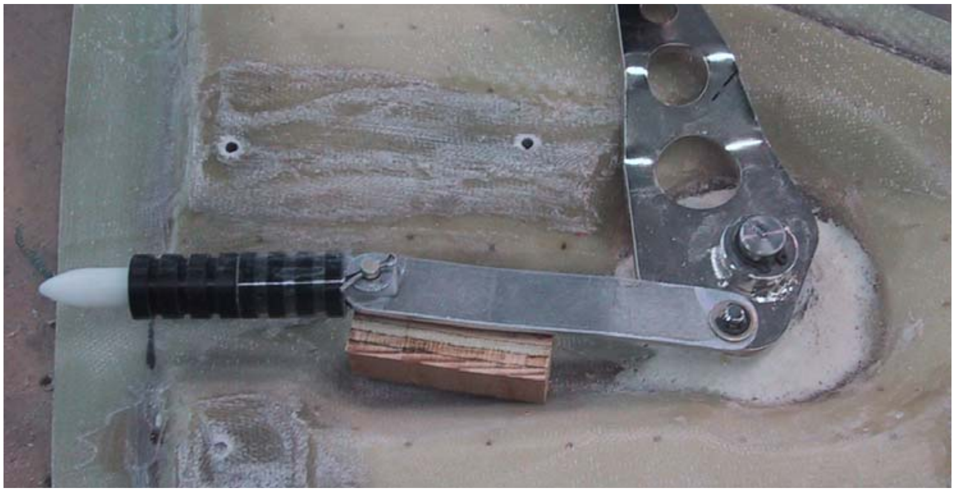


Figure 138.5: Latch Guide Sleeve Shown Ready for Bonding.

Wax the inside of the aluminum latch cover and use it as a mold to press the thick Q-cell/milled fiber mixture in place. Tape or weight it down securely. Let the excess ooze out the aft end. Don't get carried away here, you don't want a puddle inside the cover! Remove the cover as soon as the mixture is stable and hard enough to cut with a knife. Figure 139 shows the mixture being trimmed and the **taped receiver sleeve must be removed at this point**.

Apply a two-layer laminate across the "bridge" over the guide sleeve. This will reinforce the adhesive and will also be used as a material for the screw that is used to retain the strap handle and cover. Use the waxed cover again as a press to get a good clean surface.

Once the door is complete to this state, reassemble the door on the fuselage and place the non-taped receiver sleeve over the pin with the door in the closed position. Tape the door closed and make sure it is flush and against the seals. Figure 139.1 shows the finished door and the receiver sleeved in place and ready for bonding.

You can work through the window or from the inside the fuselage.

Build the mixture about 3/4" around and over the receiver (fuselage) blending it into the fuselage shell as shown in Figure 139.2, keeping in mind that it is for both security and looks. Remove the surrounding Zolatone and apply a two-layer laminate over the top of the structural mix, overlapping onto the fuselage shells.

Figure 138.6: Position of the Sleeve and Pin Relative to the Foam Core Recess.

Reference the photos at the end of Section X for additional ideas during the door latch installation.

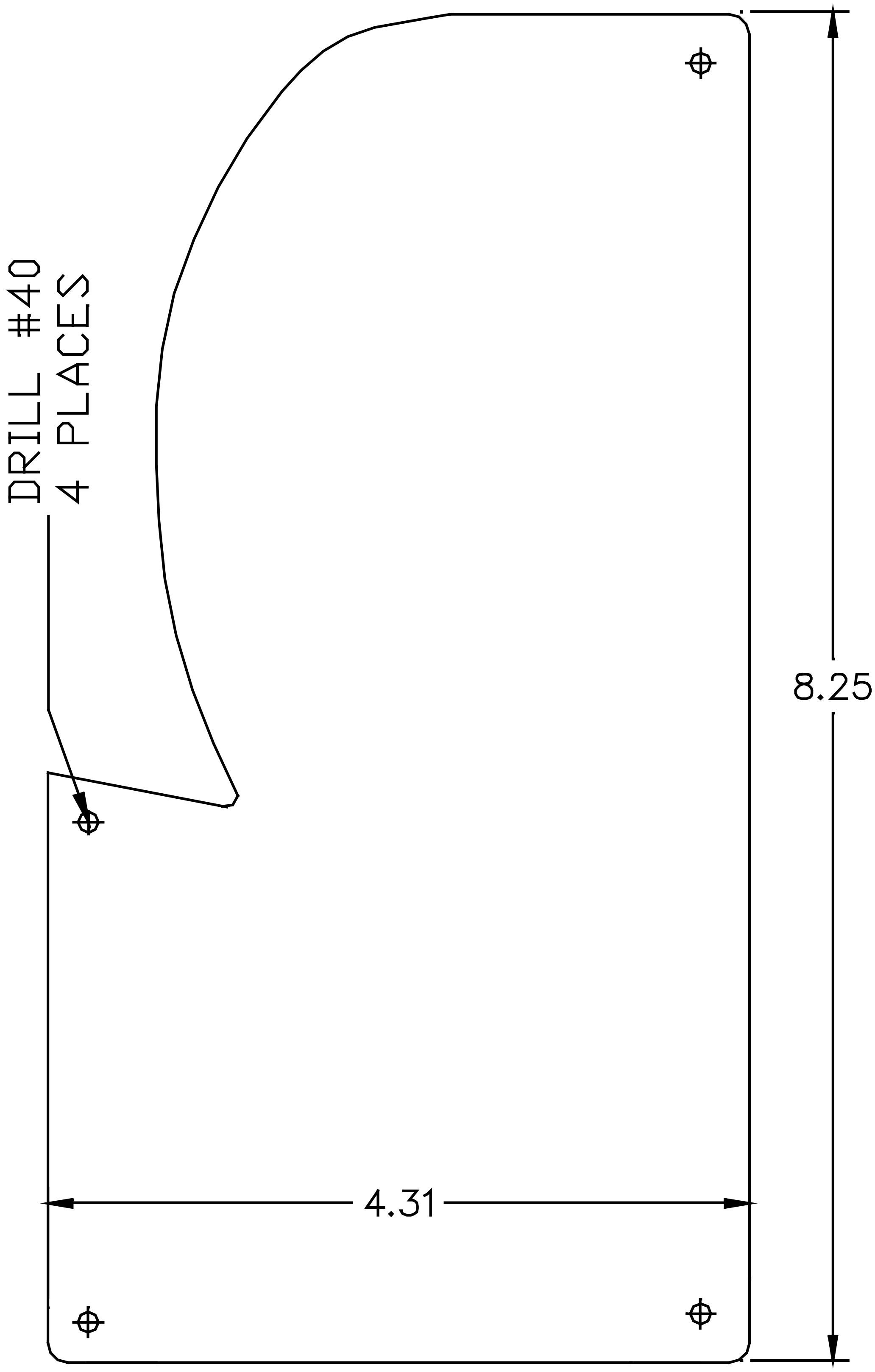


Figure 138.7: Full-scale Template for Interior Latch Cover

Figure 139: Bonding in the Guide Bushing

Figure 139 shows the second sleeve that is taped and can been seen sticking out of the adhesive. It is being trimmed and will be removed here just after it has green cured.

The first wood shim can be seen under the pin. The second wood shim that fits under the latch bar was removed in this photo.

The stop bolt shown here is installed a little too low in this picture and should be moved up higher as shown by the arrow. The threads on the stop bolt will protrude out of the cover so a strap and cap nut can be installed.

Figure 139.1: Installation of the Latch Cover Plate

After the mixture has been trimmed and cleaned away from the latching mechanism, sand fill and prime the finished door to the desired cosmetic appearance.

Finally, drill four attach screw holes through the cover as shown in Figure 139.1 and into the door with a #40 bit. Remove the cover and open the holes **in the cover** up to the final screw size. Then thread the **sheet metal screw** [228] through the cover and into the reinforced door skin, taking care not to strip the threads.

The **interior handle strap** [230] is attached to the stop bolt with a **cap nut** [229] on the forward side. The aft side of the strap is tucked under the cover plate and then retained with the fifth sheet metal screw as shown in Figure 140. Burn the ends and the holes to keep from fraying. **(Note: the figure below shows the strap on top of the cover plate but should be tucked under and retained with one screw. You may need to relieve a little of the adhesive underneath it.)**

Figure 139.2: Baggage Door Latch Pin Receiver Sleeve Installation

Figure 140: Final Installation of the Latch Cover Plate and Handle Strap

Completed: [ ]

Step 129: Final Installation of the Baggage Door Seal

Using the same techniques you used to install the seal around the cabin doors, install the seal around the baggage door. Once again, compress the seal as tightly as possible.

Completed: [ ]

Step 130: Trim the Wing-Fold Hatch Mounting Flanges

The wing-fold hatches are supplied in two pieces, an upper and a lower for each side. The hatch halves must first be fit to the recesses molded into the fuselage and deck. Then the halves are bonded together with fiberglass laminates and installed with screws and nutplates.

> **Top Deck Hatch Quarter-Turn Fastener Option** Instead of screws and nutplates, the wing-fold hatches can be secured with optional quarter-turn fasteners to provide quick removal and installation. We recommend the quarter-turn fasteners if you plan to fold your Sportsman's wings frequently. The kit includes installation instructions. Order P/N 945-01000-01.

The flanges on the fuselage and the deck where the hatches fit are rough-trimmed at the factory to a 7/8" width. Deburr and block-sand these flanges to a smooth, uniform **7/8"** width, as shown in Figure 141.

> **Note** The 7/8" width provides enough room to install the optional quarter-turn fasteners. You could trim the flange to a narrower width if you plan to install the deck hatches with screws and nutplates instead. Even in this situation, however, we recommend leaving the flange at the 7/8" width in case you ever decide to retrofit the quarter-turn fasteners.

Completed: Left [ ] Right [ ]

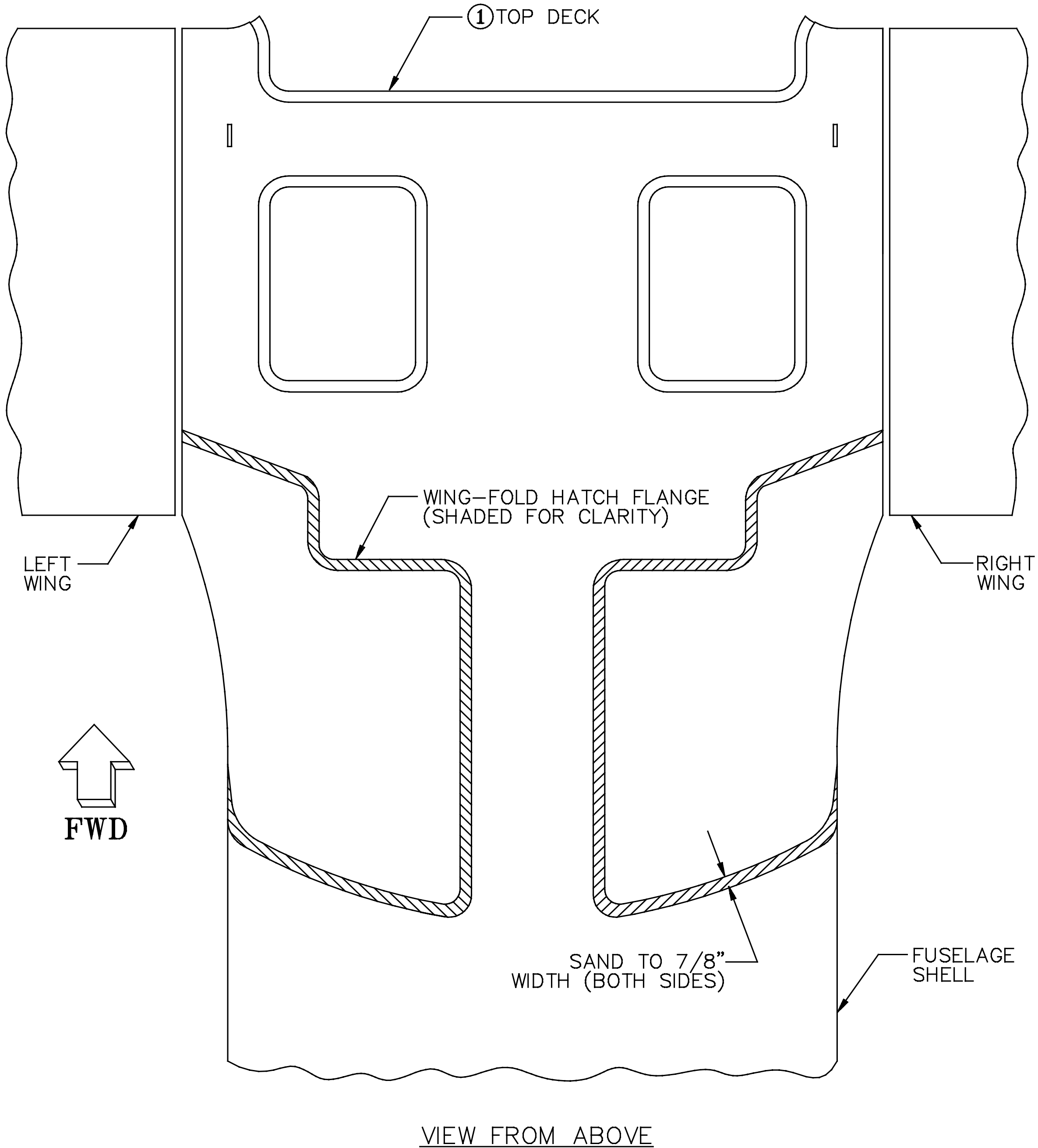


Figure 141: Trimming the Wing-Fold Hatch Mounting Flange

Step 131: Fit the Upper Wing-Fold Hatch Halves to the Mounting Flanges

Now you need to fit the left and right upper wing-fold hatch halves to their respective mounting flanges in the fuselage and the top deck. Before you can do this, you must trim the outboard sides to the scribe lines to match the joggle of the lower half and to provide clearance for the control cables in the wing root section of each upper hatch half.

If the cables are in place, you way want to use the scribe line for the cable clearance as a guide only. In any even, keep a minimum of 3/8" clearance from the cables.

After paint, a rubber seal slit down the center can be fabricated to seal this area.

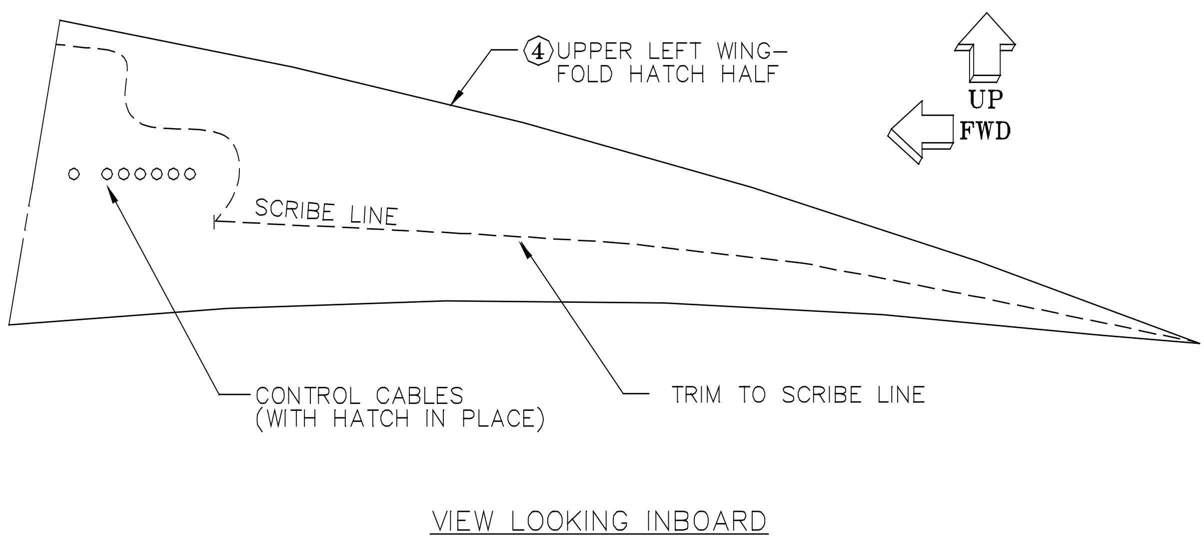


Figure 142: Trimming the Upper Hatch Half

Block-sand the edges of each upper wing-fold hatch half to fit within the perimeter of its flange on the fuselage and top deck. Scribe lines are provided on the outside surface of the hatch half to guide this trimming, but you need to trim enough to provide a **1/16"** gap between the edge of the hatch and the joggle so the hatch clears the radius at the bottom of the joggle, as shown in Figure 143.

> **Note** The wing-fold hatches are intentionally made thinner than the depth of the flange joggle to provide space for weather-stripping if desired. Experience has shown that weather stripping will not eliminate all leaks, so Glasair Aviation has also created an optional drain pan kit which is installed beneath these hatch cover openings to keep rain and moisture from entering the baggage area.
> Order Kit # 940-01100-01

When fitting the wing-fold hatch, adjust its side-to-side position by sanding its inboard edges so that the gap between the hatch and the upper wing skin matches the gap between the top deck and the upper wing skin.

Complete the procedures in this step for both the left and the right upper wing-fold hatch halves.

Completed: Left [ ] Right [ ]

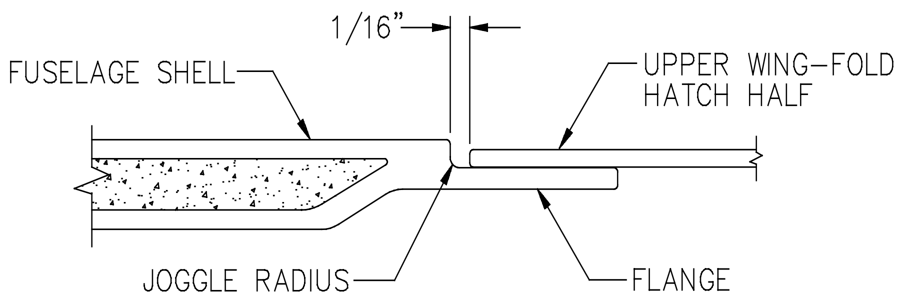


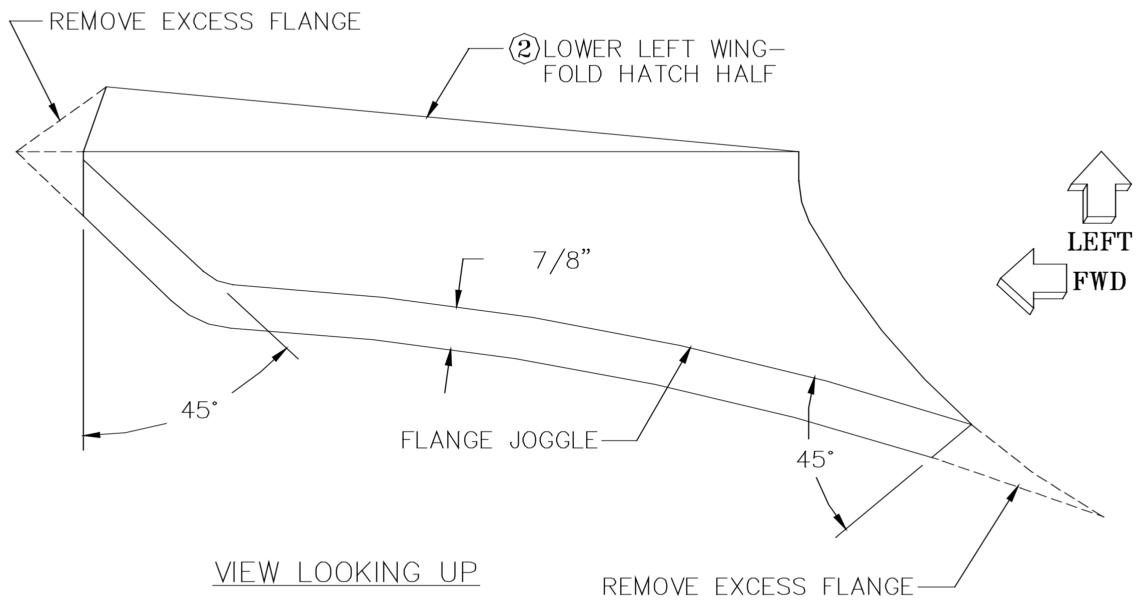
Figure 143: Fitting the Upper Hatch Half to the Flange Joggle

Step 132: Trim the Lower Wing-Fold Hatch Halves

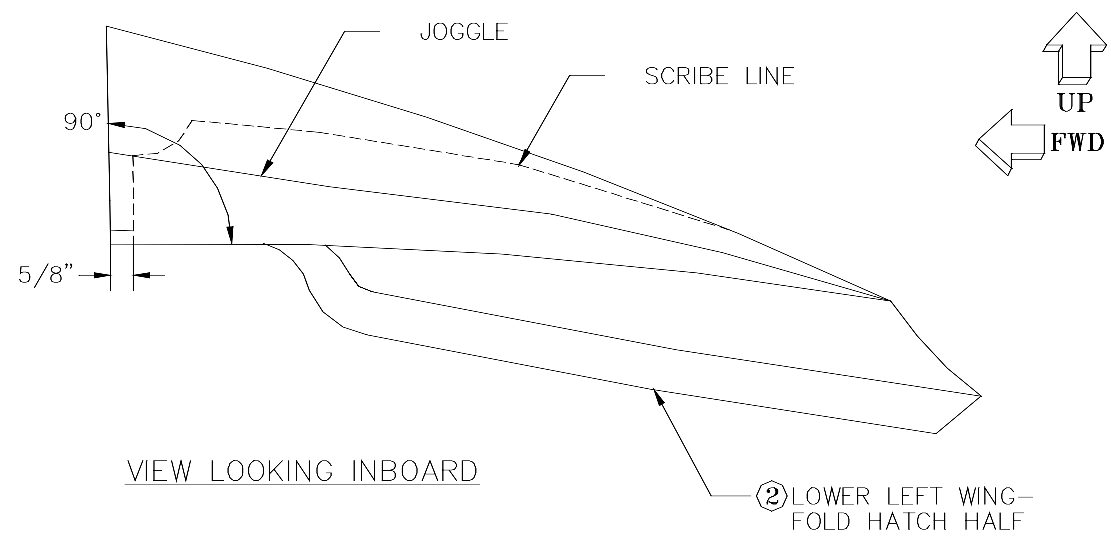
Trim the flanges along the lower edges of the **lower left** [2] and **right wing-fold hatch halves** [3] to a smooth, uniform **7/8"** as shown in Figure 144a. Trim both ends of the joggle at about a **45°** angle, as shown, removing the excess at both ends.

On the flat, wing-root portion of each lower hatch half, trim to the scribe line, as shown in Figure 144b. The joggle flange will be used to bond the upper half to the lower half with an adhesive mix. The cut-outs made at the forward end of the part are for aft spar and cable clearance.

Completed: Left [ ] Right [ ]



(A)



(B)

Figure 144: Trimming the Lower Wing-Fold Hatch Cover

Step 133: Fit the Lower Wing-Fold Hatch Halves to the Fuselage

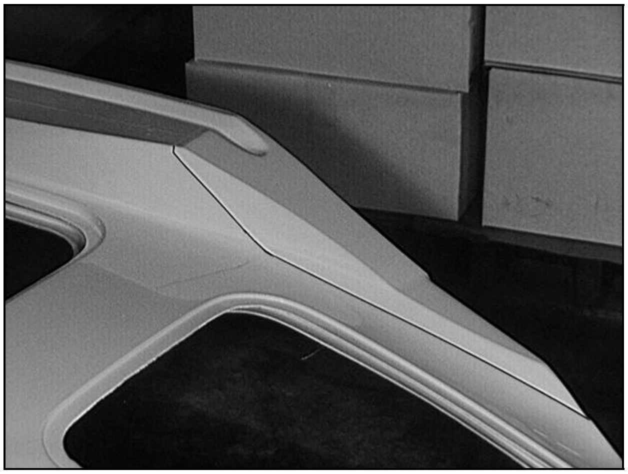


Figure 145: Scribe Line on the Fuselage for the Lower Wing-Fold Hatch Half

As shown in Figure 145, a line is marked on the outside of the fuselage shell on each side in the area where the lower wing-fold hatch half mounts. This line serves as a guide for trimming the fuselage to fit the lower hatch half. As with the upper hatch halves, the lower halves must be fitted to match the gap between the fuselage shell and the lower wing skin. Additionally, the trailing edges of the lower hatch halves must be fitted to match the trailing edge of the flap, so make sure the flap is in the fully retracted position during the fit-up; use tape to secure the flap in the retracted position, if necessary.

Note Some early Sportsman fuselages did not receive these trim markings as the tooling was not complete. We now have a marking template available that you can send for to save the time of guessing and custom fitting the lower hatch cover. Call Glasair Aviation and ask for the Sportsman Hatch Cover Trim Template. Please return the template as soon as you have your fuselage marked.

Initially trim the fuselage about **1/8"** outside the line and then trial fit the lower hatch half. Note where additional trimming is necessary to achieve the goals described in the previous paragraph (a uniform gap between the hatch half and the inboard end of the wing, and the hatch half trailing edge at the same height as the flap trailing edge). Use a sanding block to adjust the fuselage edge, and check

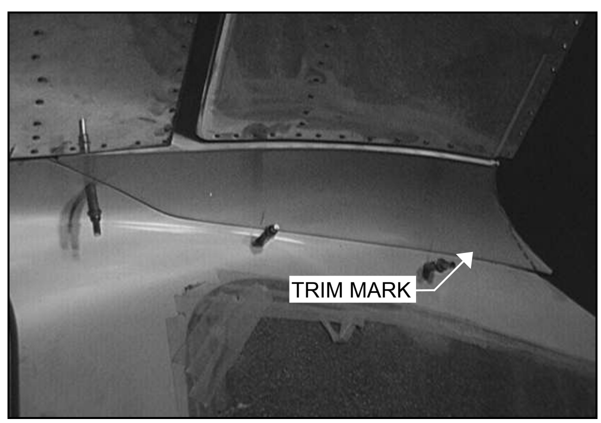


Figure 146: Fitting the Lower Hatch Cover Trailing Edge

the fit again and repeat until the hatch half fits well. Sand additionally as necessary to smooth the trimmed edge of the fuselage.

Also, trim the upper and lower hatch halves so that their trailing edges blend smoothly into the fuselage shell. The trailing edge of the lower hatch half is shown marked for such trimming in Figure 146.

Repeat for both sides.

Note Don't be overly concerned if the flanges of the lower hatch halves don't fit tightly against with the side of the fuselage; they can be clamped in place and made to conform better with the use of a heat gun.

Completed: Left [ ] Right [ ]

Step 134: Drill the Fastener Holes for the Hatches and Mark the Halves for Final Trimming

Top Deck Hatch Quarter-Turn Fastener Option The instructions for this step apply to both screw-and-nutplate and quarter-turn fastener installations.

The locations of the fastener holes on the upper wing-fold hatch halves, as shown in Figure 147a are factory set with a dimpled recess. All the holes are spaced **1/2-9/16"** from the edge. The hole pattern for the lower wing-fold hatch halves is shown in Figure 147b. Mark these hole locations on the outsides of the **fuselage** along the edge where the lower hatch half fits, spacing the holes **1/2"** from the fuselage edge.

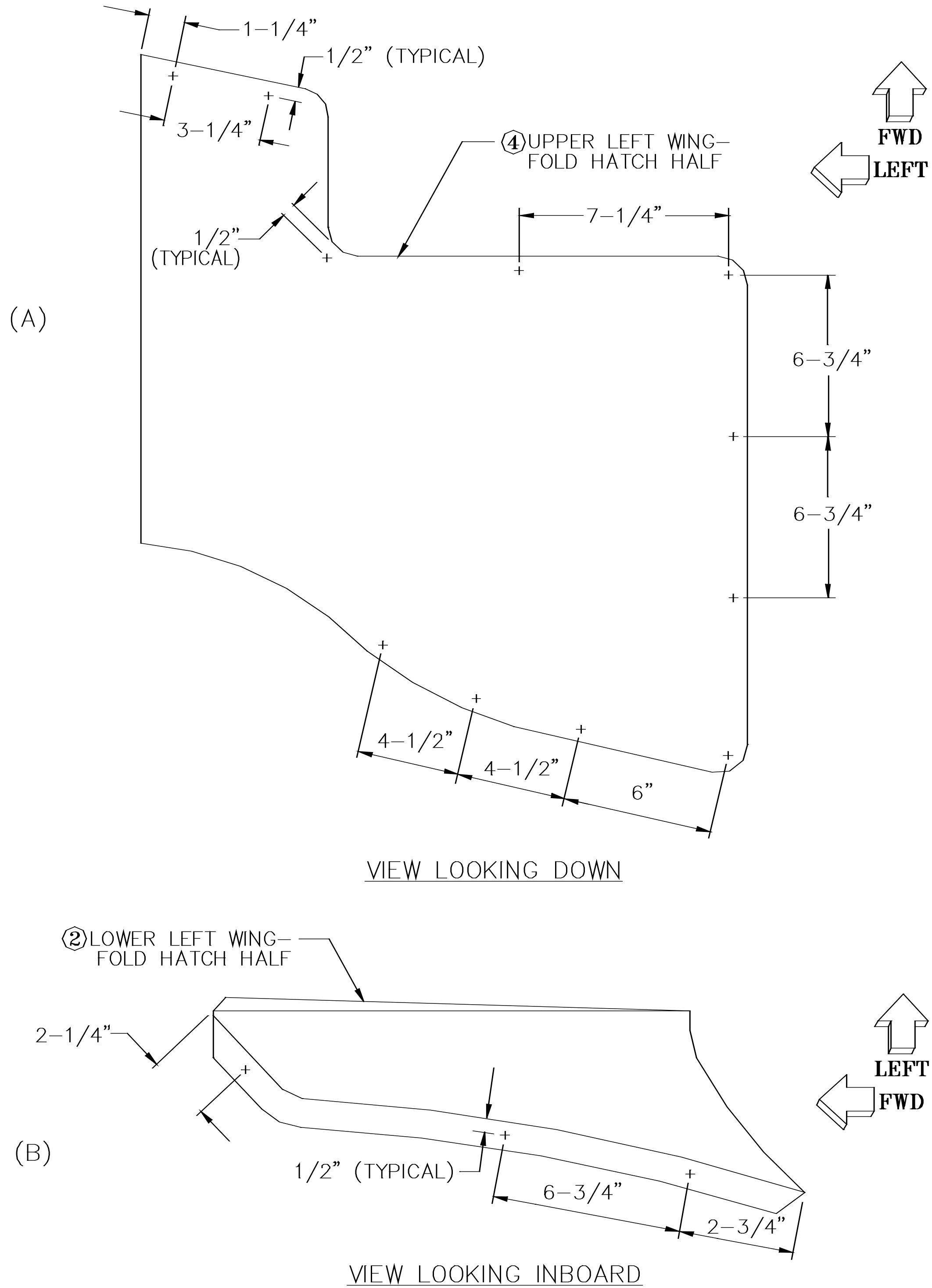


Figure 147: Fastener Locations for the Wing-Fold Hatches

Use wide masking tape to tape the upper hatch halves into position, making sure the gap is even all the way around each hatch. Then tape the lower hatch halves into position with their wing root portions joggled together with the wing root portions of the upper halves, as shown in Figure 148.

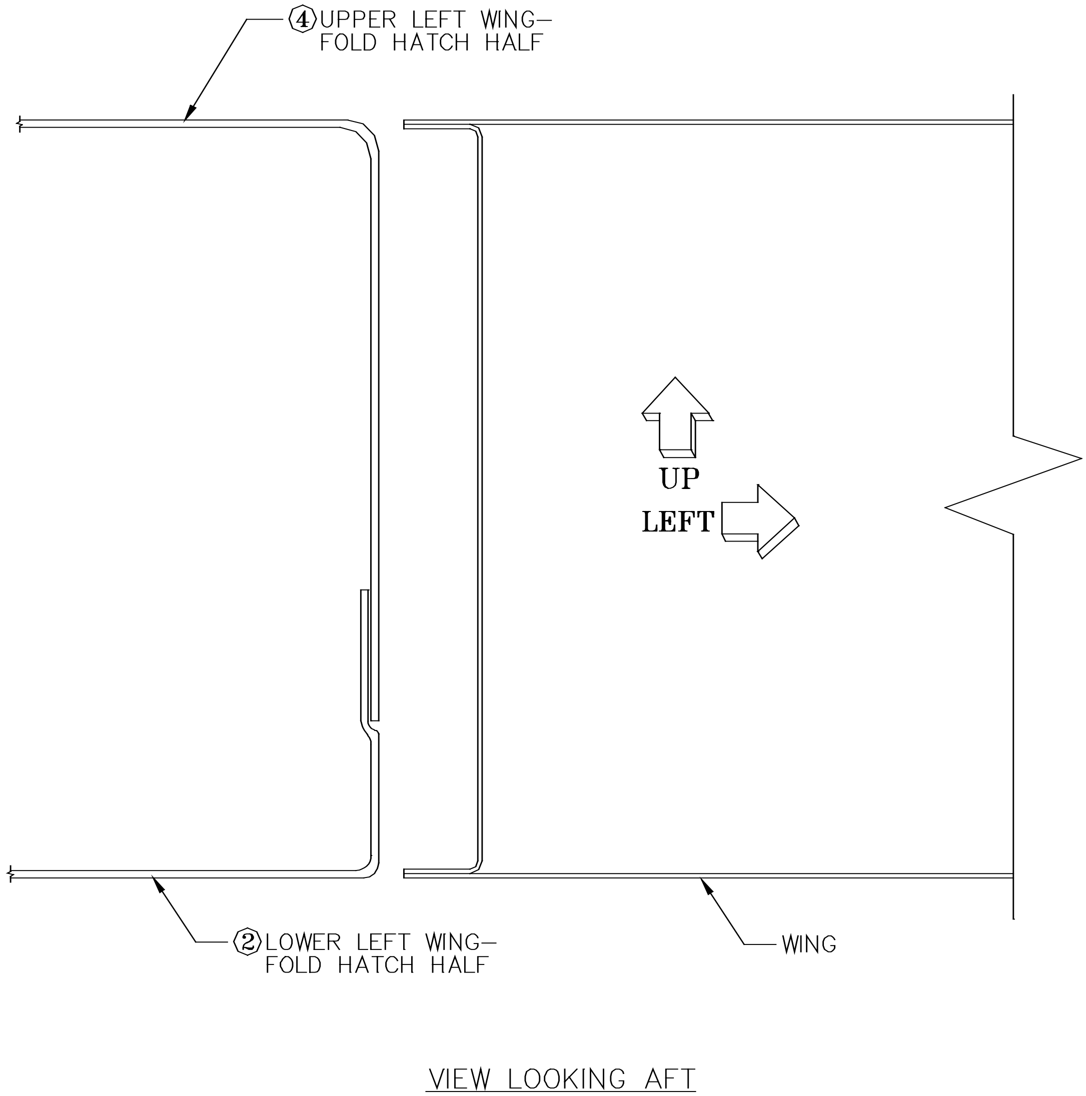


Figure 148: Fitting the Lower Hatch Half to the Upper Half

Before drilling any fastener holes, check that the upper and lower hatch halves have uniform gaps from the wing skins that match the existing gaps between the fuselage shell and the wing skins. Adjust the position of the hatches as necessary.

Drill all the fastener holes with a **#30** bit, inserting Clecos to maintain alignment as you go. Apply back-up pressure on the inside of each lower half's flange while drilling in order to keep the flange in firm contact with the fuselage. (If the flanges of the lower halves don't fit tightly against the fuselage shell, the fit can easily be adjusted with a heat gun. This adjustment will be described in a later step.)

With both the upper and the lower hatch halves still in place, verify that the outside surfaces of the two halves on each side are even with the upper and lower wing skins; squeeze the two halves together to accomplish this (it may be necessary to further trim the edge of the upper half's wing root portion). Also verify that the trailing edges of the two halves are even with the flap trailing edge and are in the same position on both the left and right sides. Adjust the positions of the trailing edges, as necessary.

Note Air loads tend to force the flaps upward in flight. Exert an upward force on the flap trailing edge, therefore, to simulate the air loads and make sure that the flap trailing edges are not drooping while you are checking the match-up of the hatches.

When satisfied with the fit of the hatches, drill and cleco the joggle joint together with approximately a 3" spacing.

When satisfied with the fit, you are ready to bond the upper and lower halves together.

Completed: Left [ ]

Right [ ]

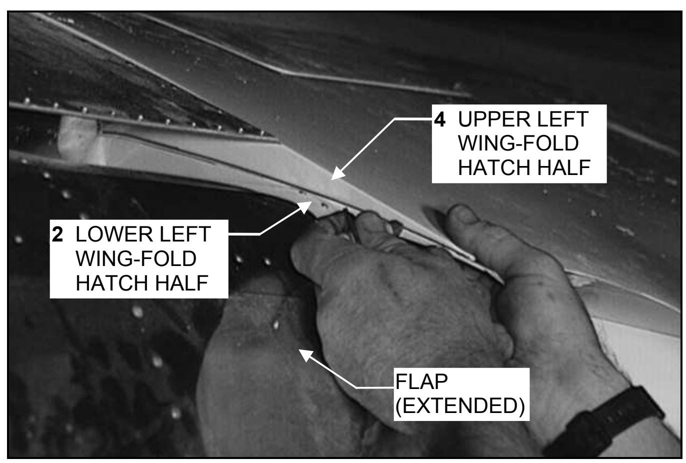


Figure 149: Marking the Wing-Root Portions of the Upper Hatch Halves for Trimming

Step 135: Bond the Upper and Lower Hatch Halves Together

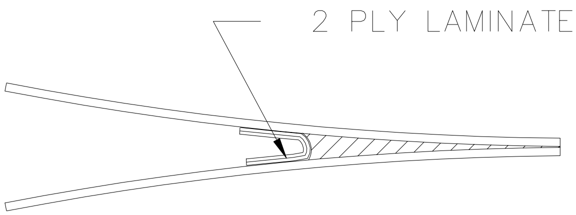
Figure 150: Clamping the Hatch Trailing Edge

Thoroughly sand the mating portions of the joggle joint between the upper and lower half, removing all traces of the primer. For the first part of this step, the upper and lower hatch halves should be Clecoed to the fuselage, and the flaps should be supported in their fully retracted positions.

Mix up a small batch of thick resin/mill fiber adhesive mixture. Apply a generous smear of the adhesive mix to the joggle flange and cleco together (Clecos facing inboard). Now install the upper and lower hatches to the fuselage with Clecos. Pry the trailing edges of the hatch halves apart and apply a small bead of the mixture between the halves. Close the trailing edge, adjust its height to match the flap trailing edge and lightly clamp the two halves together, as shown in Figure 150. Let the trailing edge bond cure, and then remove the hatch assemblies from the fuselage.

> **Note** If the trailing edge of the hatch needs to be extended to match the flap trailing edge, you can bond a two- or three-layer pre-cured laminate between the hatch trailing edges, if you want. To finish the trailing edge extension, use lightweight body filler to blend it into the rest of the hatch and sand it smooth.

After the trailing edge seams have cured, remove the hatches from the fuselage. Laminate 2 plies 7781 inside the trailing edge seam to prevent the seam from splitting apart. You may need to wipe a thick Q-cell radius inside this area prior to laminating.



Completed: Left [ ]
Right [ ]

Figure 151: Laminating the Trailing Edge

Step 136: Install the Hatch Mounting Nutplates

Top Deck Hatch Quarter-Turn Fastener Option If you are installing the optional quarter-turn fasteners, **turn to the option instructions now**. Return to Step 144 of this *Assembly Manual* when the specified option steps have been completed.

☞

Cleco the top deck hatches in place. One-by-one, enlarge the mounting screw holes to **#19** diameter for AN526-8R8 round-head machine screws, reinstalling 5/32" Clecos as you go. Use standard procedures to install K1000-08 nutplates on the fuselage and top deck flanges.

Note The top deck hatches are too thin to permit countersinking for flush-head screws. Extra laminates can be applied in each fastener location if desired.

Completed: Left [ ] Right [ ]

Step 137: Install Weather-Stripping and Mount the Hatches

Apply thin (about 1/16") weather-stripping material (not supplied) to the fuselage and hatch joggles to weather-proof the top deck hatches. A good material to use is adhesive-backed, flexible foam strip. Punch holes in the weather-stripping to clear the fasteners. Then, use either the AN526-8R8 screws or the quarter-turn fasteners to secure the hatches in place.

Keep in mind, that unless you live in a dry climate, water will leak through the fasteners.

Completed: Left [ ] Right [ ]

Page 268:

[redacted]

Page 287: A warning note will be added to the window installation regarding Silpruf silicone contamination on the exterior of the plane. You should be sure to tape and paper off any area where you might place your hands while installing the windows. Once silicone transfers from the hands to the exterior, it is very difficult to remove completely and will cause fish-eye problems during painting. We recommend PPG 330 Wax and Grease Remover. Wipe down the contaminated area with a Scotchbrite pad and clean rags two or three times.

In the Window Installation Section, a Baggage Door Window 101-14003-03 will replace the left quarter window 101-14003-01.

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from [illegible]ge these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used [illegible] ally,

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Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

Step 137.1: Wing Fold Recess Covers

Before you go and fold your wings, be advised that the inboard flap tracks will contact the fuselage before the wings can be fully folded. For this reason there is a recessed flange on the outer fuselage surface just forward of the upper aft strut attach arm as referenced in Figure 119 in the Systems section of the manual.

In order to fold the wings, you must trim the inside of the recess until you have approximately 5/8" flange left. This will make room for the flap track to pass through the shell and allow the wings to be folded to their full extent. Then install the **flap track recess cover** [233] over the flange. The covers come with a slight curvature to them, which approximates the curvature of the fuselage. The cover needs to be trimmed to shape and then it attaches to the recessed flange (forward side) using one AN507-8R8 screw and one K1000-8 nutplate. Refer also to the instructions included in the wing fold brace kit regarding the installation of the recess cups on the inside of the fuselage.

If you decide **not** to fold your wings, you can fill in the recess with a structural fill and then body finish over that. You may also chose to install the cover as described above.

Completed: [ ]

Step 138: Install the GPS Antenna (Optional)

If you're installing an external GPS antenna, the area of the top deck between the skylights is a good location. Follow the mounting instructions provided by the antenna manufacturer.

Hint When choosing a location for the antenna, be sure to pay attention to the underlying tubing structure of the cage, both so you can avoid drilling down into the tubing and so that the antenna will be positioned conveniently relative to the tubing for routing the antenna cable.

Completed: [ ]

Step 139: Install the Wing-Fold Drain Pan (Optional)

Wing Fold Drain Pan Option: When the wing-fold hatches are removed and the wings folded, the cabin becomes open to the elements. For this reason, if you intend to fold your wings often—and especially if you intend to park your Sportsman outside with the wings folded—we strongly recommend the installation of a drain pan under the wing-fold hatches The kit includes installation instructions. Order P/N 940-01100-01

No matter what the construction, drain tubes should be provided from the lowest point of the pan to the outside of the fuselage so that water caught in the pan doesn't collect there. Route the tubes along the cabin roof (where they can be hidden behind upholstery), through Bulkhead A, and then out through the bottom of the fuselage.

Completed: [ ]

Instrument Panel Installation

In this sub-section, you'll install the instrument panel; mount, wire and plumb the instruments and avionics; and fabricate and fit the glare shield.

Step 140: Cut Out and Fit the Instrument Panel

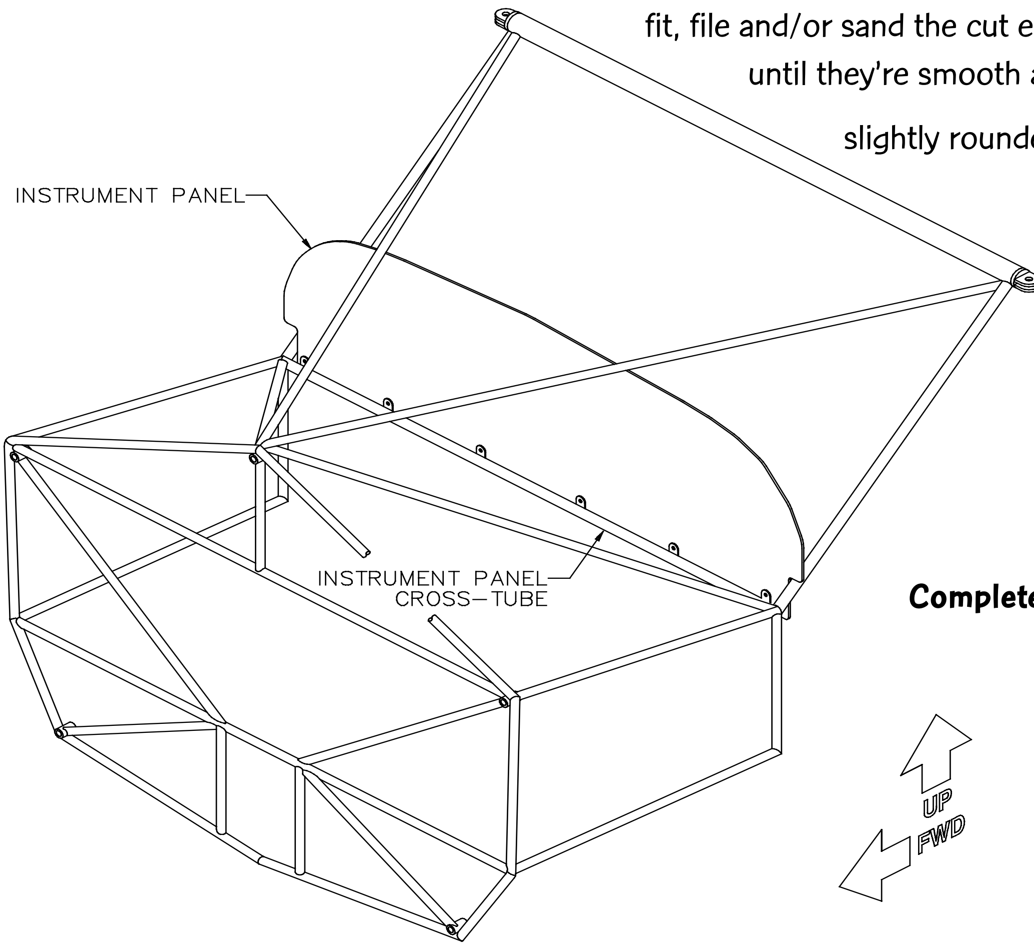
A full-sized **instrument panel template** [63] is included in the kit. Tack this template to the **.063" X 12" X 43" aluminum sheet** [70] and use a bandsaw to cut out the panel.

> **Note** The template gives a suggested shape only; the exact shape of the panel can be varied widely to suit your preferences.
>
> The Sportsman prototype is equipped with a beautiful low-profile composite instrument panel and glare shield that are available through our options desk. Ask for part numbers 912-05100-01 and 930-05000-01

Low-profile molded instrument panel for the Sportsman

Trial-fit the panel by positioning it in the cage with its lower edge on the panel-mounting cross-tube, as shown in Figure 155. Check for any interference between the ends of the panel and any fuel lines or wiring running up the cage between the windshield and door cutouts. Note any interference and relieve the end(s) of the panel as necessary to provide clearance. You don't need to leave a lot of room, but keep in mind that the panel will tend to flex and vibrate in flight, and so you absolutely can't tolerate any chafing between the edges of the panel and adjacent fuel lines or wiring.

Once you're satisfied with the panel's fit, file and/or sand the cut edges until they're smooth and slightly rounded.



Completed: [ ]

Figure 155: Positioning the Instrument Panel

Step 141: Lay Out the Panel and Make the Instrument Cutouts

You've probably been working on this step since long before you bought your kit! Most builders spend a lot of time pondering the arrangement of their instrument panels, and with good reason—you'll be spending a lot of time pondering those instruments while flying your Sportsman, and your safety and enjoyment depend in good measure on a well thought-out panel.

Note The Sportsman offers ample space for the most sophisticated IFR panel, but because of the cage structure, there are a couple locations where depth behind the panel is limited. When laying out your instruments and avionics, be sure to check that adequate depth exists for each item.

Once you've settled on a layout, make the cutouts and drill the mounting screw holes for the instruments, switches, breakers, avionics, etc., that you have selected. If you haven't yet accumulated everything you intend to put in your panel, you'll have opportunities to add these things later, but the more complete job of hacking and cutting you can do now, the easier things will be later on.

The instrument cutouts can be made either with a fly cutter or hole saws in a drill press, or with special instrument hole-cutting dies available from aircraft tool catalogs. **Don't** try to make these cutouts with a hand drill! It's virtually impossible to get good, clean holes of such large diameter using a hand drill.

Hint In addition to making the cutouts, trace onto the back of the panel the outlines of the instruments along the **upper** edge of the panel. These references marks will be helpful in the next step when you rivet a stiffener bow across the top of the panel.

Completed: [ ]

Step 142: Fabricate and Rivet the Panel Bow

A "bow" of .063" X 1/2" X 1/2" aluminum angle is bent to shape and riveted across the top of the panel to stiffen it. The first step is to determine the proper length of the bow. Since exact panel dimensions can vary widely from airplane to airplane, you need to measure your panel. Figure 156 shows the distance to be measured, labeled "X." Cut a piece of angle stock to the measured length.

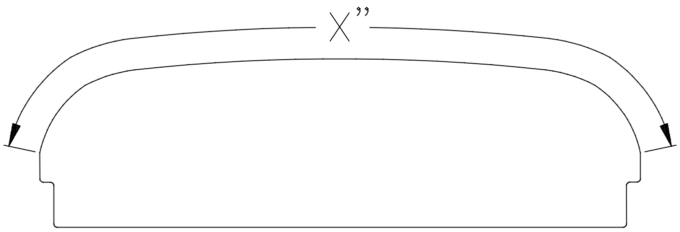


Figure 156: Measuring the Panel Bow Length

In order to bend the angle stock to match the shape of the panel top, you need to cut a number of slots through one flange of the angle, as shown in Figure 157. These slots allow the other flange of the angle to be bent into a curved shape. Start each slot with a **#10** or **3/16"** hole drilled as close to the inside radius of the angle as possible. Then use a hacksaw or bandsaw to cut a slot to meet the hole. There's no precise number of slots necessary to bend the bow to match the top of the panel. Our Sportsman prototype has only two slots in the center 18" or so of the bow where the curve is slight, and then slots roughly every **1/2"** from there outboard where the curve gets tighter. In any case, that's about as close together as you ought to cut the slots.

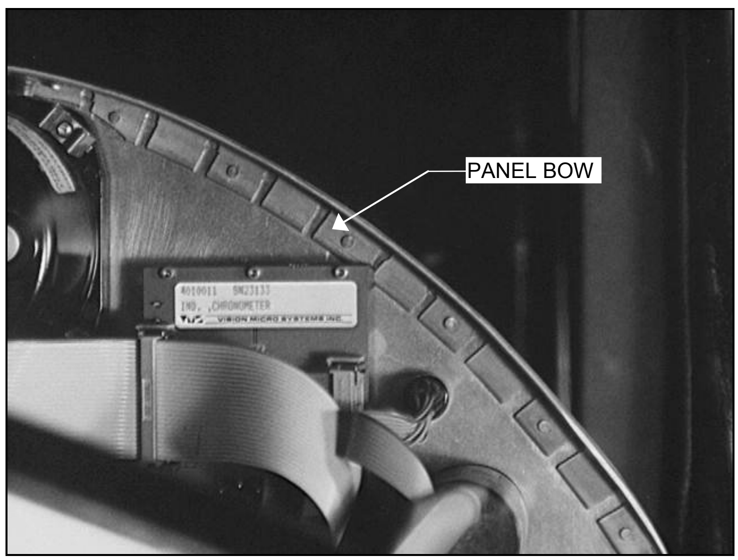


Figure 157: Bending the Bow

Bend the bow to match the panel as shown in Figure 157, and then check for interference between the tabs and the outlines of the instruments you marked on the back of the panel. Relieve any interference by cutting back the tabs. In Figure 157, the tabs around the corner of the airspeed indicator have been trimmed in this fashion.

Next, center punch rivet hole locations on the tabs. Not every tab requires a rivet—aim for a spacing interval of about **1-1/2"**. Clamp the center-punched bow to the panel with several small C-clamps, and then drill through the bow and the panel at each punched locations with a **#40** bit. Cleco as you go. Deburr all the holes in the bow and on the forward side (relative to the aircraft) of the panel, and countersink the aft side of the panel (relative to the aircraft) to accommodate 3/32" AN426AD3 flush-head rivets.

Corrosion-proof the panel and bow as you wish, and then rivet the bow to the panel.

Hint You may be tempted to prep and paint the face of the panel at this time, and indeed you can do so if you wish. However, our experience has shown that it's best to wait as long as possible—perhaps until after all the instruments and avionics have been function-tested—before finishing the panel. It seems that there's always one more hole to drill or cutout to make after you think you're all done!

Completed: [ ]

Step 143: Drill the Lower Mounting Screw Holes

The panel is secured to the fuselage cage through six attach tabs located on the cross-tube at the bottom of the panel. These tabs come with 3/16" pilot holes, which must be used to drill matching holes in the panel.

Position the panel against the attach tabs and clamp it in place with three or four Vise Grip-style locking C-clamps. The panel should be centered laterally and positioned vertically so that its lower edge is about **3/8"** above the **bottom** of the cross-tube, as shown in Figure 158.

With the panel clamped in position, drill through the unclamped attach tabs and the panel from the **forward** side with a **#10** bit. A 90° drill motor will make this drilling much easier. After each hole is drilled, screw the panel to the tab temporarily with the hardware shown in Figure 158: an NAS603-7P round-head machine screw, an AN960D10L thin aluminum washer, an AN960-10L thin steel washer and an AN315-3R jam nut. When the panel has been tightly screwed to all the unclamped tabs, remove the clamps and drill the remaining tabs. There's no need to insert screws in those holes at this time.

> **Hint** Because the cross-tube lies immediately behind the attach tabs, you need to position the nut and the forward washer **before** inserting the screw.

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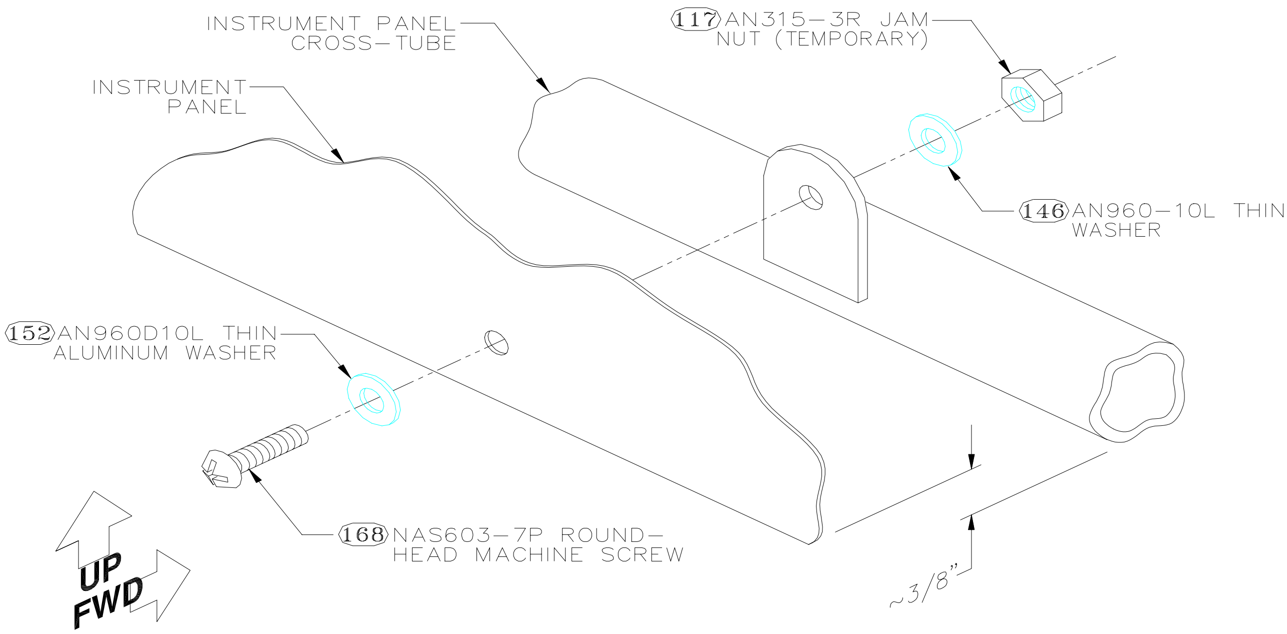

Figure 158: Temporary Panel Hardware

Step 144: Install Mounting Angles at the Ends of the Panel

In addition to the six screws along the bottom of the panel, a screw at each end helps secure it. There are no attach tabs on the cage for these screws; instead, they are secured to laminated attach tabs on the sides of the fuselage shell. Each tab is laid up in place from two layers of DBM cloth. Begin by cutting four **2" X 2"** squares of the material, two for each end of the panel.

As shown in Figure 159, the mounting angles are laminated right into the corner formed by the instrument panel and the fuselage side on the forward side of the panel (relative to the aircraft). Apply mold-release wax or equivalent to the panel in this area and roughen the adjacent fuselage shell with coarse sandpaper. Thoroughly clean the sanded area with acetone. (You may need to remove the panel to do this conveniently.) Then laminate the two squares of DBM in place and let them cure.

Note The laminated angles can be shifted vertically and/or trimmed as necessary to clear any fuel lines or wiring that might run alongside the shell in this area. Wrap such plumbing and wiring in vinyl tape to prevent the laminations from adhering to them.

When the angles have cured fully, mark and drill a hole through each end of the panel and the underlying angles. Use a **#10** bit. The precise location of these holes isn't critical, but since the screw heads will be visible on your panel, try to make them the same at each end.

When the drilling has been completed at both ends, remove the panel and deburr the holes.

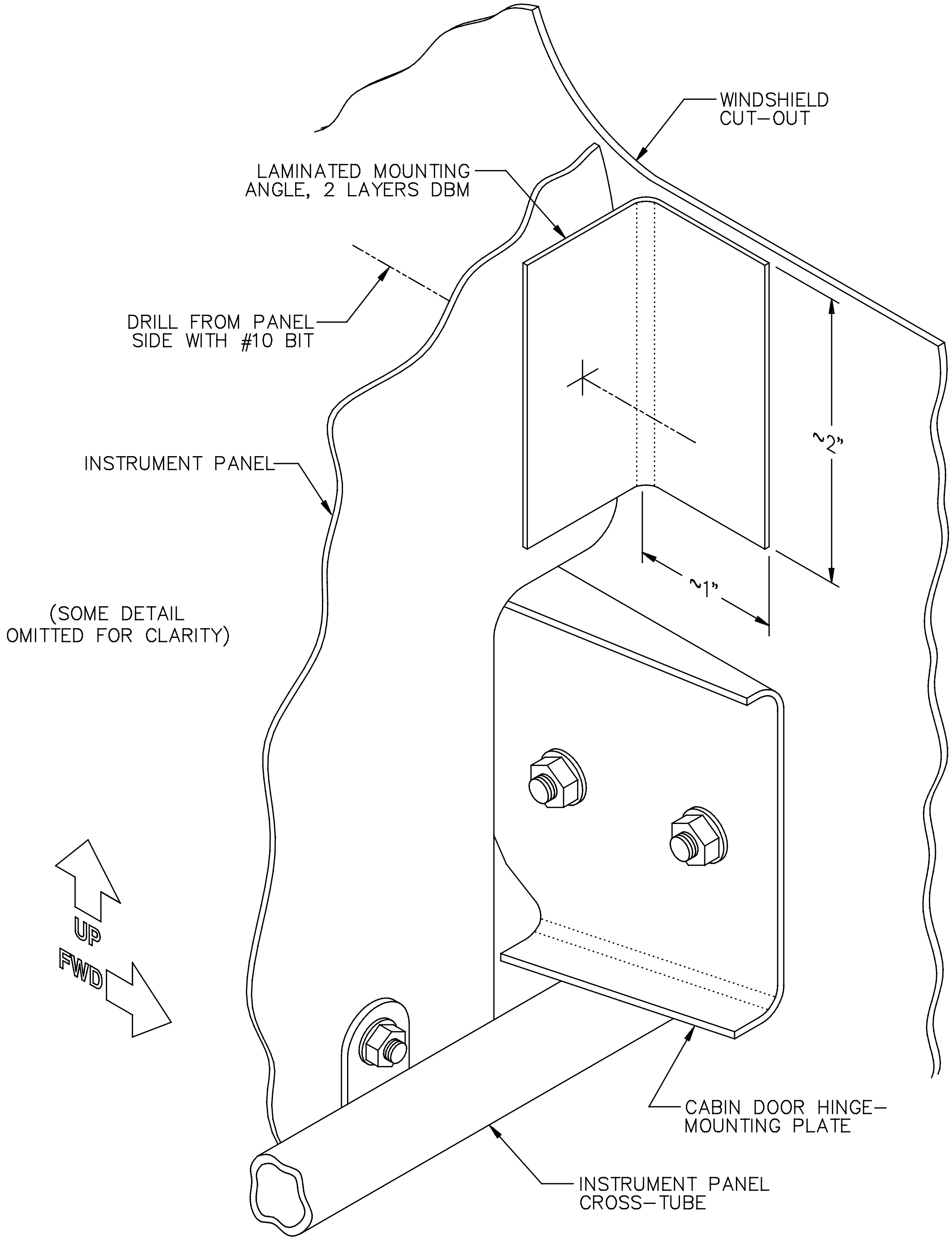

Figure 159: Laminating and Drilling the Panel-End Mounting Angles

Next, install K1000-3 nutplates on the forward faces of the two attach angles, as shown in Figure 160. Countersink the **#40** rivet holes on the **aft** face of the angle to accommodate 3/32" AN426AD3 flush-head rivets, and then rivet the nutplates in place.

Replace the panel, securing it temporarily with an NAS603-7P round-head machine screw through each of the two end holes and two or three of the six lower holes. Use an AN960D10L thin aluminum washer under each screw head. On the lower screws, use an AN960-10L thin washer and a temporary AN315-3R jam nut on the forward side of each attach tab.

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[ ]

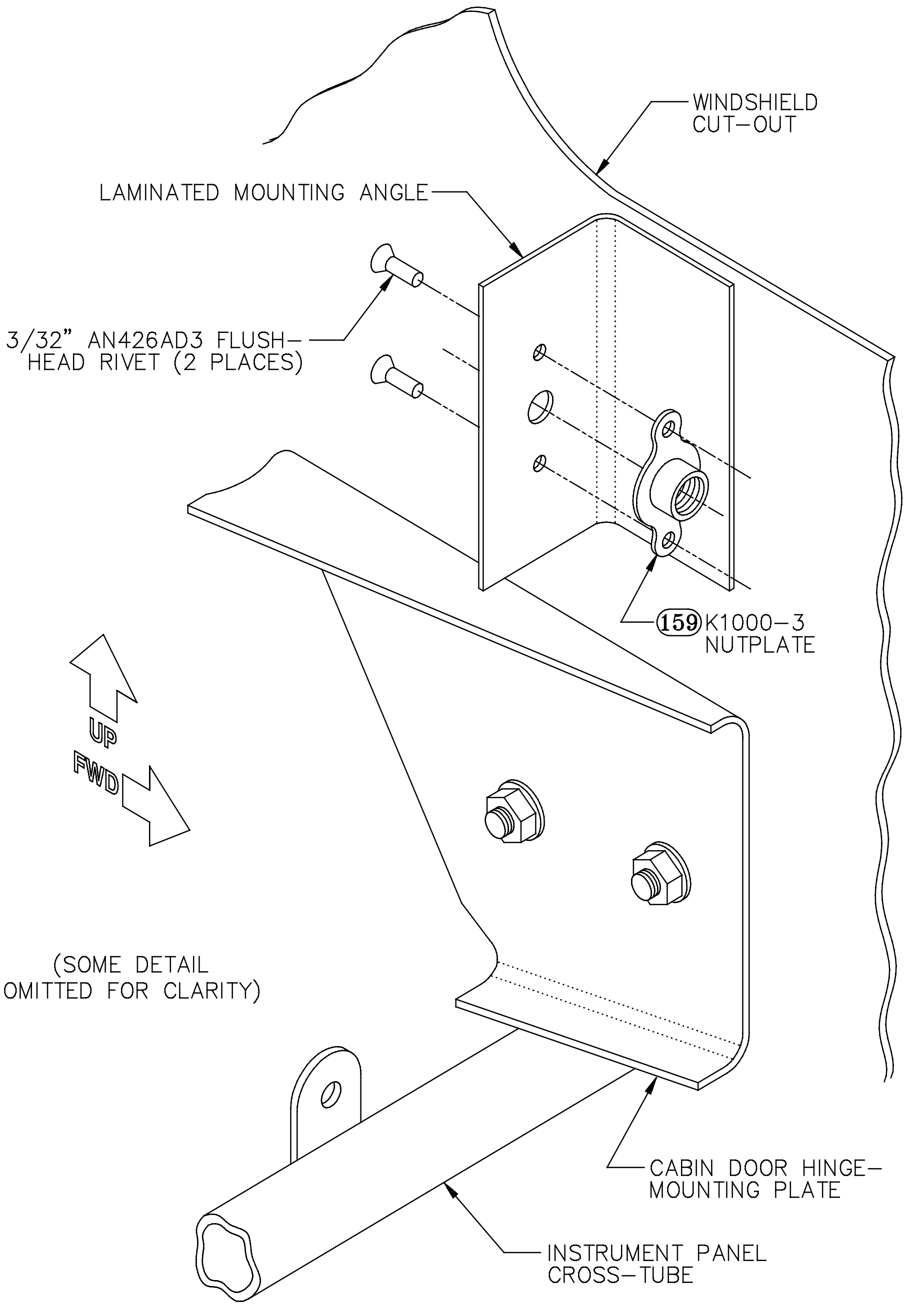


Figure 160: Installing Nutplates on the Panel-End Mounting Angles

Step 145: Fabricate and Install the Panel Braces

Two braces made of aluminum angle stock run from the top of the panel to the front of the cage to provide support to the upper edge of the panel. Cut these braces from the remaining length of .063" X 1/2" X 1/2" angle stock; each brace should be **18.5"** long. **Note:** Verify the actual length requirement against your Sportsman before cutting.

Each end of each brace must be prepared for mounting, as shown in Figure 161. The figure shows the left-hand brace; be sure to make the right-hand one a mirror image. First, cut away about **3/4"** of the **horizontal** flange at the forward end. Bevel the forward edge of the remaining horizontal flange to about **45°**. Next, mark and drill a **#19** hole through the **vertical** flange of the brace **1/4"** in from the forward end. The hole should be roughly centered vertically on the flange; just eyeball this. After drilling and deburring the hole, round the forward end of the brace, as shown. A **1/4"** radius is ideal here, but this isn't too critical—just knock the corners off the angle without shortening its overall length.

On the aft end of the brace, you need to cut away about **1-1/4"** of the **vertical** flange and bevel its aft edge to about **45°**. Then round the aft end of the brace as shown. Finally, sand or file all the cut edges smooth.

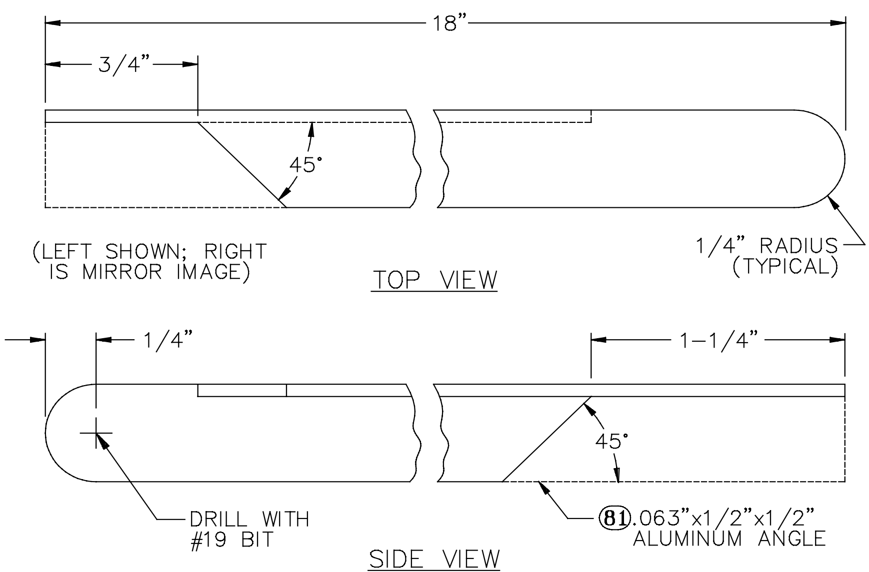


Figure 161: Trimming and Drilling the Panel Braces

Next, temporarily bolt the forward end of each brace to the angle brackets you positioned back in the "FIREWALL INSTALLATION" sub-section. As shown in Figure 163a, the braces are secured to the **inboard** side of the brackets with AN515-8R10 **round-head machine screws** [138], AN960D8L thin aluminum washers and AN364-832A nylon self-locking nuts. Don't tighten the nuts now—just get them started.

When the forward ends of the braces are secured, the aft ends should end up right at the forward side (relative to the aircraft) of the instrument panel. If necessary, file a bit of material off the aft end of the brace so that it fits cleanly. Next, bend the horizontal flange of the brace downward slightly at the aft tip so that when it is pulled up under the horizontal flange of the panel bow, it meets the bow squarely. Finally, with the brace held firmly against the underside of the bow, drill a **#19** hole down through the bow and brace, as shown Figure 163b.

> **Note** The braces should be roughly perpendicular to the instrument panel, but this is not critical.

Complete the braces by installing a K2000-08 single-lugged **nutplate** [161] at the aft end of each one, as shown in Figure 162. Countersink the **#40** rivet holes on the **upper** surface of the horizontal flange to accommodate 3/32" AN426AD3 flush-head rivets, and rivet the nutplate in place.

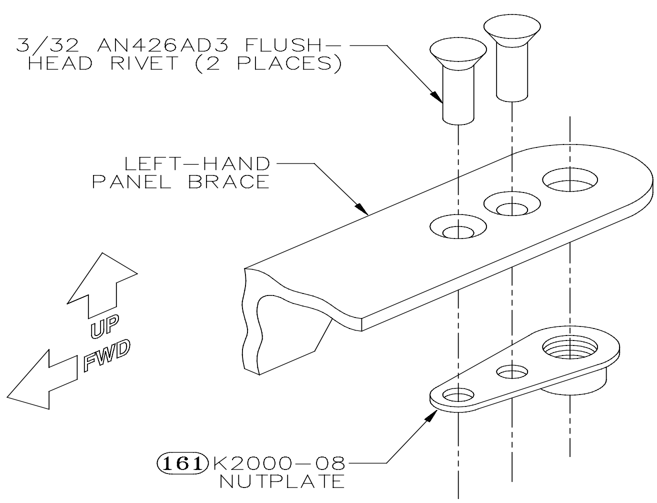


Figure 162: Riveting a Nutplate to the Aft End of the Panel Brace

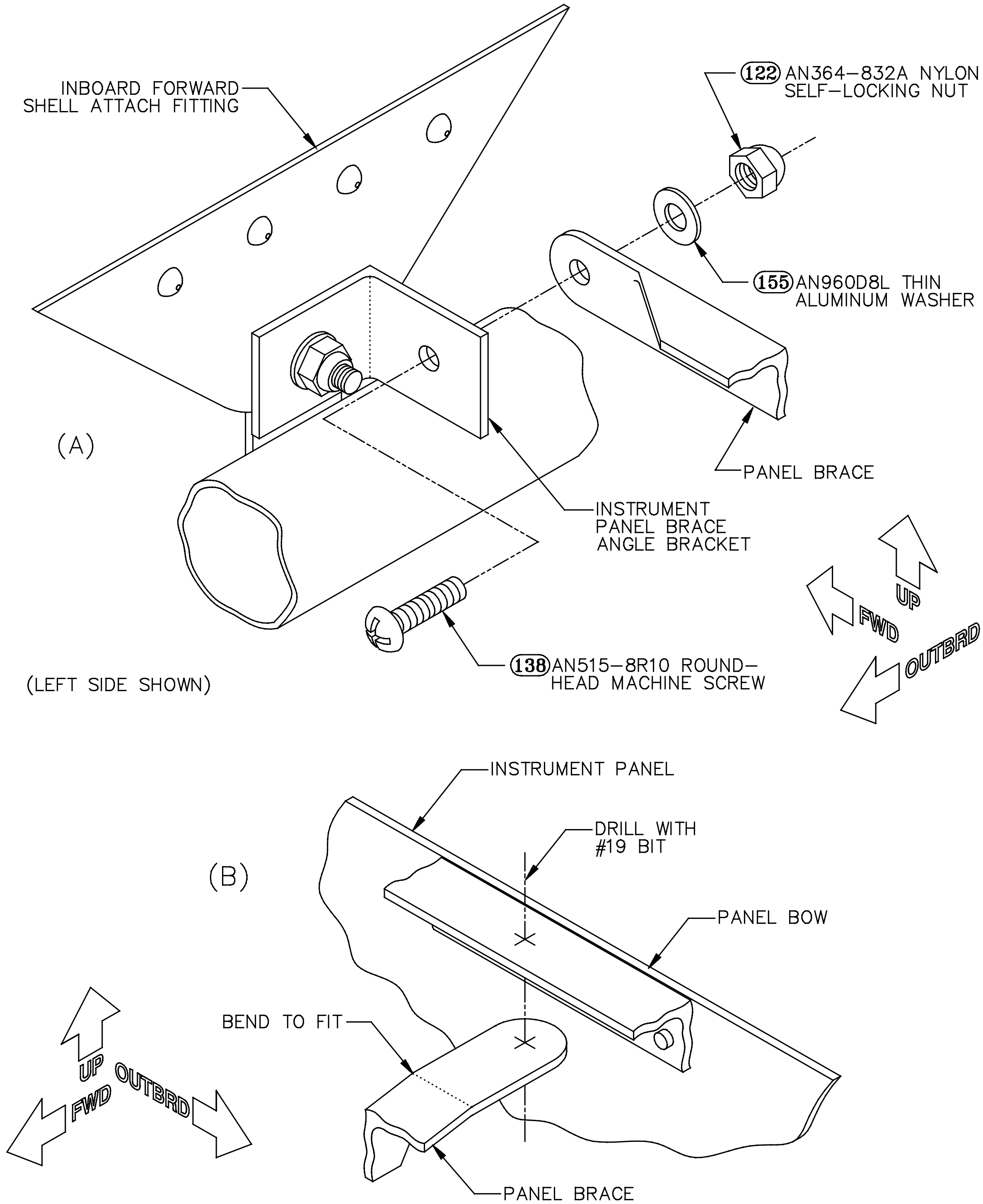


Figure 163: Drilling the Aft End of the Panel Brace

Finally, countersink the upper side of the two brace holes in the panel bow to accommodate AN507-8R8 **flush-head machine screws** [133]. Secure the aft ends of the braces temporarily by threading these screws into the nutplates.

Completed: [ ]

Step 146: Fit the Glare Shield and Install Its Mounting Tabs

The glare shield closes out the area between the top of the instrument panel and the base of the windshield. It is best constructed of thin aluminum sheet (**.016"**-thick material is ideal) in two halves with a seam down the middle. Materials for the glare shield are not included in the standard Sportsman kit.

We recommend that you first fashion cardboard templates and then, after fitting them to your satisfaction, transfer the shapes to the glare shield material. The shield should extend **2"–3"** aft of the instrument panel to provide a bit of shade from direct sunlight for the instruments. The aft edge of the shield should be rolled or otherwise provided with a blunt edge. The shield can be secured with screws through the panel bow to nutplates.

At the forward edge, simple mounting tabs that hold the shield against the inside of the windshield frame are sufficient to secure the shield (see Figure 164a). These tabs can be fabricated from sheet aluminum (**.025"**-thick material is best) or from a two- or three-layer pre-cured laminate of bi-directional cloth. Use blind rivets through the inner fuselage laminate to secure aluminum tabs; glass tabs can simply be bonded in place with resin.

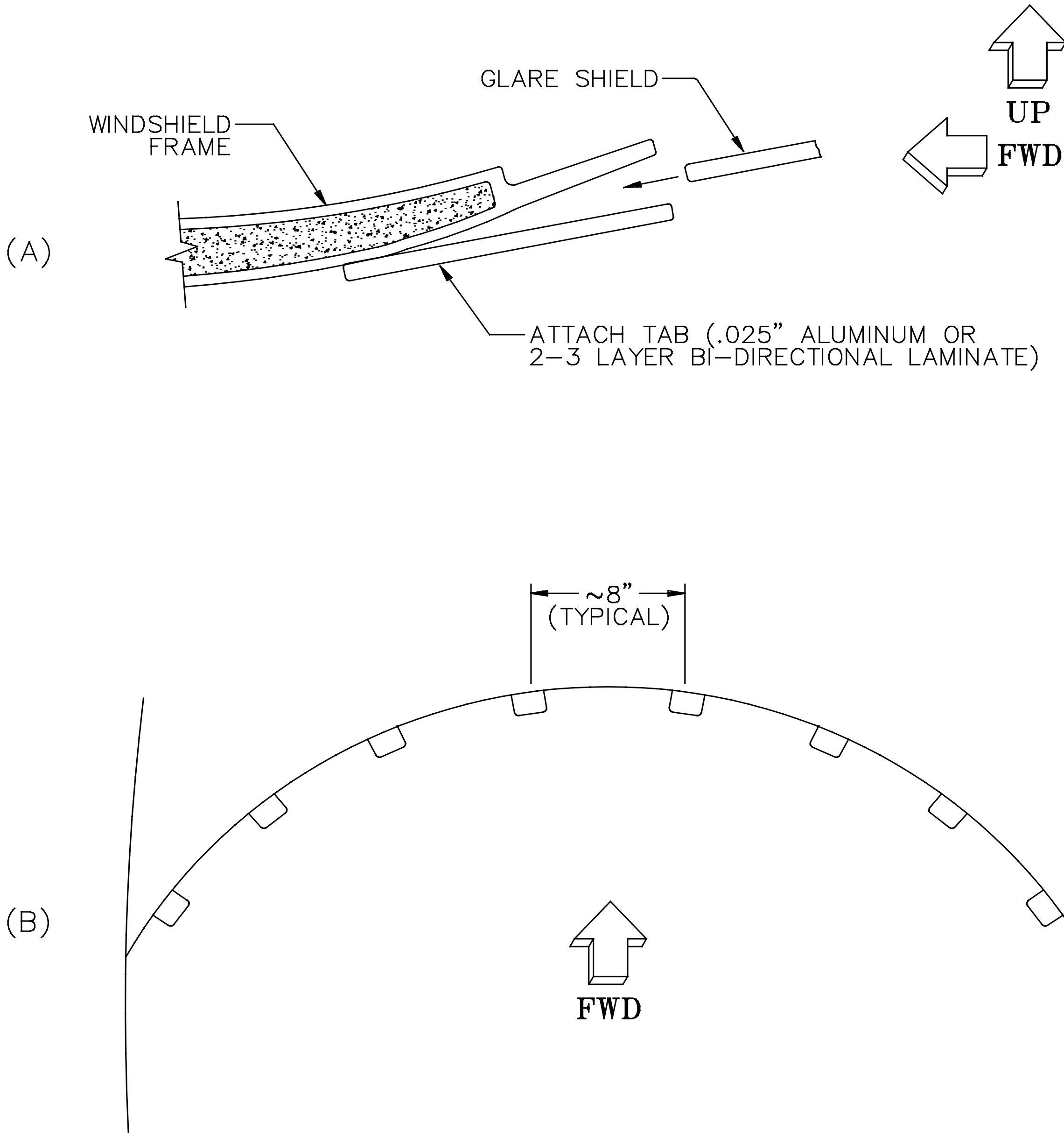


Figure 164: Glare Shield Mounting Tabs

As Figure 164b shows, space these tabs about every **8"** for best results.

Completed: [ ]

Step 147: Drill Fastener Holes in the Aft Edge of the Glare Shield

With the tabs securing the glare shield around its forward edge, you only need four or five fasteners along the aft edge to hold the shield in place. The simplest installation would be screws into nutplates riveted to the underside of the panel bow.

Position the glare shield, drill the appropriate holes through the shield and the bow, and rivet the nutplates in place. Then set the glare shield aside.

Completed: [ ]

Step 148: Mount the Instruments and Avionics in the Panel

At this time, remove the panel from the airplane and install all the goodies in it—instruments, avionics, switches, breakers, etc. Also, label the panel at this time; you'll find this much easier to do on your bench than in the cabin.

Note Don't forget your "Passenger Warning" placard. You can bet that your airworthiness inspector won't! See "SECTION I: INTRODUCTION" for the required wording.

Completed: [ ]

Step 149: Install the Panel in the Cabin for the Final Time

Return the completed panel to the airplane, securing it at every location. Use NAS603-7P screws (with AN960D10L thin aluminum washers under the heads) at each of the two end holes and all six of the lower holes. The end screws should be tightened into their nutplates, and the lower screws should be secured with AN960-10L thin washers and AN364-1032A self-locking nuts.

Next, position the aft ends of the panel braces under their respective holes in the panel bow and tighten AN507-8R8 flush-head screws into the nutplates. Finally, tighten the pair of AN364-832A self-locking nuts at the forward ends of the braces.

Completed: [ ]

Step 150: Plumb the Pressure Instruments

Pitot/Static System Options If you're installing either of Glasair Aviation, LLC's Pitot/Static System Option Kits, **turn to the *Option Instructions* now**. Return to Step 152 of this *Assembly Manual* when the specified option steps have been completed.

☞

Connect your airspeed indicator, vertical speed indicator, altimeter and/or altitude encoder to the static system and your airspeed indicator to the pitot system.

Completed: [ ]

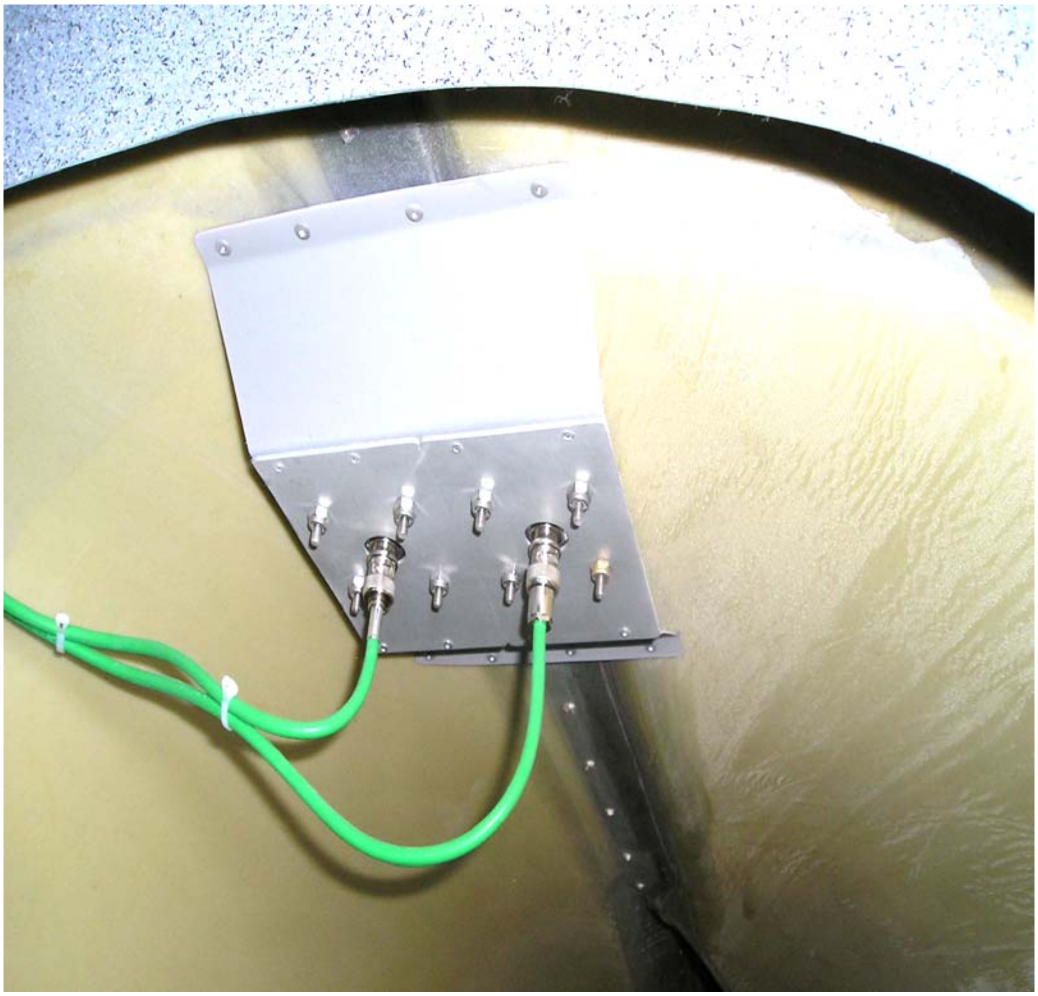
Step 151: Wire the Panel

Like Step 7 of this section, in which you "completed" the firewall forward installation, wiring the panel is a much bigger job than a single "step." And, also like the firewall forward stuff, the task of wiring the panel varies so much from airplane to airplane that we cannot offer much guidance here. However, instructions for wiring individual components are typically provided by the manufacturers; be sure to follow all such instructions rigorously.

Some builders like this part of the project better than just about any other, while other builders can't wait to get somebody else to do it. In either case, be methodical and be neat. Mark **both ends** of every wire and draw a schematic of your wiring installation as an aid to future trouble-shooting. When you have to crawl under the panel to tackle a balky radio or trace a short circuit, you'll be grateful for every hour you spent making a clean job of the wiring!

Completed: [ ]

Page 268: An optional location for the GPS antenna will be given in Step 138. This location is right behind the Bulkhead A on the upper underside of the fuselage shell.



Page 287: [redacted]

[redacted]

Note The glare shield can be installed now if you wish, but we recommend leaving it out until after your final inspection prior to flight. It will be a particular nuisance if it's in place during the installation of the windshield.

WINDOW INSTALLATION

The procedures for installing all the Plexiglas windows in the Sportsman are the same, except for differences in the methods for clamping the various windows in place while the bonding mixture cures. The following instructions therefore describe generic procedures that you can adapt to whatever particular window you're working on.

Reference the end of this Section X for additional photos, which show various window installation details.

The windows can be installed before or after the exterior paint is applied to the fuselage. Our recommendation is to install the windows prior to paint and accomplish the final gap filling described in Step 157 after paint. If you chose this method, be aware that you need to avoid getting silicone contamination on the exterior skin. It is very difficult to see and remove and causes fish-eye problems in the paint finish. We do not recommend performing the final filling of the exterior trough with Silpruf until after the application of the exterior paint.

The windows can be installed in any order, but we recommend starting with the smallest ones—the skylights—to perfect the procedures before moving on to the larger, more difficult ones. We also recommend leaving the **windshield** [21] unbonded until the last possible moment; although you were encouraged in the last sub-section to complete the instrument and avionics wiring and plumbing and the glare shield installation, it's not unlikely that you'll need to get back in there again before you're done, and such work is **much** easier with the windshield area left open. You'll minimize your opportunities to scratch the Plexiglas windshield that way, too!

The window installation procedure can be summarized as follows:

A) Check the fit of the window inside the joggled mounting flange and make minor adjustments, if necessary.

B) Prepare the mating surfaces of the window and the mounting flange on the fuselage for bonding.

c) Mask off all surfaces of both the window and the fuselage near the bonding area to ensure clean adhesive lines.
D) Paint the bonding surface of the window using Silpruf
E) Bond in the window using Silpruf.
F) Finish wipe on exterior channel once the window bonding has cured.

Note In addition to the skylights and windshield already discussed, the other windows to be installed include the **left** and **right quarter windows** [24 and 25] and the **left** and **right door windows** [22 and 23].

Step 152: Fit the Window to Its Mounting Flange

On the fuselage and doors, block sand and deburr all the fiberglass window flanges to a uniform 5/8" width (1/2" minimum).

The windows are rough trimmed at the factory and will require final trimming before installation.

Mask off the inside and outside of the window to protect the surfaces. Initially leave approximately 1.5" exposed on the inside surface. This will be masked off later. Place the window in position on its mounting flange and check its fit. For aesthetic appearances, mark any places where trimming might be required to achieve a uniform gap of **.10-.13"** all around the glass. A larger gap is acceptable, but does not look as good.

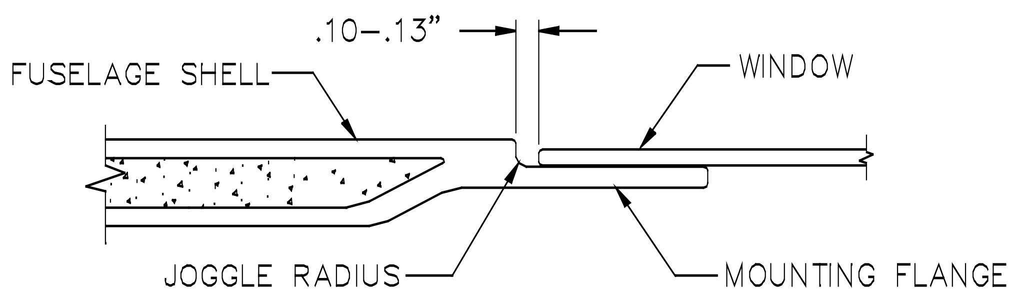


Figure 165: Checking the Fit of the Window to the Mounting Flange

Taking care not to scratch the exposed inside border, remove the window and use a drum sander or sanding disk at first and eventually sandpaper on a sanding block to finish trim its edge where necessary to adjust its fit. The goal of this final sanding is to remove from the edges of the Plexiglas all nicks, scratches and irregularities that could possibly induce cracking. In particular, the slight, scalloped indentations left by the factory trimming router must be completely eliminated. You may find it necessary to begin sanding with coarser sandpaper and finish up with 150-220 grit paper. All final sanding should be parallel to the edge, not across it. When you are done, you should have slightly radiused each corner, as shown in Figure 165.1.

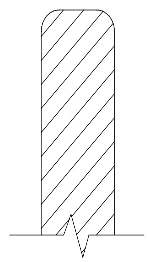


Figure 165.1: Properly Radiused Plexiglas Edge

Caution This final sanding with fine paper is an important step; removing any edge roughness eliminates stress risers that might lead to cracking.

Completed:

Skylight — Left [ ] Right [ ] Quarter Window — Left [ ] Right [ ]
Door Window — Left [ ] Right [ ] Windshield [ ]

Step 152.1: Drill Clamping Points Through the Window Flange

* Wingnut style (long reach) Clecos are expensive, but they are ideal for this application since the clamping pressure can be adjusted. #40 extra long Clecos can also be used which typically cost half as much as wing-nut style. You will need ~ 20 Clecos to do two windows at a time. We have used 10 of each type during installation.

Drill through the mounting flange (between the joggle and the window edge) at approximately 6-8" spacing with a #40 drill and insert a wingnut cleco to hold the window in position. Add more Clecos as necessary in order to secure and hold the window as desired. Mark the cleco locations on the fuselage.

Make two wooden or aluminum clamping pads (.5L x .38 wide) for every cleco used. They can be made from any thin piece of wood like a paint stir stick or something similar. One pad will be used on the exterior and will hold the window flush to the fuselage shell. The other will reinforce the inside since Clecos have a tendency to pull through fiberglass. This installation technique can be seen in Figure 169. Use a very light clamping pressure with the wingnut Clecos to avoid damage to the windows.

Completed:

Skylight — Left [ ] Right [ ] ; Quarter Window — Left [ ] Right [ ]
Door Window — Left [ ] Right [ ]; Windshield [ ]

Step 153: Mask and Prep the Mating Surfaces of the Mounting Flange and the Window

Next, mask the fuselage around the window mounting flange by applying masking tape (or vinyl striping tape) right up to the edge of the flange joggle all the way around, as shown in Figure 166. Then apply 2"-wide paper masking tape overlapping the first tape around the perimeter to further protect the outside of the fiberglass structure. **Note: if you are installing the windows before painting the plane, wrap the masking tape over the edge of the trough to protect the corner from silicone contamination.**

Also, thoroughly sand the window mounting flange of the fiberglass fuselage shell with 100-150 grit sandpaper until dull. Sand the internal fillet of the flange, but do not roll over the corner common to the fuselage exterior.

Once a uniform gap has been achieved, position the window with the Cleco clamps and mark the mounting flange edge on the **inside of the window** using a **wet erase** fine tip marker as shown in Figure 167. (VIS-À-VIS is a common brand available at most stationary supply stores.) Use of a permanent ink will leave an unsightly black or colored line visible from the exterior. Water soluble pens allow for easy removal of the pen mark.

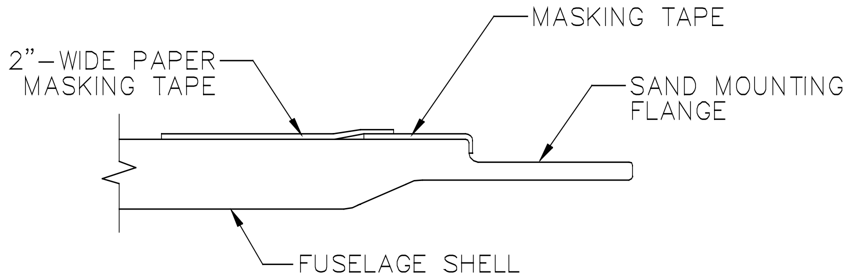


Figure 166: Sanding and Preparing the Window Mounting Flange

The mating surface on the inside of the Plexiglas must be sanded in preparation for bonding, but first it is necessary to tape off the rest of the inside of the window. Using 3/4" wide masking or vinyl tape, tape to within 3/16" of the inboard edge of the marked line.

Then using 1/4" masking or vinyl tape, tape to within 1/16" inside the marked line, as shown in Figure 168. (Note the window is upside down in the figure.) Keep the taped lines straight and the corner radiuses uniform since this edge will result in the final revealed edge. As you complete the masking, run a 6" long overlapped extension (tail) of the masking tape and then loop the tape in towards the center of the window. This makes it easy to grab the end and remove the tape when it is time. Mark this **tape #2** on the end. **Important: Completely remove the marked line with a moist towel.**

Note: It is important that these 1/4" masking tapes are applied in a <u>continuous strand</u>. If the tape breaks, start again until you achieve a continuous piece. For the best cosmetic result, you want to pull the tape off in one continuous strand.

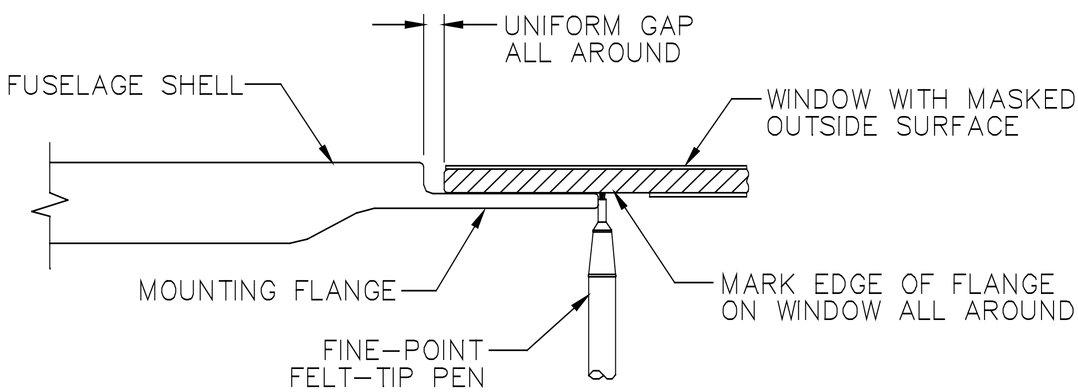


Figure 167: Marking the Edge of the Mounting Flange on the Inside of the Window

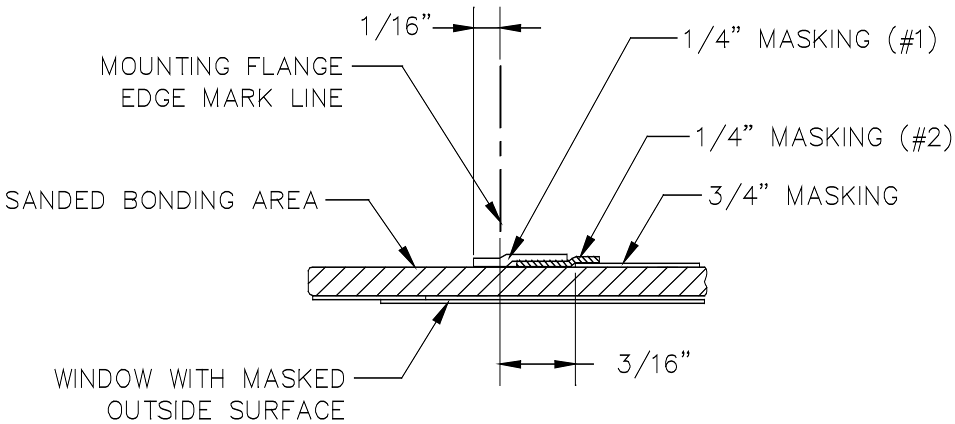


Figure 168: Masking the Inside Surface of the Window

Again using 1/4" masking tape, apply a second layer over the #2 1/4" masking tape, but tape just outboard of the edge (where the marked line was) by roughly 1/16" as shown in Figure 168. Using the same technique as the first application, overlap the tape and run a second tail towards the center of the window and **mark this tape #1.** The #1 tape will be removed first and the #2 tape will be removed second.

Using 150-220 grit sandpaper, sand the bonding surface of the window being very careful not to sand on the 1/4" masking tape. Sand to within 1/16" of the taped edge. Keep your sanding strokes parallel to the window perimeter so as not to scratch across the edge that was previously prepared.

Clean all the bonding surfaces thoroughly with air or dry wipe, but **be careful not to use solvents on the window surfaces.**

Completed: Skylight — Left [ ] Right [ ] Windshield [ ]

Quarter Window — Left [ ] Right [ ]Door Window — Left [ ] Right [ ]

Step 154: Paint the Bonding Surface of the Window

A thin layer of Silpruf will be applied to the bonding surface of the window. This will give the window a very clean and finished appearance from the outside free of air voids. Apply a caulking gun bead approximately 1/4" wide by 1/8" thick. Using your finger, spread the bead out into a uniform layer over the bonding surface of the window. Wipe any excess away from the tape edge, so that when the tape is pulled, it leaves a thin, clean edge. Once you are satisfied, slowly remove the tape marked #1. Set the window aside and allow to cure for 12-24 hours. Perform the standoff portion of Step 155 so the Silpruf standoffs can cure at the same time as the opaque surface. If you want, mask the rest of the exterior surface of the windows out to the edge to protect them.

Completed: Skylight — Left [ ] Right [ ] Windshield [ ]

Quarter Window — Left [ ] Right [ ]Door Window — Left [ ] Right [ ]

Step 155: Set the Window Depth in the Bonding Flange

The window joggle flanges are all slightly deeper than the windows themselves. This will allow for the bonding agent to fill the gap and then the exterior of the window to be approximately flush with the outside of the fuselage. It is a little difficult to set the depth of the window during bonding unless you have some standoffs at the locations of the previously drilled Cleco fasteners in Step 152.1. This will keep the window from settling in too deep or riding too high during bonding.

There are several ways to accomplish this and the method described here is by no means the only way. Feel free to modify the technique, just end up with the same results.

Squirt a small pea sized mound of Silpruf on the center of the fiberglass mounting flange at each Cleco location. Apply one "pea" every 6-8" along the perimeter of the flange and allow these to cure fully. Be sure each pea is a minimum 3/16" in height. Also squirt a 1/4" diameter Silpruf bead by 6" long on a piece of scrap aluminum and let dry.

After the painted window and the peas have cured, place the window on the mounting flange and begin to shave down the standoffs with a new razor until the window can be pressed flush to the exterior of the fuselage with slight pressure.

Mark the location of each standoff on the fuselage to identify the positions once the window is in place. If you need additional standoff, slice them from the 6" bead.

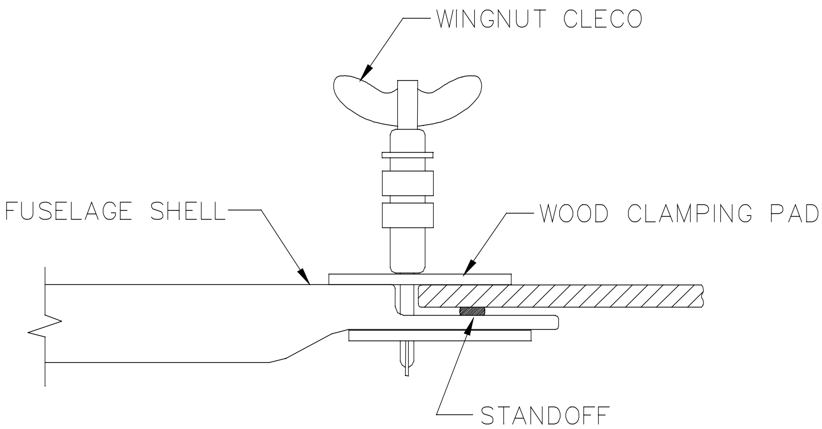


Figure 169: Wingnut Cleco Clamp Positioning the Window

Complete [ ]

Step 156: Bond the Windows in Place

Make sure you have plenty of clean rags and remember to keep yourself and your tools clean during the next step.

Mask off the interior of the fuselage mounting flange around the perimeter of the window. Protecting the Zolatone finish will pay big dividends in reducing the amount of interior touch up work later. Clean the window mounting flange surface with a paper towel and some acetone.

Begin by applying a thin layer of Silpruf to the window on the 1/16" gap between the pre-cured color coat and the #2 masking tape on the inside of the window. Smooth this out with your finger tip. Remember to apply it and smear it flat without any trapped air.

Next, apply a thick 3/8" bead of Silpruf on the mounting flange. Favor the bead to the inside 1/3 of the flange. Also put a dab of Silpruf on each standoff. Position the window on the flange and press it down into position on the standoffs. Insert the wingnut Clecos and wooden pads and draw the window carefully down to the standoff and flush with the exterior allowing the excess to squeeze out around the interior and the exterior.

Use a tongue depressor to remove any excess squeeze-out in the exterior gap between the Clecos. This gap must be wiped well below the final desired radius as shown in Figure 170. If you have rolled the exterior tape into the trough, you will need to remove any significant Silpruf buildup here in order to pull the tape in preparation for paint. Use a narrowed tongue depressor to smooth out the reveal down inside the trough and clean up the Silpruf next to the Clecos.

Use a radiused tongue depressor to smooth out the reveal between the interior joggle flange and the #2 masking tape or simply wipe the fillet with your finger as shown in Figure 170. For the best finished edge, be sure not to have excess Silpruf over the masking tape prior to pulling the tape. When satisfied with the results, slowly pull the **#2** (1/4") masking tape off the interior perimeter of the window.

Note Taking extra care to clean up excess Silpruf thoroughly and to form a smooth, deep radius on the outside. The clean up here is important as you do not want any high or ragged edges interfering with the final exterior application and wipe.

Let the bonding mixture cure completely for 2-4 days, depending on temperature.

Completed:

Skylight — Left [ ] Right [ ] Quarter Window — Left [ ] Right [ ]
Door Window — Left [ ] Right [ ] Windshield [ ]

Step 157: Finishing Touches

Remove the Clecos and clean up these locations by removing the high spots with a new razor where the Silpruf bridged the gap under the clamping pads. Check to make sure that no high spots of cured Silpruf will prevent a radiused tongue depressor from making a smooth sweep along the perimeter. Pull any loose slivers of Silpruf free. They have an annoying way of sticking out on the surface during the final wipe.

The final application of Silpruf into the trough can be done now if the plane was painted before window installation, or once you have finished painting.

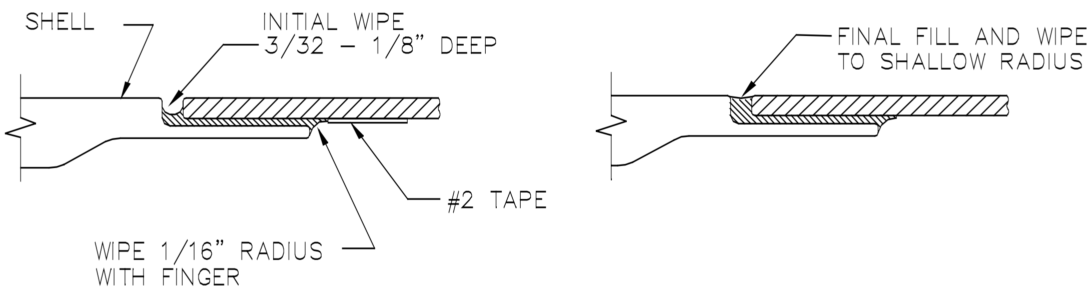


Figure 170: Wiping the Silpruf

Apply a generous bead of Silpruf into the exterior gap and sweep a smooth radius with a shallow radius tongue depressor.

Remove all masking tape when satisfied with the finish and allow to fully cure.

Completed: [ ]

CONTROL SURFACE BALANCING AND FAIRING INSTALLATION

All the control surfaces of the Sportsman are counterbalanced to prevent the possibility of flutter. With the exception of the rudder, all the surfaces are balanced to 100%, meaning that they have the same moment forward of the hinge line as they do aft of it. For this balancing to be as accurate (and thus as safe) as possible, the surfaces should be balanced **after** they have been painted, since paint significantly affects the weight of the surfaces. If necessary, you can defer the next several steps until you're ready for them. However, the ailerons, trim tab and elevator definitely **must be counterbalanced prior to flight.**

Note: Figures 171-177 have been deleted.

Step 158: Install the Aileron Counterweights

In Steps 4 and 5 of "Section VII: Aileron and Flap Assemblies," you drilled holes in the aileron counterweight ribs and mounted nutplates for securing the aileron counterweights. In this step, you will fasten the aileron counterweights to the outboard ends of the ailerons. Begin by removing the wingtip fairings, if installed.

In early Sportsman kits, mounting holes were pre-drilled in the **left** and **right aileron counterweights** [36 and 37]. These holes were eliminated from the counterweights shipped with later kits due to alignment difficulties. If your aileron counterweights already have mounting holes, skip the procedure described in the following two paragraphs and in Figure 178.

To drill the mounting bolt holes most accurately, use the pre-existing holes in the aileron counterweight ribs as guides. Slide each aileron counterweight between its respective pair of ribs, as shown in Figure 178. Pay careful attention to the orientation of the weight, as shown in the figure: the "fat" sides of the counterweight go up and outboard. Slide the arm between the ribs until its aft end comes into contact with the spar web inside the aileron. Make a mark on the arm where it emerges from the aileron, as shown in Figure 178a. Then withdraw the arm from between the ribs until the mark is **7/32"** forward of the leading edge of the aileron, as shown in Figure 178b. With the arm in this position, mark the locations of the two mounting bolt holes, as shown.

Note It is recommended that you check the balance of the ailerons at this point. If more weight is needed forward of the hinge, slide the aileron CW arm forward until you have reached an absolute minimum edge margin of **.31"** between the center of the hole and the edge of the steel tube. You are better off a little heavy so weight can be removed to obtain balance.

Withdraw the arm from the aileron, center punch the two bolt hole locations and drill them with a **#10** bit. Drill all the way through both sides of the tubing. Use a drill press if you have one, but strive in any case to keep the holes perpendicular to the arm. Deburr the holes after drilling.

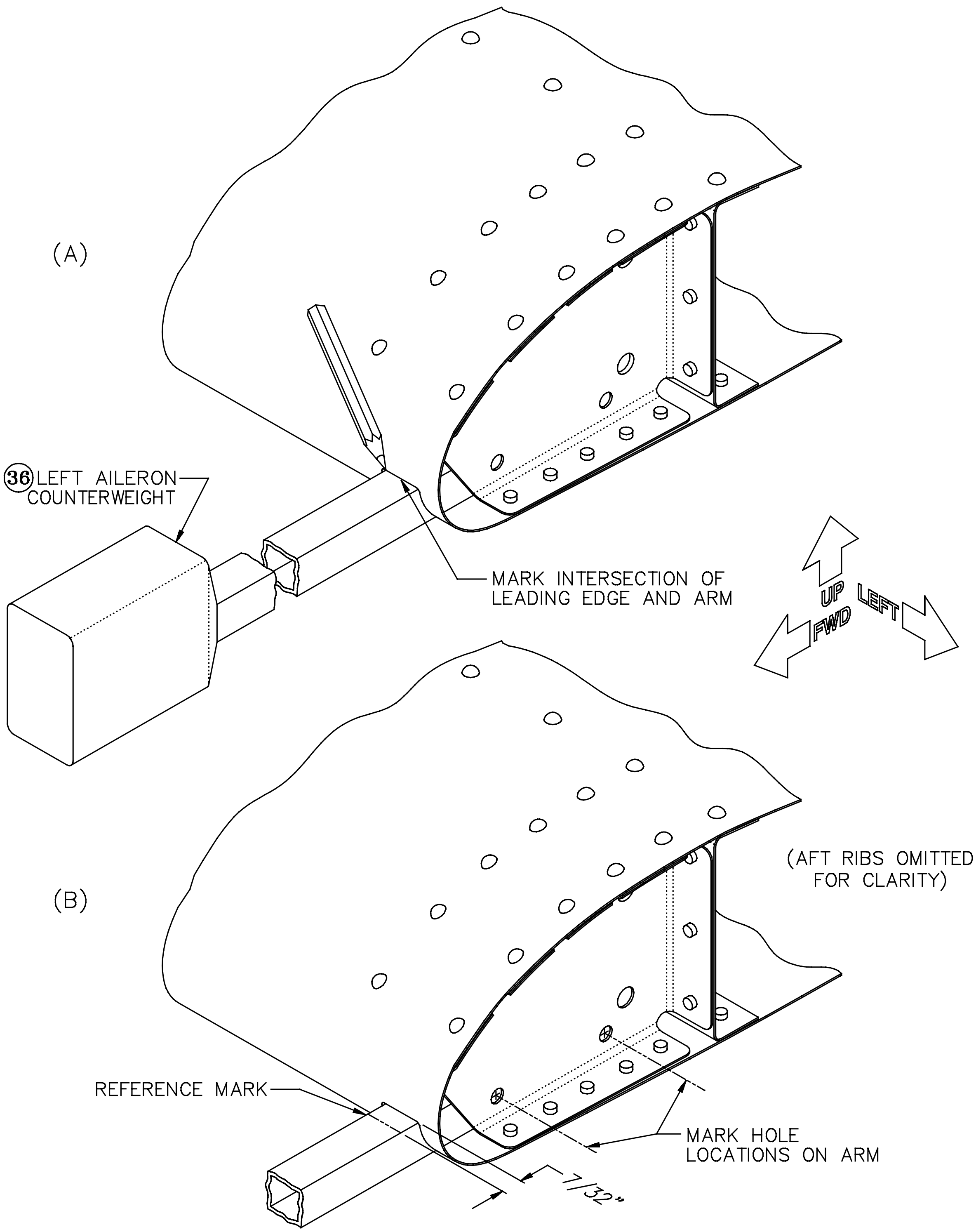


Figure 178: Drilling the Mounting Bolt Holes in the Counterweight Arms

Insert each drilled counterweight arm into its respective aileron and secure it, as shown in Figure 179, with AN3-7A **bolts** [116] and AN960D10L thin aluminum washers. Pay careful attention to the orientation of the lead weight so that you match the correct counterweight assembly to each aileron.

Hint The counterweight will have to be installed and removed several times during fit-up. To simplify installation and removal and to help preserve the self-locking feature of the nutplates, temporarily stack several extra washers under each bolt head to limit the bolt's penetration into the nutplate. Remove the extra washers before installing the counterweight for the final time.

Completed: Left [ ] Right [ ]

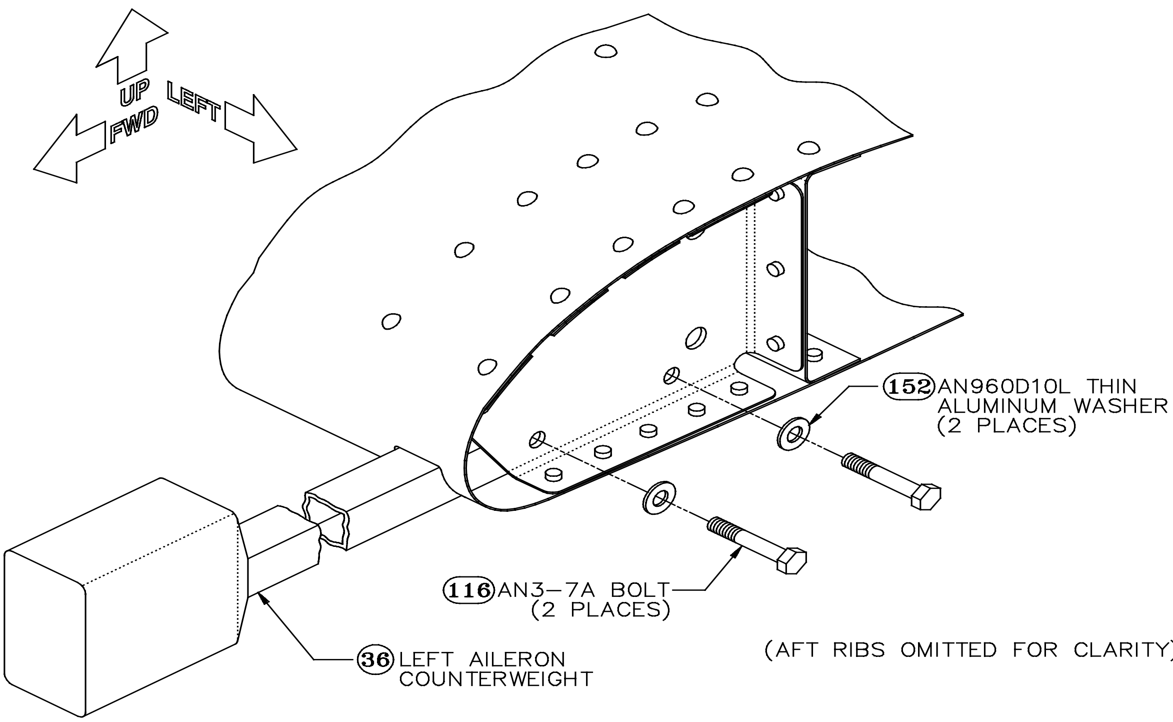


Figure 179: Installing the Counterweight

Step 159: Adjust the Aileron Counterweights

Scribe lines are provided on the wingtip fairing for a slot through which the counterweight arm passes. The scribe lines provide only an approximate reference for locating the counterweight slot. Cut about **1/8"** inside the lines first and then secure the tip fairing to the wing with one or two screws to check the fit of the counterweight in the slots.

Note To get the best fit in the scribed slot, you may have to bend the counterweight arm **outboard** slightly. Clamp the aft end of the counterweight arm in a vise, and bend the forward end about 1/8" outboard, measuring just aft of the lead weight. You can make the bend cold, but **do not** grasp the lead weight itself during bending. Even though the weight is secured with internal reinforcement dowel pins, you could still loosen it enough to cause it to rattle.

Enlarge the slot in the tip fairing until there is a minimum clearance of **3/16"** between the counterweight arm and the fairing. Smooth the slot with files and sandpaper.

Warning Make sure you provide a **minimum** 3/16" clearance for the counterweight. Since the counterweight can vibrate during flight, you want to be **absolutely certain** that it will not contact the tip fairing, causing the ailerons to bind.

Note When cutting the notch for the counterweight in the tip fairing, you will notice that the narrow portion of the fairing inboard of the counterweight arm is purely cosmetic, since it provides no structural support for the fairing. We think the fairing looks better with this small strip left in place (although you must be more careful with the fairing when it is removed from the wing), but you can cut it away if you choose, which will open up a gap about 1/2" wide on the inboard side of the counterweight arm.

Once the counterweight is well fitted relative to the slot in the fairing, bend the arm down until the weight is flush with the bottom of the fairing when the aileron is in the neutral position (you will need to bend the arm down approximately **1/4"** measured just aft of the weight). Again, clamp the arm in a vise and bend it cold, being careful not to loosen the lead weight.

Temporarily reinstall the arm in the aileron. Then temporarily disconnect the pushrod so the aileron is free to pivot on its hinges. As shown in Figure 180, trim lead from the forward upper corner of the counterweight until the aileron is balanced.

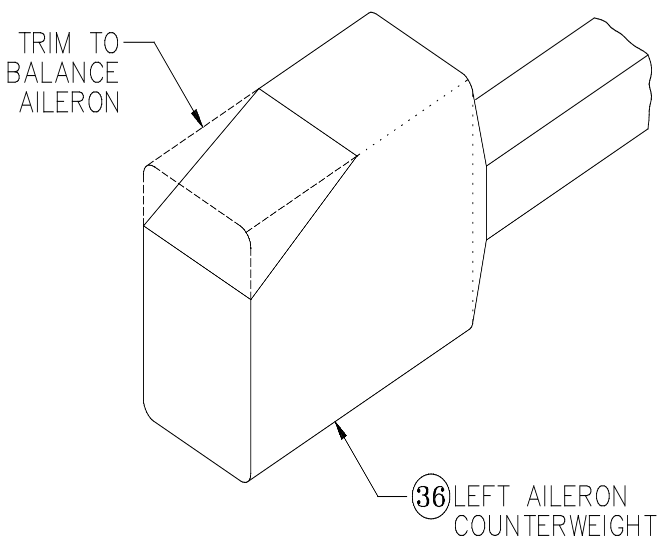


Figure 180: Trimming the Counterweight

When you've achieved a balanced condition, re-connect the pushrod. Deflect the aileron full-up and check to see that the control stick pivot bracket in the cabin contacts its stop **before** the aileron counterweight contacts the wingtip fairing. If necessary, put the arm back in a vise and bend it downward a bit more to eliminate this problem.

When the counterweight is fitted satisfactorily, you can smooth the lead weight with body putty (Bondo) and paint it if you want a nice finish. We recommend that you slosh a primer paint on the inside of the tube as well. Then permanently install the counterweight arm, remembering to remove the extra washer from under the bolt heads.

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Warning If you are installing wingtip lighting of any kind, it is **recommended** that you install a **close-out bulkhead** in the wingtip fairing just aft of the aileron counterweight arm cutout. It is **essential** that all wingtip light wiring be secured well clear of the aileron counterweight to preclude the possibility of light wiring jamming or impeding free movement of the ailerons. The close-out, if used, could consist of a simple two- or three-layer pre-cure of bi-directional cloth bonded into the fairing.

Note The following eleven steps, which cover counterbalancing the trim tab and elevator, were included in slightly different form in the initial release of "SECTION V: ELEVATOR ASSEMBLY." If you completed your horizontal stabilizer, elevator and trim tab according to those early instructions, then you should just skim the following pages to make sure that you have completed the work.

Completed: Left [ ] Right [ ]

Step 160: Determine the Size of the Elevator Trim Tab Counterweight

Note: This step applies to **Manual Trim Only**

Since no two trim tabs are likely to weigh exactly the same, the amount of weight required to counterbalance the tab will also vary from airplane to airplane, and must therefore be determined by experimentation. Begin by suspending the tab between two supports on short lengths of hinge pin, as shown in Figure 182. The supports can be anything that will hold the tab 10–12" above the bench—wooden blocks, paint cans, etc. The height is not critical but should be the same at both ends.

With the tab suspended between the supports, you can determine with a simple experiment how much weight is required on the counterweight arm to bring the tab into balance. Hang a weight from a thin string or wire through the forward-most hole at the bottom of the counterweight arm, as shown in Figure 182. Vary the weight until the tab is balanced in a roughly horizontal position, as shown.

Hint A good weight to use is a small container (like the bottom half of a tin can) filled with BBs, since it's easy to add or subtract weight.

Once the tab is balanced, remove the weight and weigh it (including the can and the string or wire) to the nearest ounce. We'll call this the **experimental weight**. We also need the horizontal distance from the hingeline to the forward hole in the counterweight arm, which we'll call the **experimental arm**; this is **4.0"**. Multiplying the experimental weight by the experimental arm gives us the **total moment** of the trim tab. Now, the **actual arm** of the counterweight is slightly smaller than the experimental arm, because the counterweight isn't centered on the forward-most hole in the arm but rather between the two holes; this distance turns out to be **3.7"**. Now we're almost home: dividing the total moment by the actual arm yields the **actual weight** required.

Figure 181 shows a sample calculation.

Note Keep in mind that your weights will almost certainly be different than those used in the example. However, the experimental and actual arms in the example **are** the real figures that you should use in your own calculations.

Completed: [ ]

Experimental Calculation	**Actual Calculation**
EXPERIMENTAL WEIGHT = 5 oz.	
EXPERIMENTAL ARM = 4.0 in.	ACTUAL WEIGHT = TTL. MOMENT ÷ ACTUAL ARM
EXP. WEIGHT X EXP. ARM = TOTAL MOMENT	20 in.-oz. ÷ 3.7 in. ≅ **5.5 oz.**
5 oz. X 4.0 in. = 20 in.-oz.	

Figure 181: Sample Trim Tab Counterweight Calculation

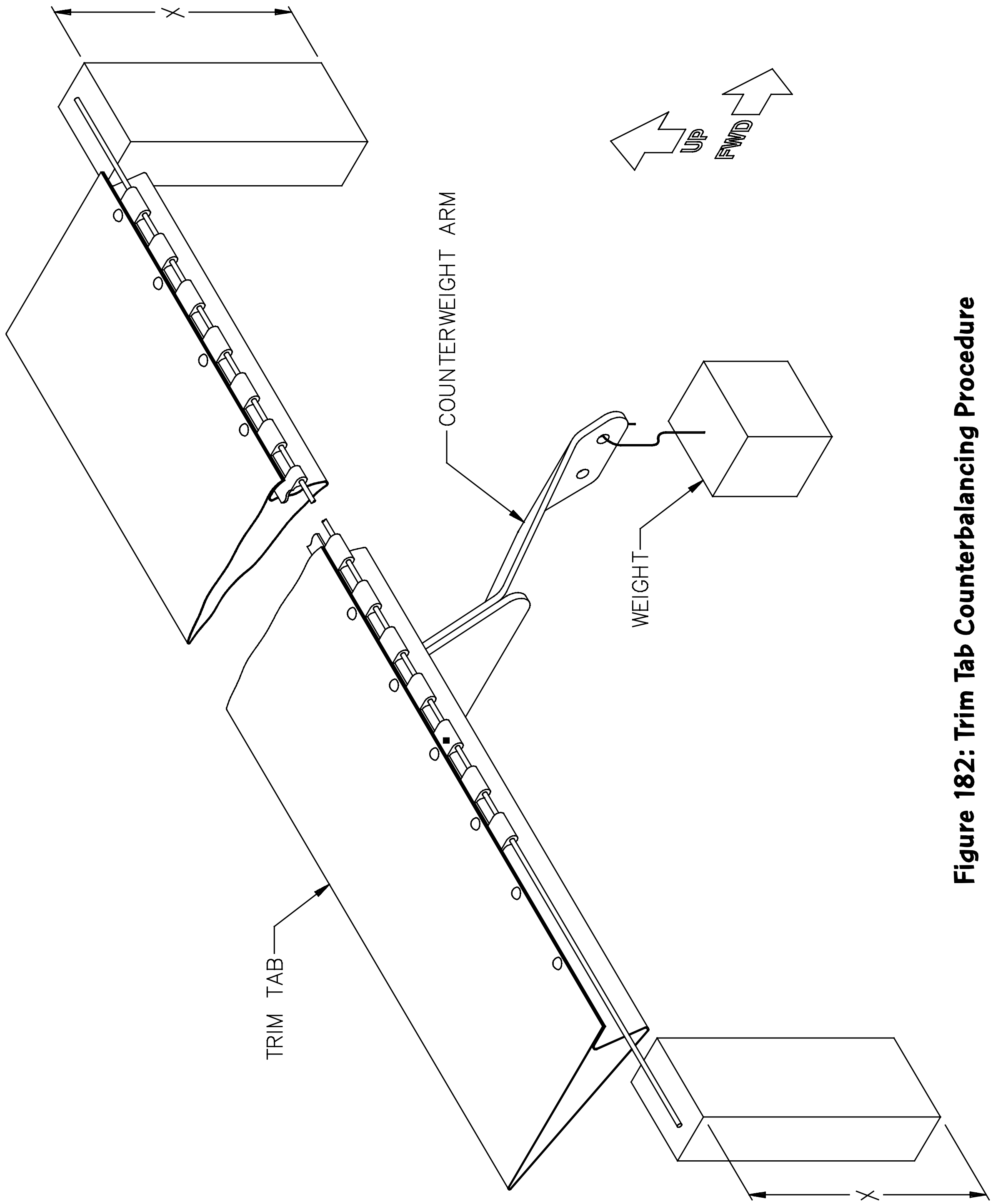

Figure 182: Trim Tab Counterbalancing Procedure

Step 161: Cut and Install the Trim Tab Counterweight

Note: This step applies to **Manual Trim Only**

From the **12"-wide lead sheet** [109] left over from "SECTION III: RUDDER ASSEMBLY," cut several small pieces approximately **1-3/8" X 2"**, as shown in Figure 183. As the figure shows, the upper forward corner of each piece should be lopped off at about a 45° angle; this ensures that the counterweight won't hit the stabilizer or fuselage when full down elevator is applied. Cut a couple more pieces than are necessary to equal the counterweight amount you calculated in the preceding step.

Stack up the pieces and drill two **#10** holes through the stack corresponding to the two holes at the bottom of the counterweight arm. As shown in Figure 183, the holes should be drilled about **1/2"** above the lower edge of the lead and centered longitudinally.

When you have completed the lead pieces, weigh them along with their mounting hardware: two AN509-10R13 **flush-head machine screws** [134], two AN970-3 **large washers** [156] and two AN364-1032A nylon self locking nuts. Subtract lead pieces and/or trim them slightly to achieve the required weight you calculated. Then mount the lead **outboard** of the arm, as shown in Figure 183. The large washers may have to be ground down slightly to clear one another.

Completed: [ ]

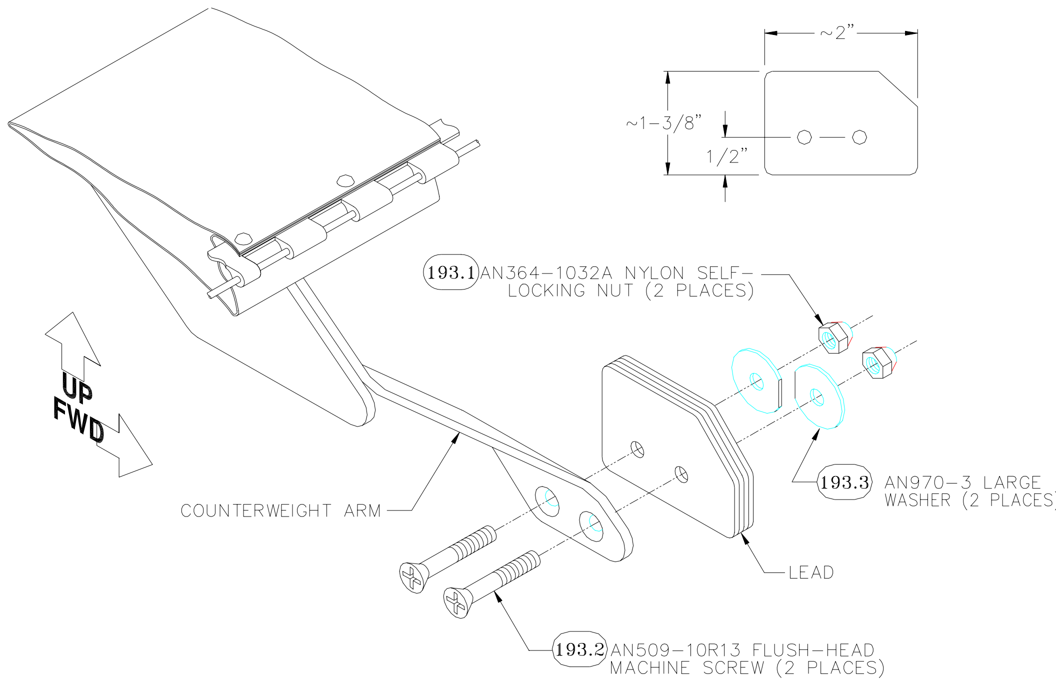

Figure 183: Cutting and Installing the Trim Tab Counterweight

Step 162: Install the Trim Tab on the Elevator

Align the trim tab hinge halves and insert the hinge pin, with its bent end to the **right**. A light coat of WD-40 or Teflon spray lubricant on the pin will help it go in more easily. Don't worry about safetying the hinge pin yet; that will be taken care of in a subsequent step.

Completed: [ ]

Note Early Sportsman kits had the stabilizer tip fairing and the closeout taped together without a differentiation in part numbers. Later kits the parts were identified with the part numbers shown in Figure 184. It is also recommended you do a dry run of installing both the fairings for the stabilizer and elevator **before** actually drilling holes, just in case it is necessary to make any adjustments.

Step 163: Install the Horizontal Stabilizer Tip Fairing

Figure 185 shows how the **horizontal stabilizer tip fairings** [48] are positioned on the stabilizer: their inboard edges should be **11/16"** inboard of the end of the stabilizer, and they should be pulled back tightly against the leading edge bend. Insert the **tip fairing closeout** [62] and trim back as necessary in order to achieve the 11/16" dimension. Tape the closeout in position and tape the fairing on the stabilizer. The closeout will be bonded in later.

Next, you must mark four screw hole locations on each fairing. As shown in Figure 185, these holes should all be **3/8"** outboard of the inboard edge of the fairing. The fore-and-aft dimensions given—**1-1/2"** and **3-1/2"** forward of the aft edge of the fairing on both the top and bottom—are not critical. **Just be sure the holes avoid the flutes in the center of the upper and lower flanges of the tip rib.**

With the screw hole locations marked and/or the pilot hole locations verified, position the fairing on the stabilizer and tape it in place with duct tape or masking tape. Then drill through the fairing, the skin and the underlying tip rib flange at each location with a **#19** bit.

Remove the fairing, and then position and drill K1000-08 nutplates at each hole using standard procedures. After drilling, thoroughly deburr all the holes and, if necessary, use a chip chaser to clean any aluminum shavings out from between the skins and the rib flanges.

Dimple the skins and rib flanges and rivet the nutplates in place with 3/32" AN426AD3 flush-head rivets. Also rivet any extra skin-to-rib holes at this time. Finally, using AN526-8R7 round-head machine screws, install the fairings.

Completed: Left [ ] Right [ ]

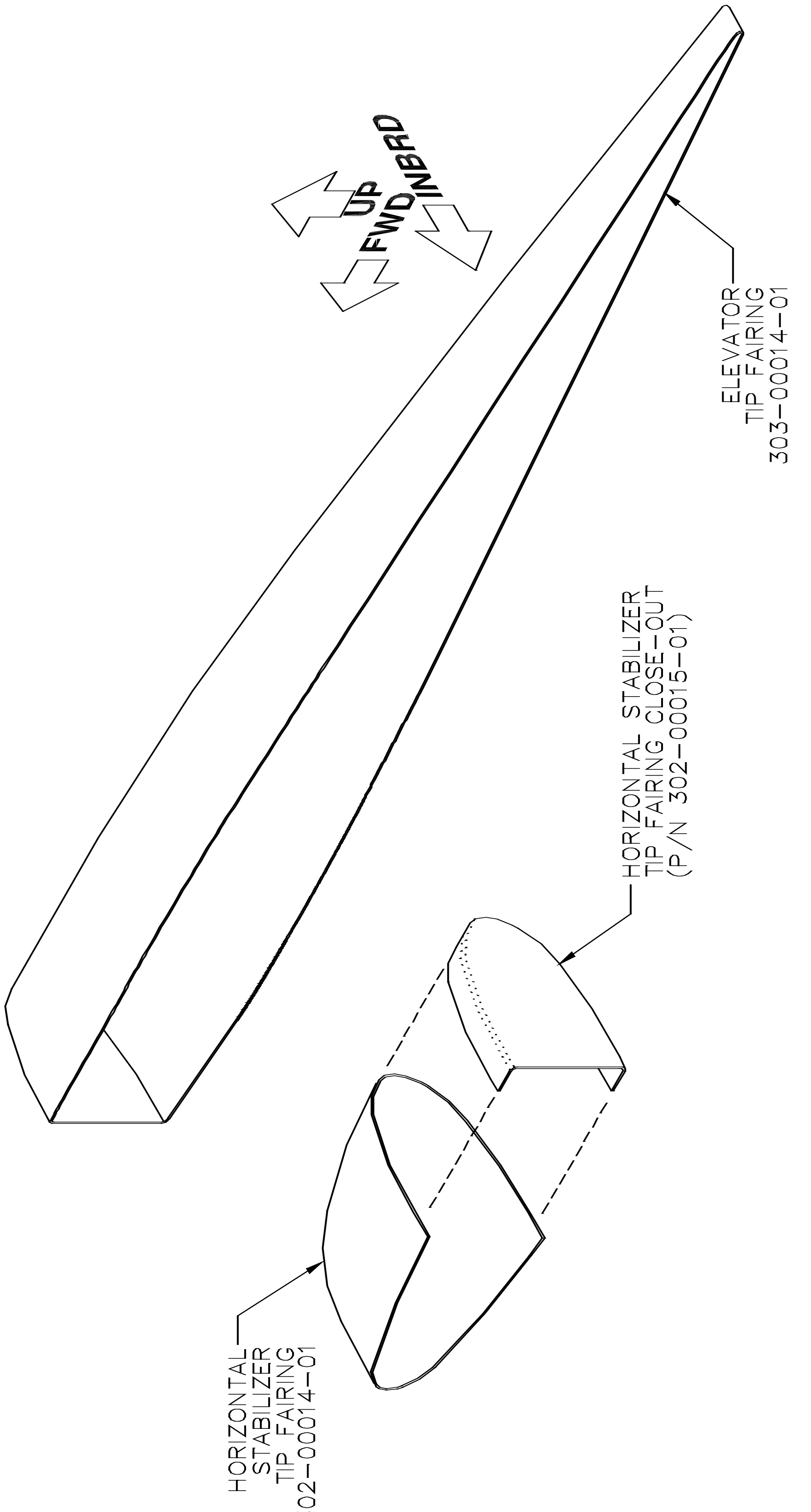

Figure 184: Horizontal Tail Tip Fairing Installation

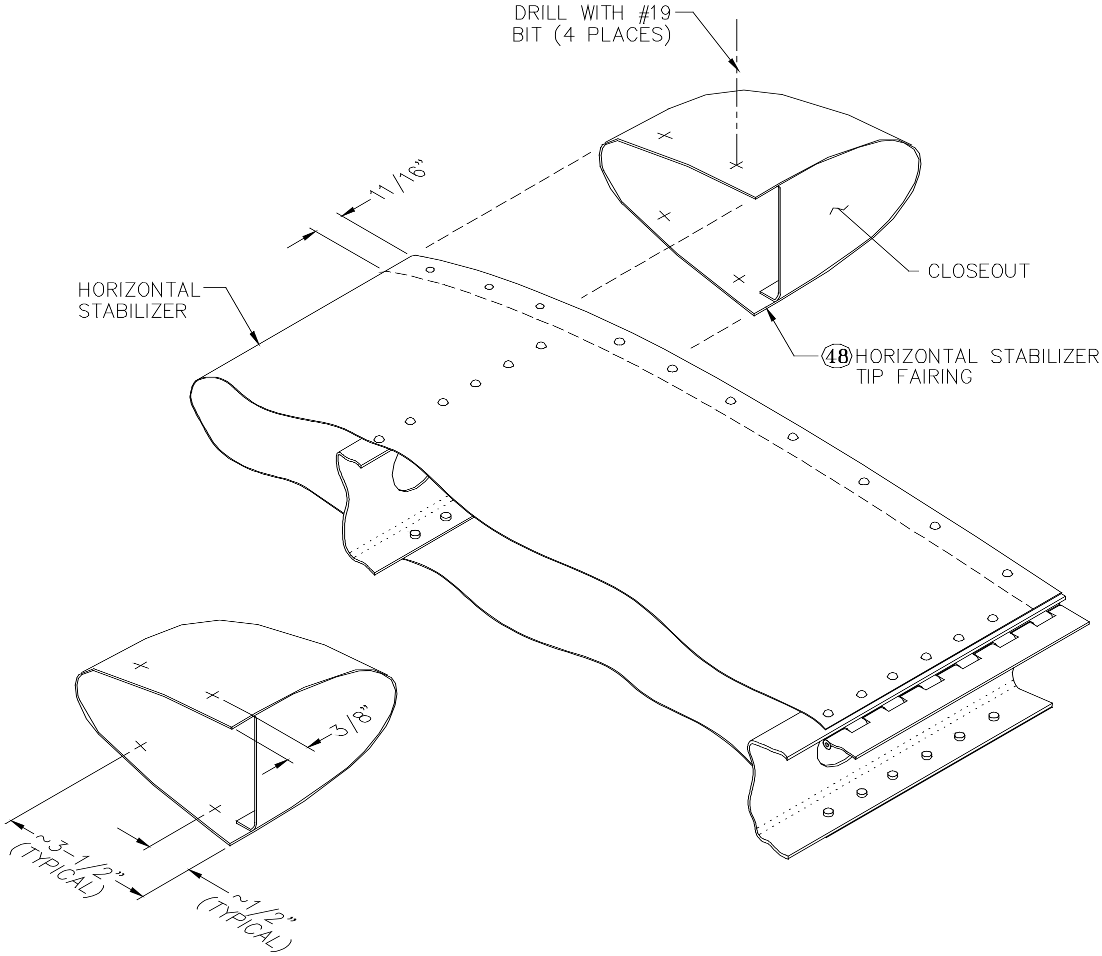

Figure 185: Positioning and Drilling the Horizontal Stabilizer Tip Fairings

Remove the fairing, and then position and drill K1000-08 nutplates at each hole using standard procedures. After drilling, thoroughly deburr all the holes and, if necessary, use a chip chaser to clean any aluminum shavings out from between the skins and the rib flanges.

Dimple the skins and rib flanges and rivet the nutplates in place with 3/32" AN426AD3 flush-head rivets. Also rivet any extra skin-to-rib holes at this time. Finally, using AN526-8R7 round-head machine screws, install the fairings.

Completed: Left [ ] Right [ ]

Step 164: Install the Elevator Tip Fairings

Note Because of the shape of the fiberglass fairings, **the forward corners of the elevator CW ribs** may need to be trimmed to match the fiberglass contour. Do so carefully and trim only as much as required. The fairing must be installed while the elevator and stabilizer are joined together. Space the counterweight rib 1/4-**5/16"** from the edge of the stabilizer skin so no binding between the two can occur.

The elevator tip fairings and their nutplates are positioned and drilled in much the same way as the stabilizer fairings and nutplates. Begin by laying out and marking **sixteen** hole locations along the upper and lower edges of each fairing. As shown in Figure 186, all these locations should be **1/4"** outboard of the inboard edge of the fairing. The forward-most holes top and bottom should be positioned about **1/2"** aft of the leading edge of the fairing. The aft-most holes should be located roughly **4"** forward of the trailing edge of the fairing. The intervening holes should be spaced on roughly equal centers, but they should be shifted fore or aft as necessary to remain clear of the flutes in the rib flanges.

Note Because of the taper at the aft end of the tip rib, the aft-most two pairs of holes top and bottom must be staggered slightly to provide clearance for the fairing mounting screws.

When the hole locations have been marked, slide the fairing over the tip rib and position the fairing as far forward as possible so that the elevator trailing edge nests snugly in the fairing trailing edge. You may even trim the trailing edge slightly to achieve the desired results.

After you have the screw hole locations marked, remove the fairing and look at the rivets common to the tip rib and the elevator skin. This rib should be fully riveted between the screw hole locations, especially The forward 8 inches right up to the leading edge corner of the skin. Drill and install flush rivets in this area where the rivet spacing is greater than 1.38 inches, avoiding any flutes.

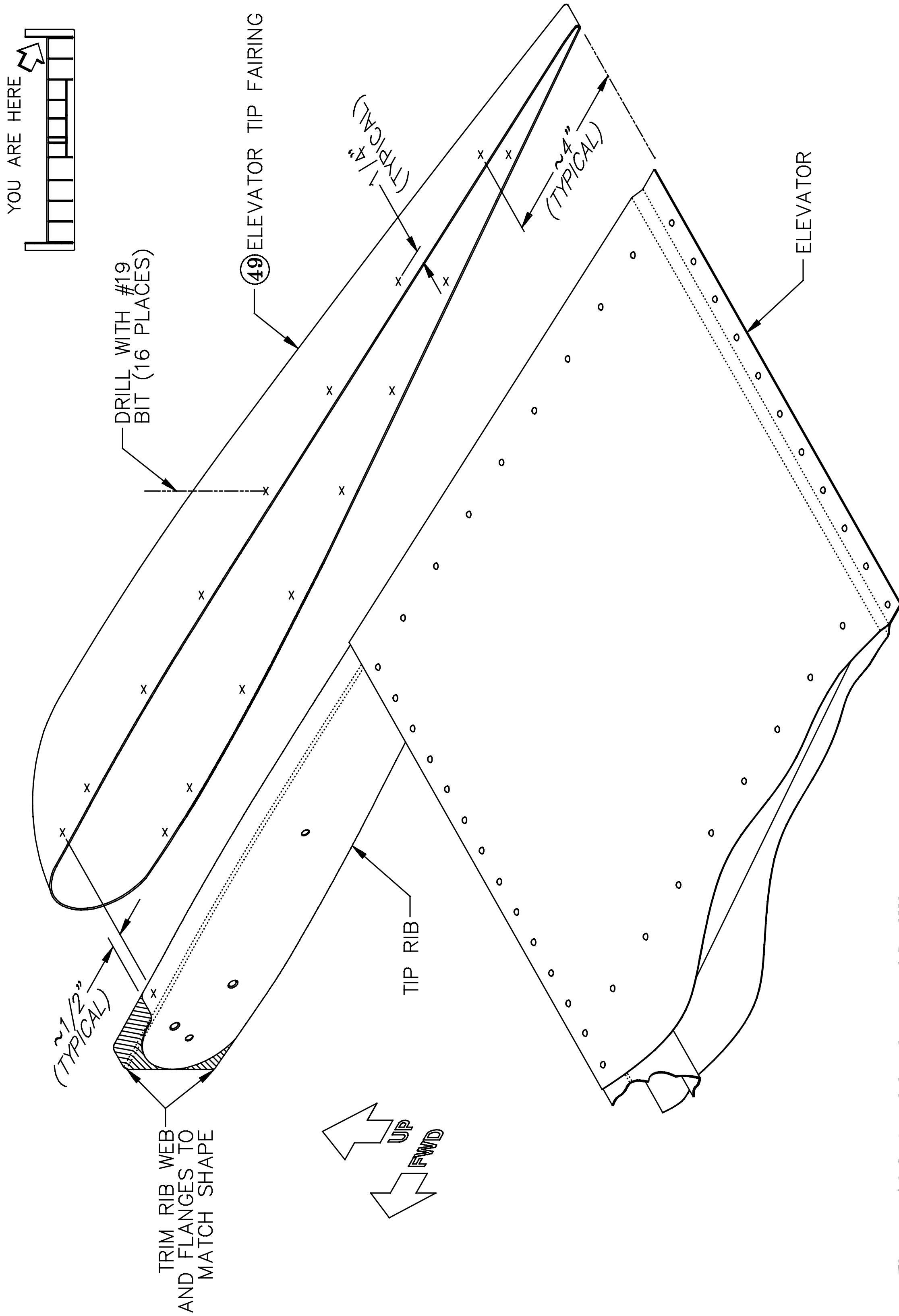

Figure 186: Positioning and Drilling the Elevator Tip Fairings

Note Don't worry if the gap between the horizontal stabilizer and elevator fairings appears too small. You will adjust the gap when the fairing close-outs are installed in a subsequent step. For now, just snug the aft end of the elevator fairing up tight against the trailing edge of the elevator.

With the fairing properly positioned fore and aft, confirm that all the hole locations are clear of the rib flutes. Then position the fairing so that its inboard edges are flush top and bottom with the web of the tip rib. With the fairing held in this position, check the alignment of the outboard edge of the fairing with the outboard edge of the corresponding stabilizer fairing. **Ideally, they will be flush, but in order to get them flush you may have to trim the inboard edge of the elevator tip fairing**. Adjust the elevator fairing left or right as necessary, and then tape it in place to the elevator.

With the fairing in position, drill at each of the sixteen hole locations with a **#19** bit. Use these holes in the rib flanges to position and drill rivet holes for K1000-8 nutplates. Thoroughly deburr all the holes and remove any shavings from between the skins and rib flanges. Then dimple the rivet holes to accommodate 3/32" AN426AD3 flush-head rivets and install the nutplates.

The fairings will be secured with AN526-8R7 round-head machine screws, but it's a bit premature to install them at this time. Should you choose to use AN507-8R7 flush head screws, apply a reinforcing laminate around the perimeter of the fairing or just under the screw heads in order to have enough thickness for countersinking.

Completed: Left [ ] Right [ ]

Step 165: Install the Fairing Close-Outs

The open aft ends of the stabilizer tip fairings are finished off with special close-out piece, as discussed above. These pieces are designed to fit **inside** the radii of the fairings (see Figure 184).

Using six or eight AN526-8R7 screws on each, mount the elevator fairings. Determine how far the flange on each close-out should be inserted into its respective fairing to provide a minimum clearance between them of **3/8"**. (Every horizontal stabilizer and elevator will be slightly different, and so you have to determine the placement that is uniquely appropriate for your Sportsman.)

When you have determined how far the close-outs must be inserted into the fairings, mark this distance off on the flanges. Next, check the length of the close-outs in a spanwise direction relative to the available space. Trim them to fit.

Remove the fairings from the stabilizer and, using a generous amount of thick resin/mill fiber mixture, bond the close-outs in place. At this point, don't worry about filling or sanding the gaps around the close-outs.

Completed: [ ]

Step 166: Calculate the Size of the Elevator Counterweight

It's necessary to calculate the amount of weight required to balance your elevator just as it was for the trim tab. To prepare for the necessary experiment, install both elevator tip fairings with at least six or eight AN526-8R7 screws, if you haven't already done so. Then temporarily disconnect the elevator pushrod so that the elevator is free to pivot on its hinges.

Place an object of known weight near the end of each tip fairing, as shown in Figure 187. The two objects don't need to be of identical weight, but each should be about **5 pounds**. Move the objects forward or aft as necessary to balance the elevator in a horizontal position.

Note If your Sportsman is a taildragger, raise the tail to approximately level-flight attitude for this procedure. Also, you may wish to have your surfaces painted first before balancing as the weight of paint will affect the results.

Next, measure the distance from the hingeline to the approximate center of mass of each object. We'll call these distances the **left** and **right experimental arms**. Multiply each arm by the weight of the corresponding object and add these two products. This sum is the **total moment** of the elevator.

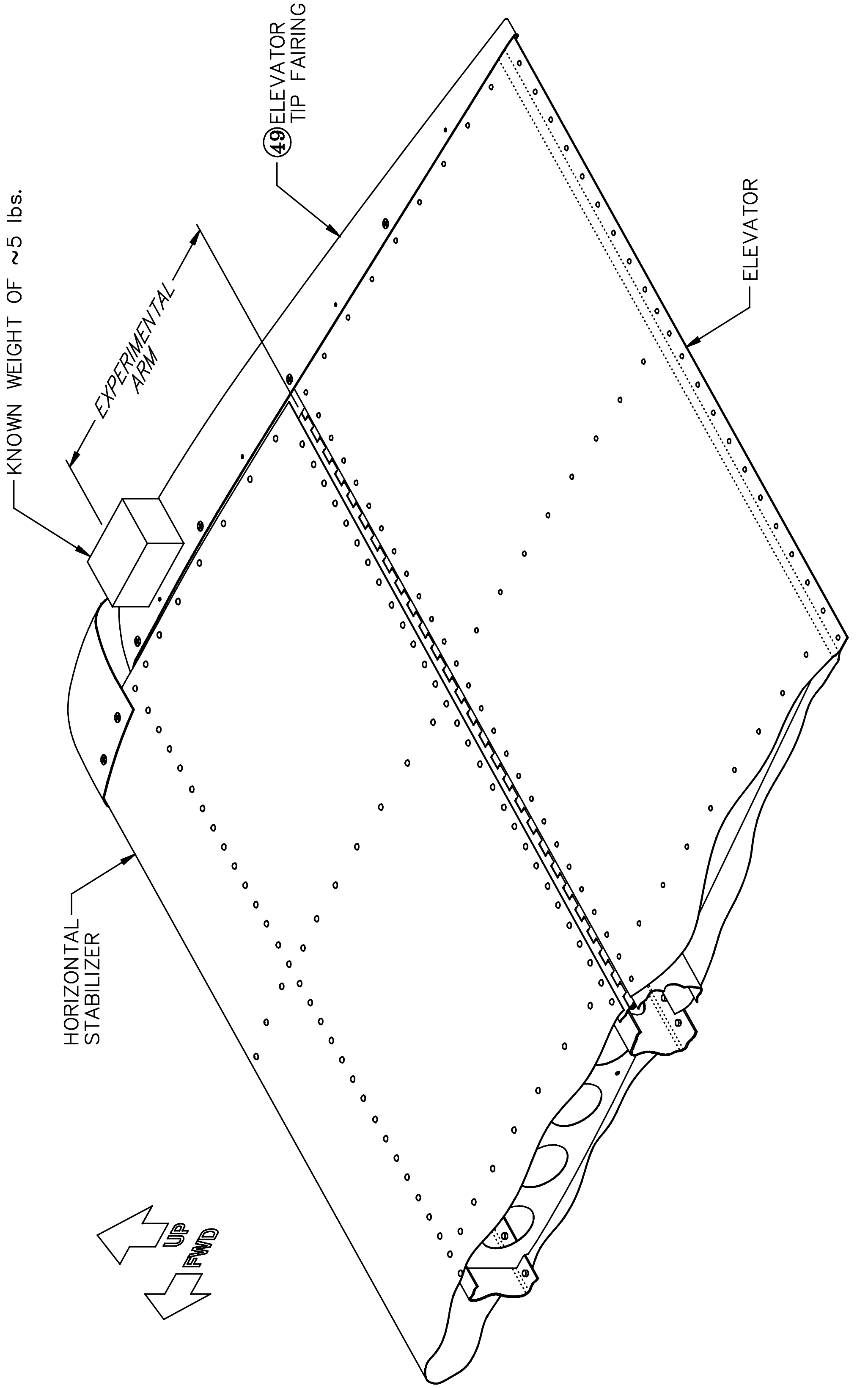

Figure 187: Elevator Counterbalancing Procedure

To find the amount of weight that actually needs to go in each elevator tip rib, you need to divide the total moment by the **actual arm**—that is the actual distance between the hingeline and the center of mass of the counterweights. On the Sportsman, this distance is **11.75"**. Finally, of course, the total weight must be divided by two to get the amount required in each tip. An example of these calculations is given in Figure 188.

When you've completed your calculations, re-connect the elevator pushrod.

Completed: [ ]

Experimental Calculation

LEFT EXPERIMENTAL WEIGHT = 5 lb., 8 oz. = 5.5 lb.

LEFT EXPERIMENTAL ARM = 9-3/8 in. = 9.375 in.

LEFT EXPERIMENTAL WEIGHT X LEFT EXPERIMENTAL ARM = LEFT-SIDE MOMENT

5.5 lb. X 9.375 in. = 51.56 in.-lb.

RIGHT EXPERIMENTAL WEIGHT = 5 lb., 4 oz. = 5.25 lb.

RIGHT EXPERIMENTAL ARM = 9 in.

RIGHT EXPERIMENTAL WEIGHT X RIGHT EXPERIMENTAL ARM = RIGHT-SIDE MOMENT

5.25 lb. X 9.0 in. = 47.25 in.-lb.

LEFT-SIDE MOMENT + RIGHT-SIDE MOMENT = TOTAL MOMENT

51.56 in.-lb. + 47.25 in.-lb. = 98.81 in.-lb.

Actual Calculation

TOTAL MOMENT ÷ ACTUAL ARM = ACTUAL WEIGHT

98.81 in.-lb. ÷ 11.75 in. = 8.4 lb.

WEIGHT PER TIP = ACTUAL WEIGHT ÷ 2

8.4 lb. ÷ 2 = **4.2 lb.**

Figure 188: Sample Elevator Counterweight Calculation

Step 167: Cut and Install the Elevator Counterweights

As with the trim tab counterweight, the elevator counterweights are simple stacks of lead sheet. The exact number and dimensions of the lead pieces you'll need obviously depend on the results of your calculations in the preceding step. However, we recommend that you cut pieces about **2"** high by **3-1/2"** long. Cut a couple more pieces than are necessary to equal the counterweight amount you calculated in the preceding step.

> **Hint** For the neatest job, make a cardboard template of the shape of the tip rib, marking the locations of the two mounting screw holes. Use this template to cut out and drill the lead sheets.

> **Note** The calculations by which you determined the amount of weight needed to counterbalance your elevator were based on a specific actual moment arm. This arm will be correct **only if the weight you install is centered between the two mounting holes** you drilled in the tip ribs back in "SECTION V: ELEVATOR ASSEMBLY." Keep this in mind when sizing your stacked lead.

Remove the tip fairings, stack the lead pieces together in two equal stacks and drill two **#10** holes through each stack corresponding to the holes you drilled in the elevator tip rib webs in Step 40 of "SECTION V: ELEVATOR ASSEMBLY." Dimple the three #10 counterweight-mounting holes in each rib web with the male die **inboard**. Countersink the first piece of lead in each stack to match the dimples.

> **Note** Refer back to Step 17 in "SECTION III: RUDDER ASSEMBLY" for the procedure for dimpling a #10 hole. Use one of the AN509-10R24 **flush-head machine screws** [137] as the male die.

Finally, weigh the lead with its mounting hardware: six AN509-10R24 flush-head machine screws, six 850-3235-028 beveled washers, six AN970-3 large washers and six AN364-1032A nylon self-locking nuts, as shown in Figure 189. Subtract and/or trim lead pieces until the entire counterweight is equal to the required weight, and then install the weights on both sides, as shown in Figure 189.

Completed: Left [ ] Right [ ]

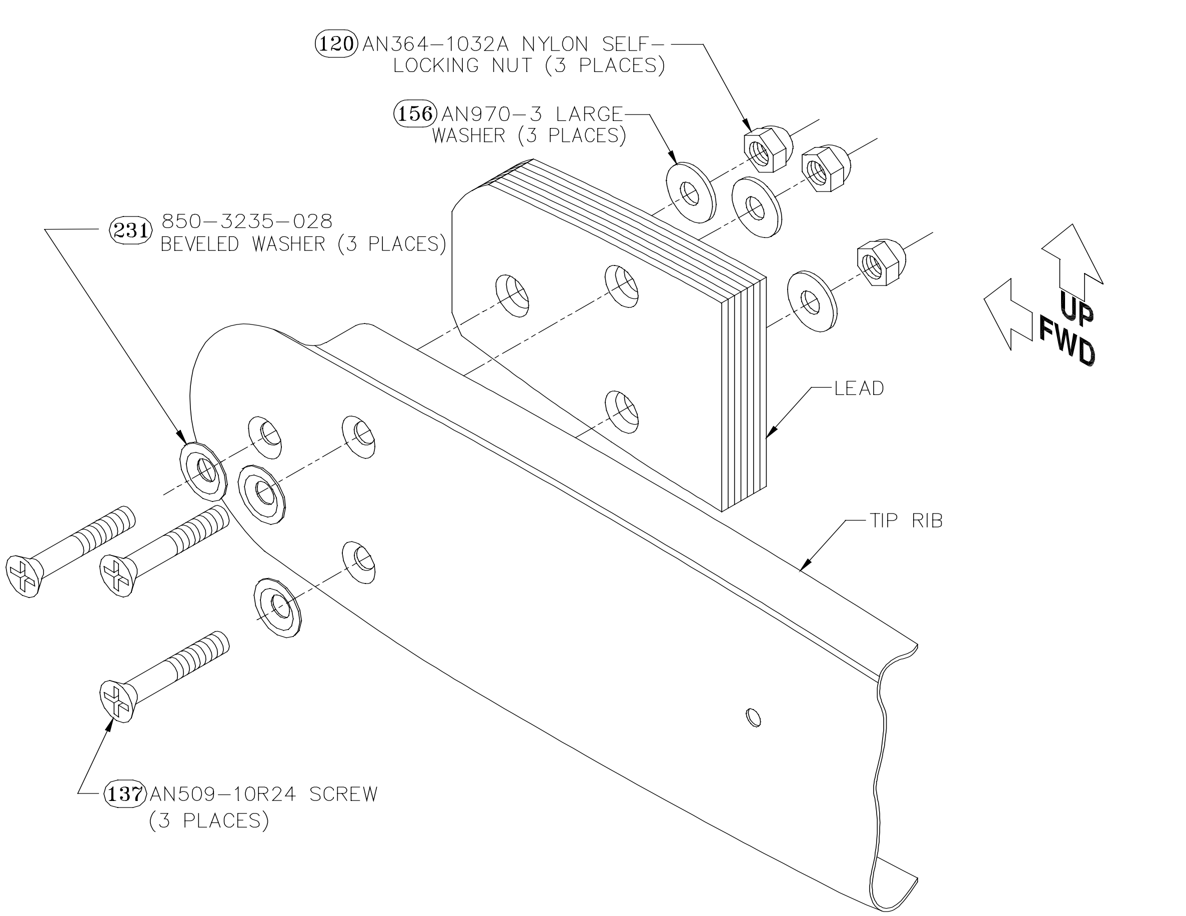

Figure 189: Installing the Elevator Counterweight

Step 168: Finish the Tip Fairings

Now that you're through stacking weights on them, you can finish the elevator tip fairings, along with the stabilizer fairings. Fill the gaps where the close-outs meet the fairings with body filler and file and sand the corners round. Then sand and finish the entire fairing to your own standards and preferences. See the discussion of "PREPARING FIBERGLASS PARTS FOR FINISHING" in "SECTION II: TOOLS AND TECHNIQUES."

Completed: [ ]

Step 169: Fabricate and Install Hinge-Pin Retainers on the Elevator and Trim Tab

The final step in this sub-section has nothing to do with counterbalancing or installing fairings on control surfaces, but the elevator and trim tab hinges need to be safetied, and this is as good a time as any to do it!

Begin by fabricating **five** hinge-pin retainers from leftover hinge stock; either the extruded hinge stock left over from the elevator or the rolled stock left over from the main gear leg fairings can be used. As shown in Figure 190, cut off five "knuckles" from the hinge. Drill a **#19** hole in the center of the tab of each knuckle and install an MF5000-08 floating nutplate there. Angle the nutplate to fit the available space. Countersink the **#40** rivet holes for 3/32" AN426AD3 flush-head rivets, as shown.

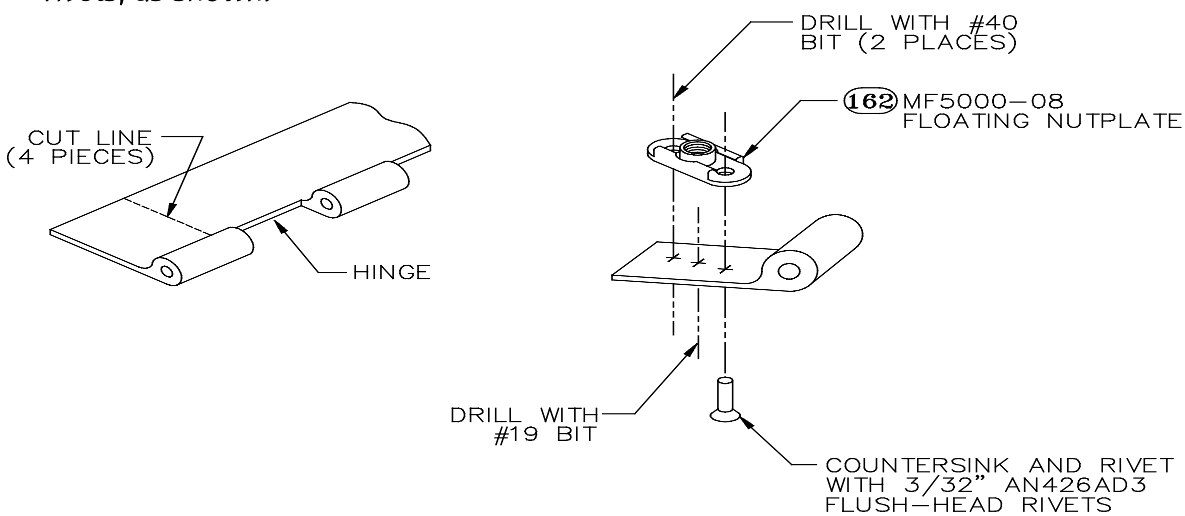

Figure 190: Fabricating the Hinge-Pin Retainers

Earlier, in "SECTION V: ELEVATOR ASSEMBLY," you left five unriveted holes along the elevator and trim tab hinge lines—one for each outboard elevator hinge, two for the center elevator hinge and one for the trim tab hinge. (If necessary, refer back to Figures 55 and 56 in that section to refresh your memory. We certainly had to!) Drill each of these holes now with a **#19** bit. After drilling, clean and deburr each hole thoroughly and, if necessary, use a chip chaser to remove shavings from between the layers of metal.

Then, as shown in Figure 191, slide a hinge-pin retainer over each bent pin end, position the retainer under the corresponding hole in the spar flange, and secure it to the spar with an AN526-8R6 round-head machine screw and an AN960D8L thin aluminum washer.

Completed: [ ]

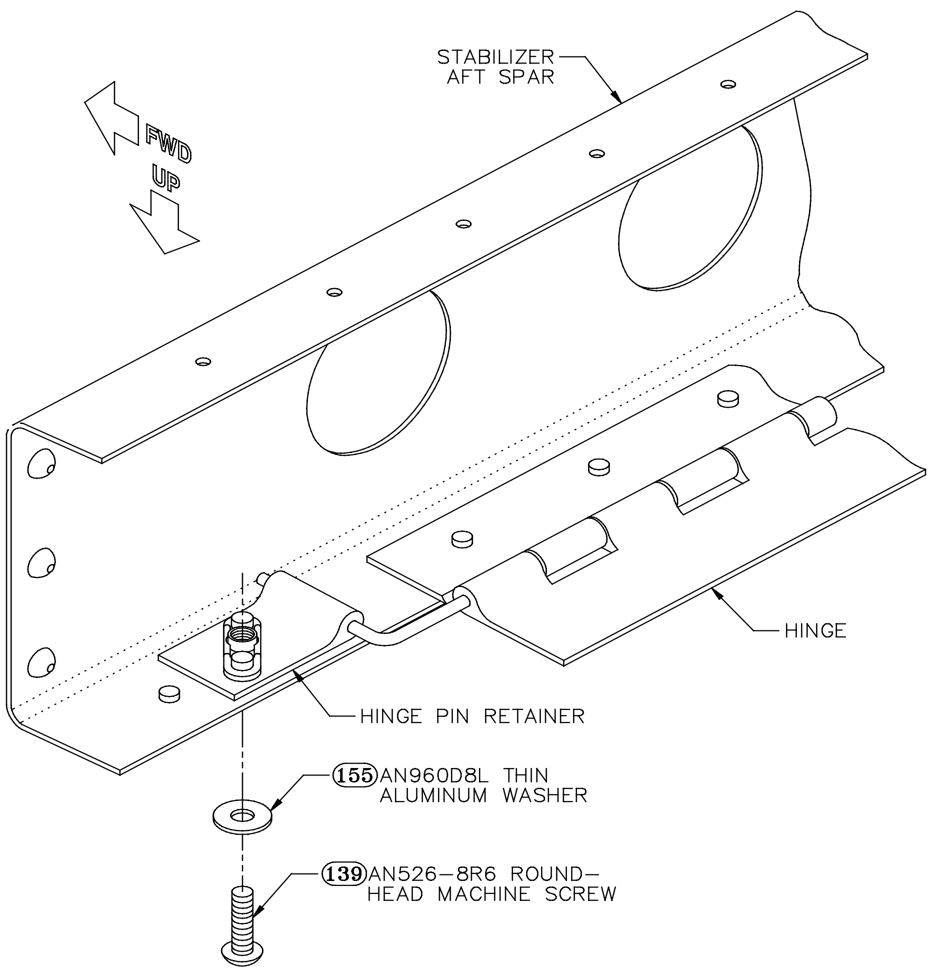

Figure 191: Installing the Hinge-Pin Retainers

Final Control System Rigging

This sub-section includes instructions for fabricating and installing the crossover cable guide, adjusting the control surfaces to achieve the required range of travel, installing stops for various controls, tensioning the cables and safetying the turnbuckles.

Step 170: Fabricate the Crossover Cable Guide

A guide is needed at the top center of the fuselage to organize the bundle of crossover cables and to keep them from wearing on each other. The guide is made from two pieces of phenolic with notches cut along one edge of each piece. The two pieces are fastened together with their notches opposite each other to retain and guide the cables. The completed guide assembly mounts to the same bolt that fastens the upper center aft shell attach fittings to the fuselage cage.

Make an aluminum sheet metal template first and verify your installation. When you are satisfied with that then cut the two pieces of the crossover cable guide from the supplied **3/16" X 3" X 4" phenolic sheet** [84], as shown in Figure 192. Drill the two **#10** holes in each piece for fastening the two pieces together. Cut the notches for the cables by first drilling **#19** holes in the locations shown and then cutting tangents from the holes to the nearest edge.

> **Note** The one cable notch that is spaced wider from the others is for the aileron crossover cable. The guide will be installed with this notch **aft**.

Completed: [ ]

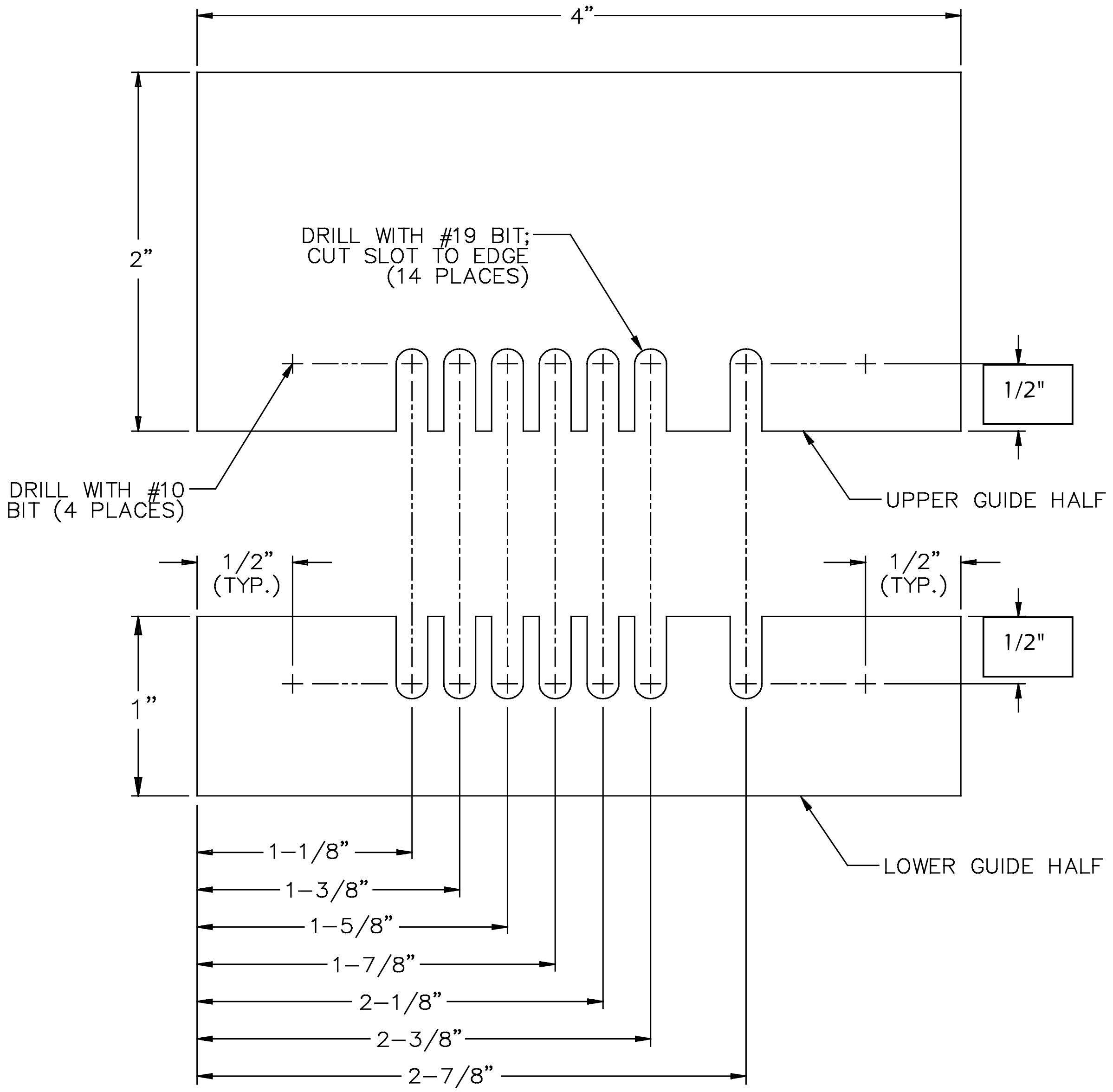

Figure 192: Cutting Out the Crossover Cable Guide

(Verify your dimensions first with a sheet metal template)

Step 171:

Install the Crossover Cable Guide

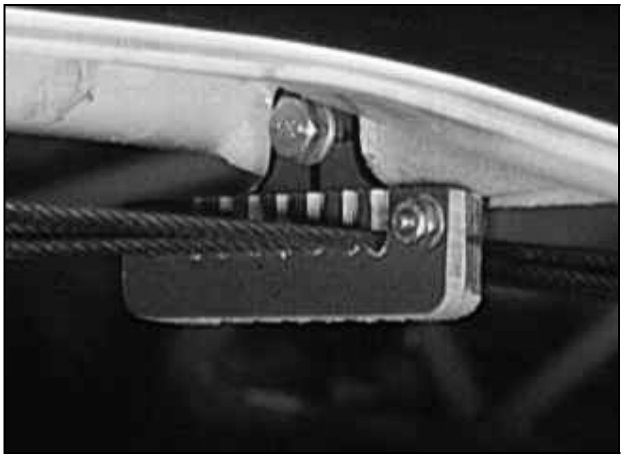

Figure 193: Finished Cable Crossover Guide on a GlaStar

A finished crossover cable guide (slightly different than the one described here) is shown in Figure 193. To complete the installation, the location of the bolt that fastens the upper center aft shell attach fittings to the cage must be transferred to the cable guide. After a hole for this bolt has been drilled in the upper half, excess material will be trimmed away and the two halves will be joined and secured to the airframe.

With both wings extended (and the crossover cables thus taut), hold the upper guide half in position near the upper aft shell attach fittings. Fit the cables into the notches of the guide, being careful to arrange them in such a way that rubbing between cables is minimized. To coincide with their positions in the crossover pulley groups at the upper sides of the cage, the flap deployment cables should fit best in the forward two notches, the flap retraction cables should fit into the next two notches aft, the aileron actuation cables should fit in the third pair of notches from the front and, as mentioned previously, the aileron crossover cable should fit into the single, more widely spaced notch at the aft end of the guide.

With all the cables in the cable guide notches, the guide half will tend to rest in the position that deflects the cables the least amount in the fore-and-aft direction. With the guide half in this position, mark on the guide the longitudinal location of the upper aft shell attach fitting mounting bolt, as shown in Figure 194a.
Remove the guide half from the cables and drill a **1/4"** hole through it spaced **1/2" below** the upper edge at the marked fore-and-aft location, as shown in Figure 194b. Remove excess material from the upper half, as shown, being careful to maintain a **1/2"** edge margin to the center of the mounting hole and a **1"** minimum width at the forward and aft ends. Also, sand or file a roughly **3/8"** radius on the lower corners of the upper guide half and on all four corners of the lower half.

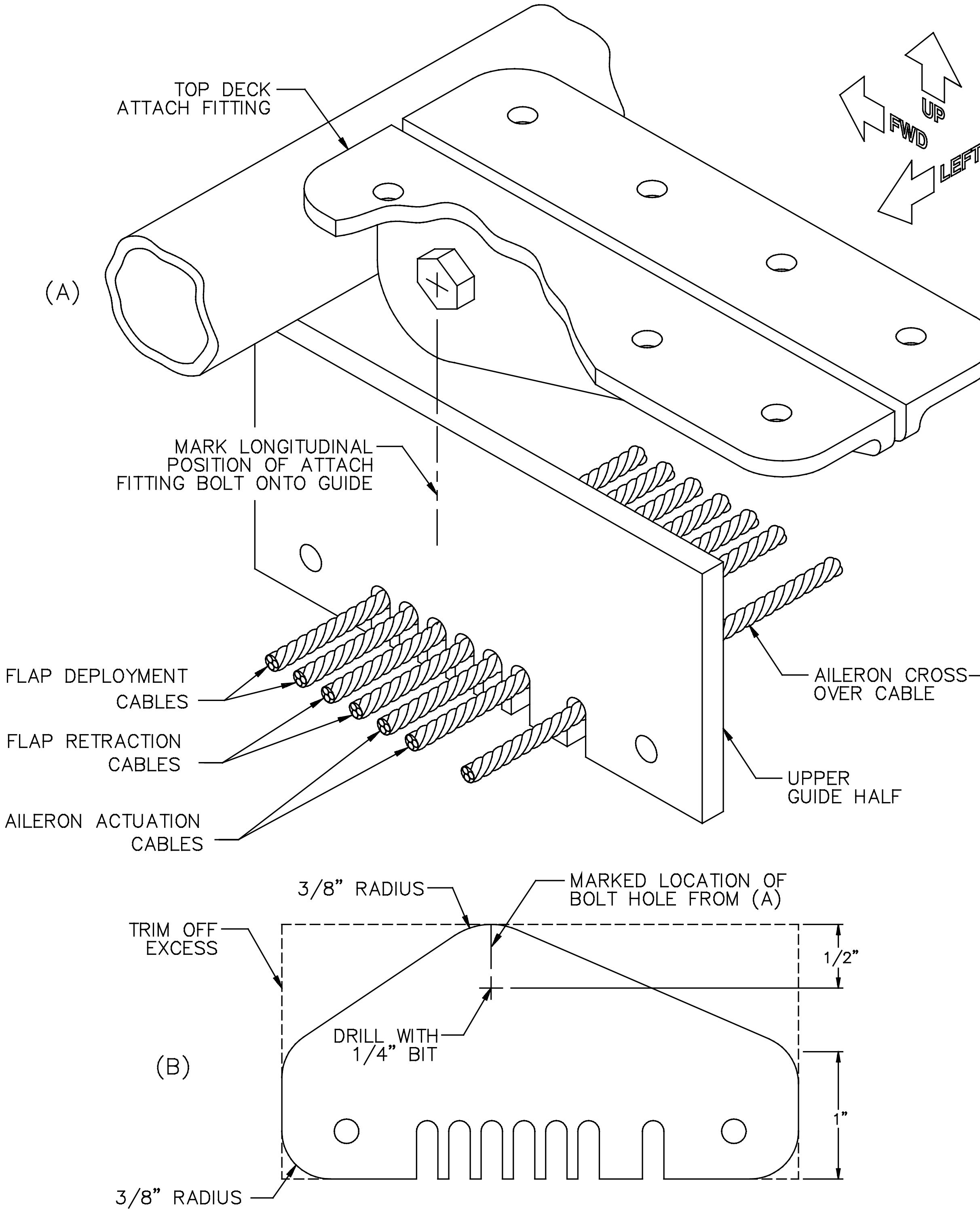

Figure 194: Finishing the Crossover Cable Guide

Remove the AN4-10A bolt, the two AN960D416 aluminum washers and the AN364-428A nylon self-locking nut fastening the upper aft shell attach fittings to the cage tab. (You installed this hardware back in Step 135.) Position the upper guide half over the cables as you did before, and then secure it to one of the shell attach fittings, as shown in Figure 195. It doesn't matter whether you select the left or right fitting. Then fit the cables into the notches in the lower guide half and fasten it to the upper guide with two AN3-6A bolts. Use two AN960-10 washers for each bolt—one under the head and one under the AN364-1032A nylon self-locking nut.

Completed: [ ]

Step 172: Safety the Rudder Cable Turnbuckles

Because the rudder control cables form an "open-loop system," they do not need to be tensioned, and you're therefore ready to safety the rudder cable turnbuckles for the final time. We recommend doing this with MS21256-1 **turnbuckle locking clips** [166] using the procedure described in *"Safetying Turnbuckles"* under "CONTROL CABLES" in "SECTION II: TOOLS AND TECHNIQUES." If you prefer, however, traditional safety wire is certainly acceptable. For a description of safety wire methods for turnbuckles, consult AC43.13, any A&P Technician General Textbook, or even the Aircraft Spruce and Specialty catalog. (See "RECOMMENDED READING" in "SECTION I: INTRODUCTION.")

Completed: [ ]

Step 173: Verify the Elevator Travel

The required elevator travel is **23° up** and **20° down**, with a tolerance of ±**1°** in each direction. Use a bevel gauge and the procedures described in Step 60 of "SECTION VIII: FUSELAGE ASSEMBLY" to check the elevator travel. Set the bevel gauge to **157°** to check the up travel and to **200°** to check the down travel. Make both measurements on the **upper** surface of the stabilizer and elevator (the hinge side).

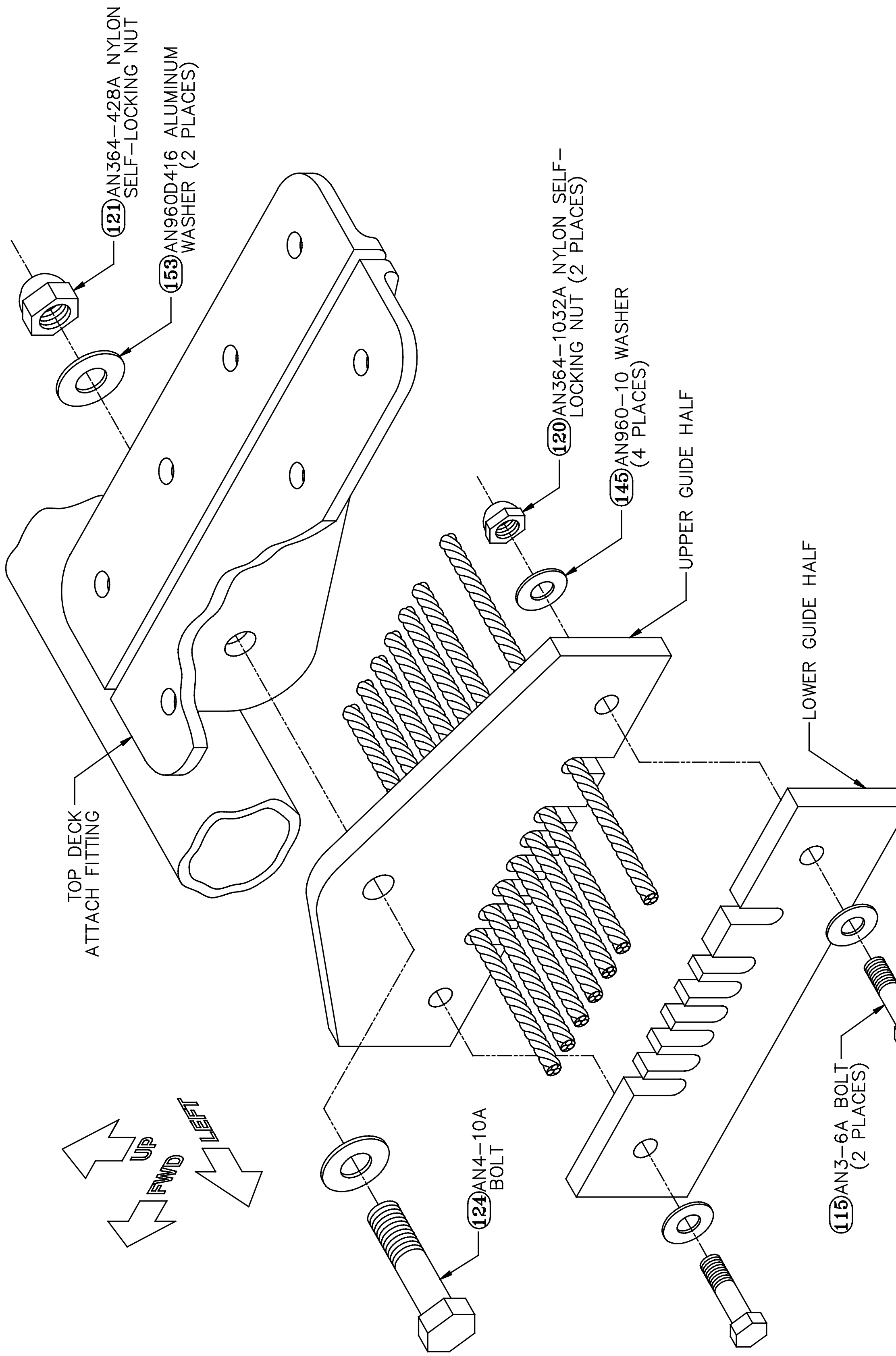

Figure 195: Installing the Crossover Cable Guide

The geometry of the elevator control system should permit more than enough elevator travel in both directions.

Note If the elevator travel is less than required in either direction, first check for obstructions in the control system. Remedy any such obstructions you find. You may have to enlarge the pushrod pass-through holes in Bulkheads D and E, for example, to achieve free elevator travel.

Completed: [ ]

Step 174: Fabricate and Install the Elevator Control Stop

Using the bevel gauge method to check, hold the elevator at its **up** travel limit of **23°** and mark the location of the aft face of Bulkhead E onto the elevator pushrod with a felt-tip pen. Then hold the elevator at its **down** travel limit of **20°** and make a similar mark on the pushrod. These marks will be used to position the bellcrank after the stabilizer/elevator assembly has been removed so that the elevator limit stops can be adjusted.

Disconnect the elevator pushrod from the control horns and remove the stabilizer/elevator assembly from the airplane. Next, disconnect the control cables from the elevator bellcrank by removing the clevis pins that secure the ends of the cables to the control cable attach tabs. Remove the bellcrank from the airplane by disconnecting the pushrod and removing the pivot bolt. Remove the cable attach tabs and associated hardware from the bellcrank.
Figure 196 is a **full-sized** template of the elevator stop plate. Use a bandsaw to cut the plate out from the **.125" X 6" X 12" aluminum sheet** [108]. File or sand the edges smooth.

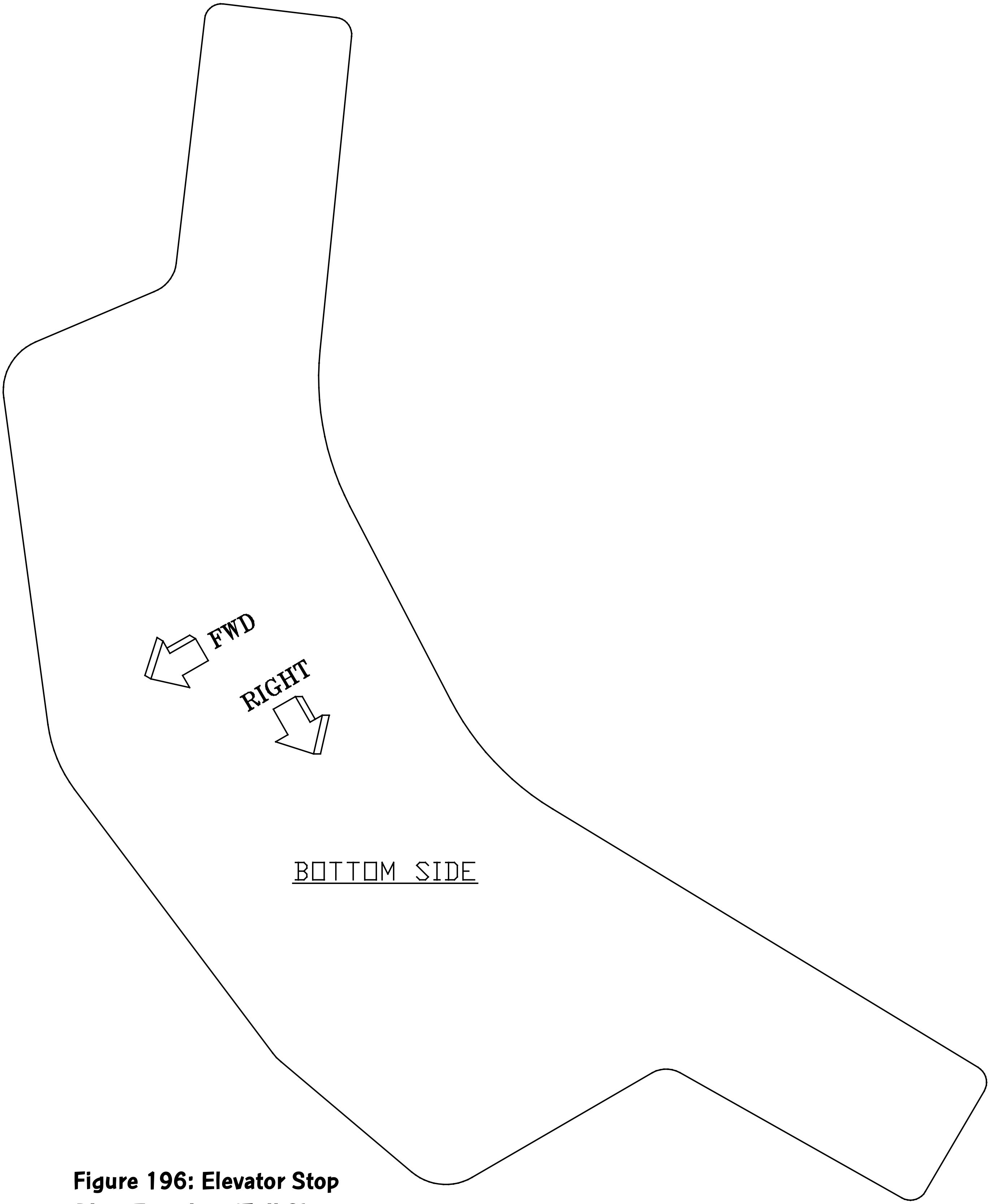

Figure 196: Elevator Stop Plate Template (Full Size)

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Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

331? **Page 133:**

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Position the plate against the lower half of the elevator bellcrank, aligning the forward edges of the two parts, as shown in Figure 197. Using the pushrod attach holes in the bellcrank as guides, drill a matching **1/4"** hole through the stop plate. Insert a bolt through these holes to maintain alignment. Then use the cable attach holes in the bellcrank as guides to drill **#10** holes through the stop plate. Finally, center punch the stop plate through the bellcrank bearing hole.

Remove the stop plate from the bellcrank and drill at the center-punched location with a **1/2"** hole saw; this hole is oversized to provide clearance for the NAS43DD4-39 aluminum spacer that goes under the bellcrank. Deburr all the holes.

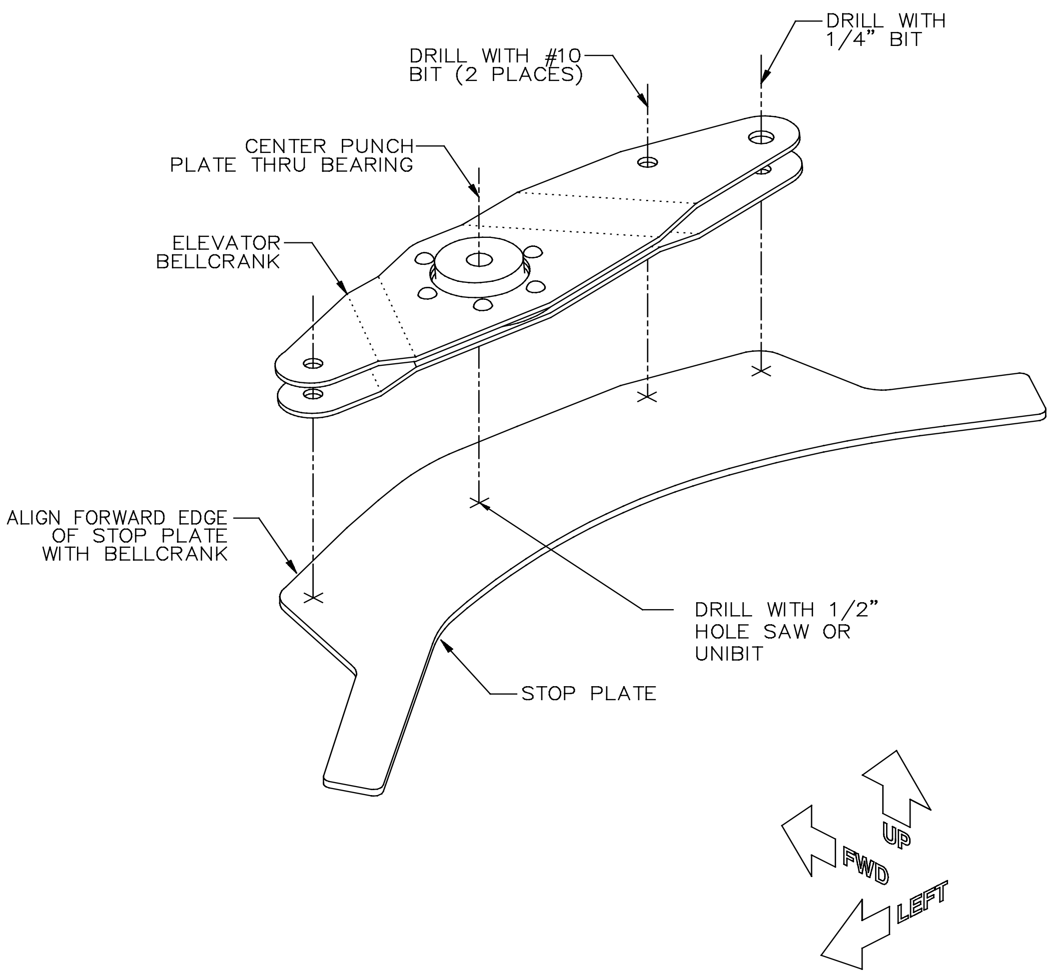

Figure 197: Drilling the Elevator Stop Plate

Use the original hardware to reattach the control cable attach tabs to the elevator bellcrank, as shown in Figure 198, fastening the elevator stop plate to the **lower side** of the bellcrank at the same time. The **left** end of the bellcrank is thinner than the right end. To accommodate the different thicknesses and to keep the stop plate parallel to the bellcrank, insert an AN970-3 large washer between the bellcrank and the stop plate at the **left** end, as shown.

Use the original pivot bolt and its associated spacers and washers to reinstall the bellcrank between the two bellcrank brackets on Bulkhead C. Use the original bolt to fasten the forward end of the elevator pushrod between the two halves of the bellcrank. Do **not** install the nuts on the pivot bolt or the pushrod-attach bolt for the time being; you will still have to remove the bellcrank assembly from the fuselage several times to adjust the elevator stop arms.

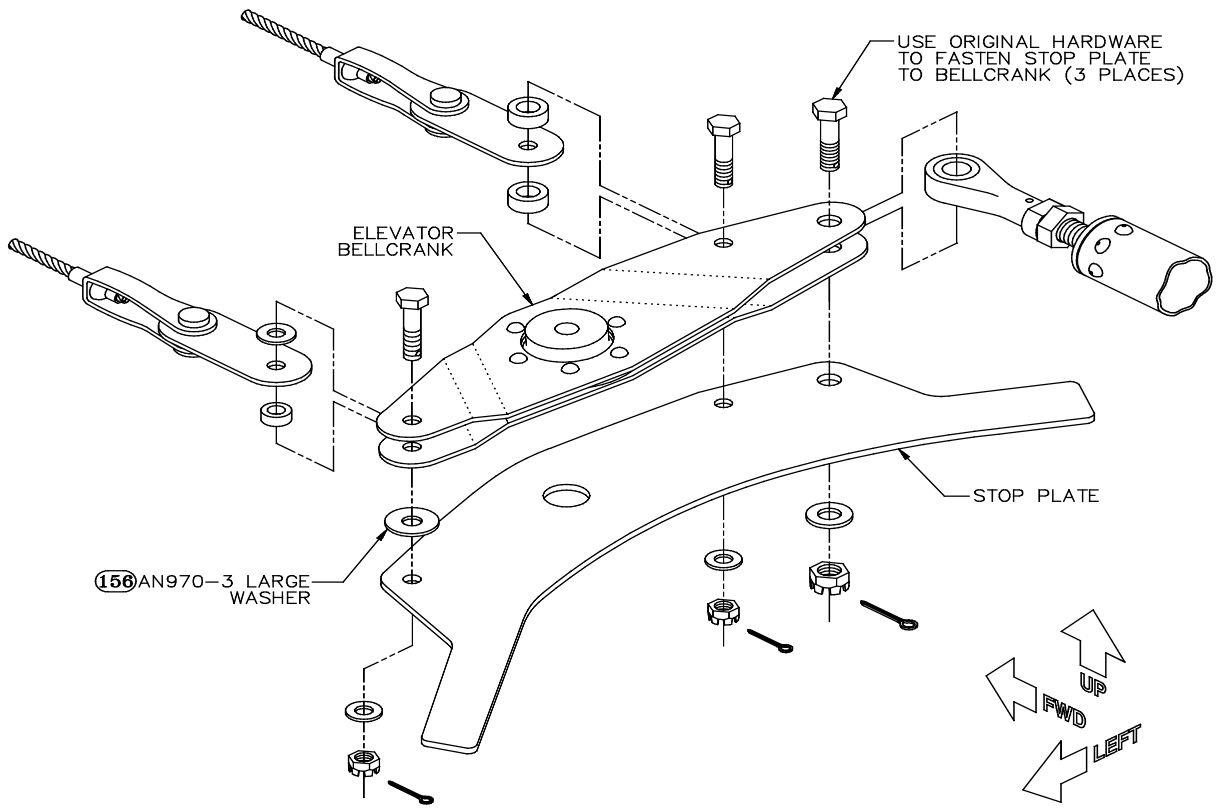

Figure 198: Elevator Stop Plate Installation

Cut two **1"** square elevator stop contact pads from the supplied **.125" X 2" X 2" UHMW polyethylene sheet** [101]. Temporarily tape the pads in place on the aft face of Bulkhead C between the bellcrank brackets where the arms of the stop plate contact the bulkhead (see Figure 199).

Trim the **forward** edges of the elevator stop plate arms until they contact the polyethylene pads just as the elevator reaches its travel limits. Trim the right-hand stop plate arm to adjust the **down** elevator travel; trim the left-hand stop plate arm to adjust the **up** elevator travel. Use the marks you made on the pushrod at the beginning of this step as a reference for the elevator travel limits. (This will save you having to re-install the stabilizer/elevator assembly to check the travel between each stop plate arm adjustment.) The easiest way to trim the stop plate arms is to remove the bellcrank assembly and use a belt sander. Several iterations of checking the travel, removing the bellcrank for stop plate adjustment, re-installation and re-checking may be required. When you're satisfied with the elevator stop adjustment, remove the stop plate from the bellcrank one last time. File and sand the trimmed edges of the arms smooth and apply corrosion-proofing.

Drill two **#30** holes through each polyethylene stop pad and through the **aft** laminates of Bulkhead C, as shown in Figure 199, being careful not to drill in areas where the stop plate arms contact the pads. Use **1/8" aluminum blind rivets** [105] to secure the contact pads to the bulkhead.

Re-install the bellcrank assembly, reconnecting the elevator cables to the attach tabs and the pushrod to the bellcrank, using all the original hardware (refer back to Figure 198). Make a final inspection of all the control system hardware that's accessible in the tail of the airplane. Make sure all nuts are tightened firmly and that cotter pins are installed and properly bent in all castle nuts and clevis pins. Verify that both rod-end bearings on the elevator pushrod are threaded on past their inspection holes. Make sure the jam nuts that secure the rod-end bearings are tightened firmly against the rod-ends.

Completed: [ ]

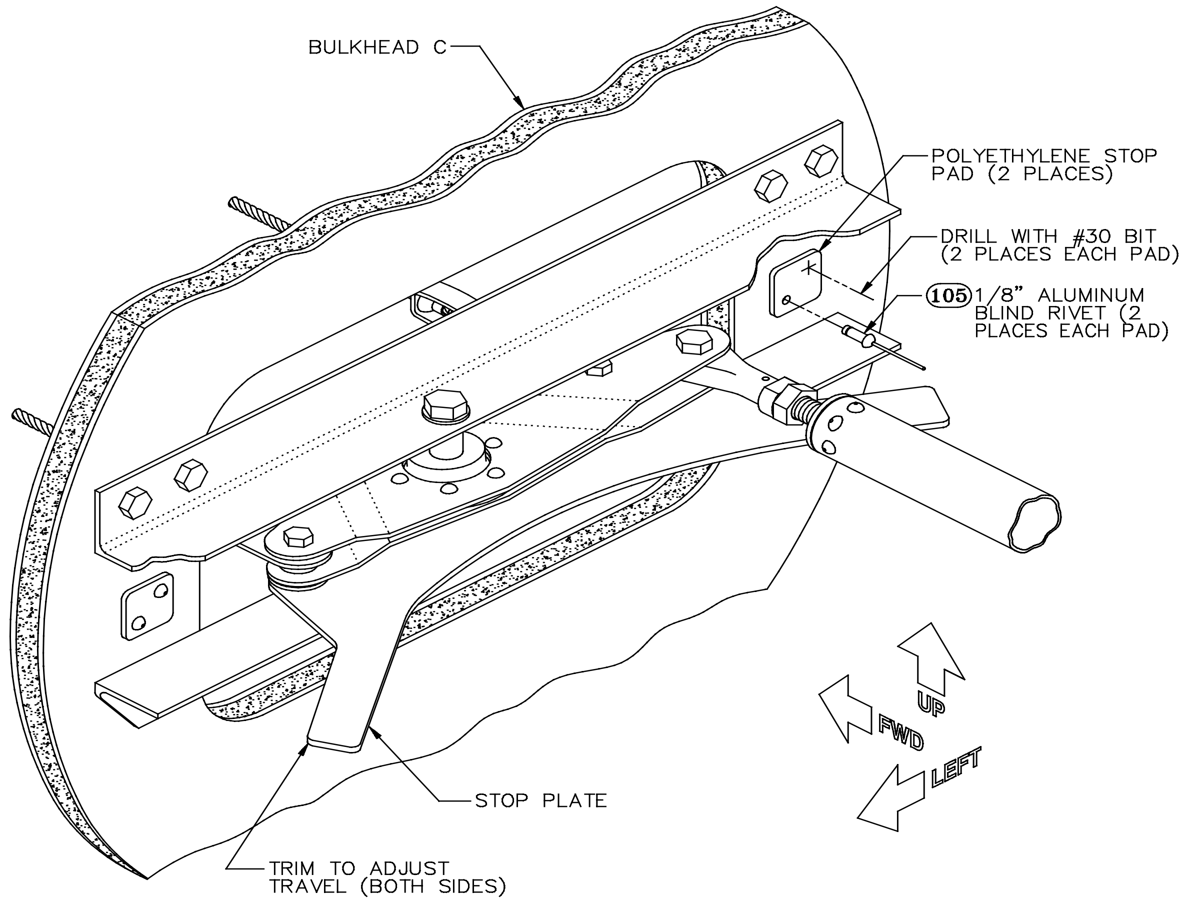

Figure 199: Elevator Stop Adjustment

Step 175: Tension and Safety the Elevator Control Cables

Because the elevator control cables form a "closed-loop system," they must be precisely tensioned. Determine the required tension for the elevator cables by using the cable rigging chart provided in Figure 8 in *"Tensioning"* under "CONTROL CABLES" in "SECTION II: TOOLS AND TECHNIQUES." Use the chart to determine the maximum cable tension for **1/8"**, **7 X 19** cable at the temperature of your workshop or hangar.

Use the turnbuckles to adjust the cable tension, checking your work with a cable tensiometer, as described in "SECTION II: TOOLS AND TECHNIQUES." Adjust the up and down cables equally so you don't change the elevator bellcrank and control yoke neutral positions. However, you need to check the tension in only one of the cables; since the two cables form a closed loop, the tension will be equal throughout the loop.

Note In tensioning these cables (as well as the flap and aileron cables in Steps 183 and 185), test the control system out after achieving the prescribed tension. The controls should move freely without binding or excessive friction. In our Sportsman prototype, we found that smooth control movement—of the ailerons in particular—required that the cables be slackened from the maximum prescribed tension. This is acceptable if necessary, but slacken the cables only enough to provide smooth control movement. For comparison, the standard tension in control cables for Cessna aircraft is 30 lb.

Once the proper cable tension has been achieved, follow standard procedures to safety the turnbuckles, using either locking clips or safety wire.

Completed: [ ]

Step 176: Adjust, Tension and Safety the Flap Control Cables

In "SECTION IX: SYSTEMS INSTALLATION," you adjusted the flap pushrod so that the flap bellcrank arms contacted the edges of their openings in the aft spars when the flaps were fully extended with the flap roller bearings at the aft ends of the slots in the flap tracks. Check that this condition still exists, and, if not, adjust the lengths of the pushrods to achieve it. Make sure that the jam nuts are firmly tightened against the rod-ends on both pushrods.

Move the flap handle to the flaps-extended position (with the flap plunger pin engaged in the highest notch in the ratchet plate). Tighten both the left and right flap **deployment** cables by turning the turnbuckles until the flaps are in the fully extended position (with the flap bearings firmly against the aft ends of the flap track slots). Loosen the flap retraction cables if necessary to achieve this. Refer to the cable rigging chart in "SECTION II: TOOLS AND TECHNIQUES" to determine the required cable tension, depending on the temperature, and use a tensiometer to set both the left and the right deployment cables to this tension, making sure the two cables are tensioned equally.

Now, with the flap handle still in the fully extended position, set the left and right **retraction** cables to the required tension, again making sure that the two cables are tensioned equally. If this operation moves the flaps out of the fully extended position, set the retraction cables to a tension **slightly** less than the deployment cables.

Check the operation of the system. When the handle is in the retracted position (with the pin in the lowest notch), the flap roller bearings should firmly contact the forward ends of the flap track slots. As you move the handle to the fully extended position (highest notch) the flap roller bearings should reach the aft ends of the slots slightly before the flap plunger pin snaps into the notch (this will pre-load the deployment cables slightly in the fully-extended position). At the two intermediate flap positions, the flaps should extend equally. Adjust cables and pushrods, as necessary.

When satisfied with the operation of the flap control system, follow standard procedures to safety the flap cable turnbuckles, using either locking clips or safety wire.

Completed: [ ]

Step 177: Eliminate Flap Cable Contact with the Fuselage Cage

There may be places near the flap handle where the flap cables contact the fuselage cage. This contact must be eliminated; otherwise, wear on the cables could weaken them or a hole could be worn in the cage tubing.

You can use any appropriate material to protect the cage where the cables contact. Small pieces of UHMW polyethylene or phenolic, or lengths of nylon tubing slit open lengthwise to fit over the cable and secured to the cage to keep them from sliding will all work well. The configuration of these wear pads will vary, depending on where the contact occurs. Secure the pads with cable ties, safety wire or any other means that keeps them positively in position between the cable and the cage.

> **Note** Any wear pads installed must be inspected at regular intervals—certainly no less often than during your annual condition inspection—for excessive wear. With this in mind, choose materials and installation methods that will make the pads easy to replace.

Completed: [ ]

Step 178: Tension and Safety the Aileron Control Cables

The required travel for the ailerons is **22.5° up** ± **2.5°** and **17.5° down** ± **1°** . You verified aileron travel and set the aileron limit stops during initial aileron cable installation (Step 45 in "SECTION IX: SYSTEMS INSTALLATION"). At this time, perform a final check that you have the required aileron travel. Check also that the interconnect tie rod is centered relative to the elevator/aileron control yoke when the ailerons are in their neutral positions and that the aileron control stops are properly adjusted (i.e., the control stick pivot bracket arms contact the control yoke pivot arms when the ailerons are at their travel limits).

When satisfied that the aileron control system is ready, use standard procedures to adjust the cables to the proper tension. Follow standard procedures to safety the aileron cable turnbuckles, using either locking clips or safety wire.

> **Note** When tensioning the aileron cables, you must adjust **all three** turnbuckles in the system in order to avoid changing the neutral positions of the ailerons, the bellcranks and the interconnect tie rod. However, because the crossover cable balances the two actuation cables (refer back to Figure 93 in "SECTION IX: SYSTEMS INSTALLATION"), you must tighten the crossover cable turnbuckle **two** turns for every **one** turn you tighten **both** actuation cable turnbuckles.

Completed: [ ]

Step 179: Tension the Tailwheel Steering Cables (Taildragger Only)

With the Sportsman sitting on its gear, neutralize the rudder and center the tailwheel. Unhook the steering chains from the forward connector clips on both sides.

Have an assistant grab a steering chain with a pair of pliers just forward of the spring and pull it forward in a direct line toward the end of the steering cable basically as hard as he or she can. The spring should be extended by this pull. With your assistant holding the chain in this position (i.e., doing all the real work!), take up the slack in the chain and hook it back up to the connector clip on the cable thimble. When the chain is released, both the cable and the chain should be under constant tension when the airplane's weight is on the tailwheel.

Repeat the process for the other side.

Completed: Left [ ] Right [ ]

MISCELLANEOUS FINAL ASSEMBLY DETAILS

Step 180: Install the Fuel Gauges or Fuel Gauge Sender Units in the Tanks

Fuel Gauge Options Fuel gauges are not included in the standard Sportsman kit. However, they are required under the FARs. Glasair Aviation offers two fuel gauge options. The Mechanical Fuel Gauge is a plastic-floated, adjustable, lever-action gauge with a sealed dial assembly that bolts right onto the fuel gauge mounting flange on the inboard end of the main tank. Mounting hardware and gaskets are included with the gauge. Order P/N 201-40010-01; two are required per aircraft. If you're installing the mechanical fuel gauges, do so now.

The second option is to use electronic fuel gauges, which rely on capacitance probes in the tanks. Glasair Aviation, LLC's Vision Standard Fuel Tank Probe Adapter Kit (P/N 933-03000-01) consists of special female threaded adapters that allow you to bolt such probes right to the fuel gauge mounting flanges of the main tanks. The adapters are designed specifically for the probes manufactured by Vision Microsystems, but they will accept any capacitance probe with male 3/4" NPT threads. All necessary hardware, gaskets and instructions are included in the kit.

Vision Microsystems probes can be installed as part of the VM 1000 integrated engine monitoring system or the EPI 800 individual-gauge system. The entire line of Vision Microsystems products is available at competitive prices direct from S-H.

If you're installing the Vision Standard Fuel Tank Probe Adapter Kit, **turn to the option instructions now**. Return to Step 188 of this *Assembly Manual* when the specified option steps have been completed.

☞

Completed: [ ]

Step 181: Install the Inboard Delta Wings

Taking care to match each inboard delta wing cap with its matching support, use 3/32" AN470AD3 universal-head rivets to rivet the pairs together. The manufactured heads should be on the upper surface of the cap. Then use 1/8" AAPQ-42 blind rivets to rivet the inboard delta wings to the wing-root areas of the fuselage, using the four holes for each support that you drilled in Step 93.

Completed: Left [ ] Right [ ]

Step 182: Install the Outboard Delta Wings

For access reasons, it's necessary to rivet the outboard delta wing supports to the wing leading edges before riveting the caps to the supports. Use 1/8" AAPQ-42 blind rivets to install the supports, using the four holes for each support that you drilled in Step 93. Then rivet the caps on with 3/32" AN470AD3 universal-head rivets. If you are installing the composite version, then use the appropriate AN507 screw on the aft end.

If you plan on painting your wings, install the delta wings after final paint.

Completed: Left [ ] Right [ ]

Step 183: Fabricate and Install a Cover for the Lower Aft Fuselage Inspection Hole

Here's one you probably thought we forgot about! In Step 61 of "SECTION VIII: FUSELAGE ASSEMBLY" you cut an inspection hole in the bottom of the fuselage shell. Now you need to fabricate a cover for it.

There are two methods in making your cover. The easiest and lightest in weight would be to fabricate an aluminum cover plate from any scrap .032 aluminum sheet that is approximately 1-1/2" larger in diameter than the hole you cut in the fuselage. Roll this cover slightly to match the contour. Install the cover with (2) #8 or #10 sheet metal screws, threading them directly in to the center seam of the fuselage skin, one each on the forward and aft end of the cover.

Alternatively, if you saved the plug from the hole, you can use it now to make a cover for the hole. As shown in Figure 200, angled build-ups of thick resin/mill fiber mixture must be applied around the perimeters of both the inspection hole in the fuselage floor and the plug that you cut from the fuselage back in SECTION VIII. Apply a thick layer of this material to both areas, and then after it has cured use a sanding drum or a half-round file to bevel it as shown in the figure until you have a snug fit between the plug and the hole.

Next, cut a piece of .063" X 1/2" X 1/2" aluminum angle long enough to bridge the inspection hole with about **1/4"** overlap onto the solid fuselage floor at each end. Drill a **#10** hole in the center of one flange of the angle and install a K1000-3 nutplate there. Drill and countersink a matching **#10** hole in the center of the plug, and secure it with an AN507-10R16 flush-head machine screw. In order for the screw length to work out correctly, the angle should run perpendicular to the fuselage seam and contact the foam-core portion of the fuselage floor, as shown in the figure.

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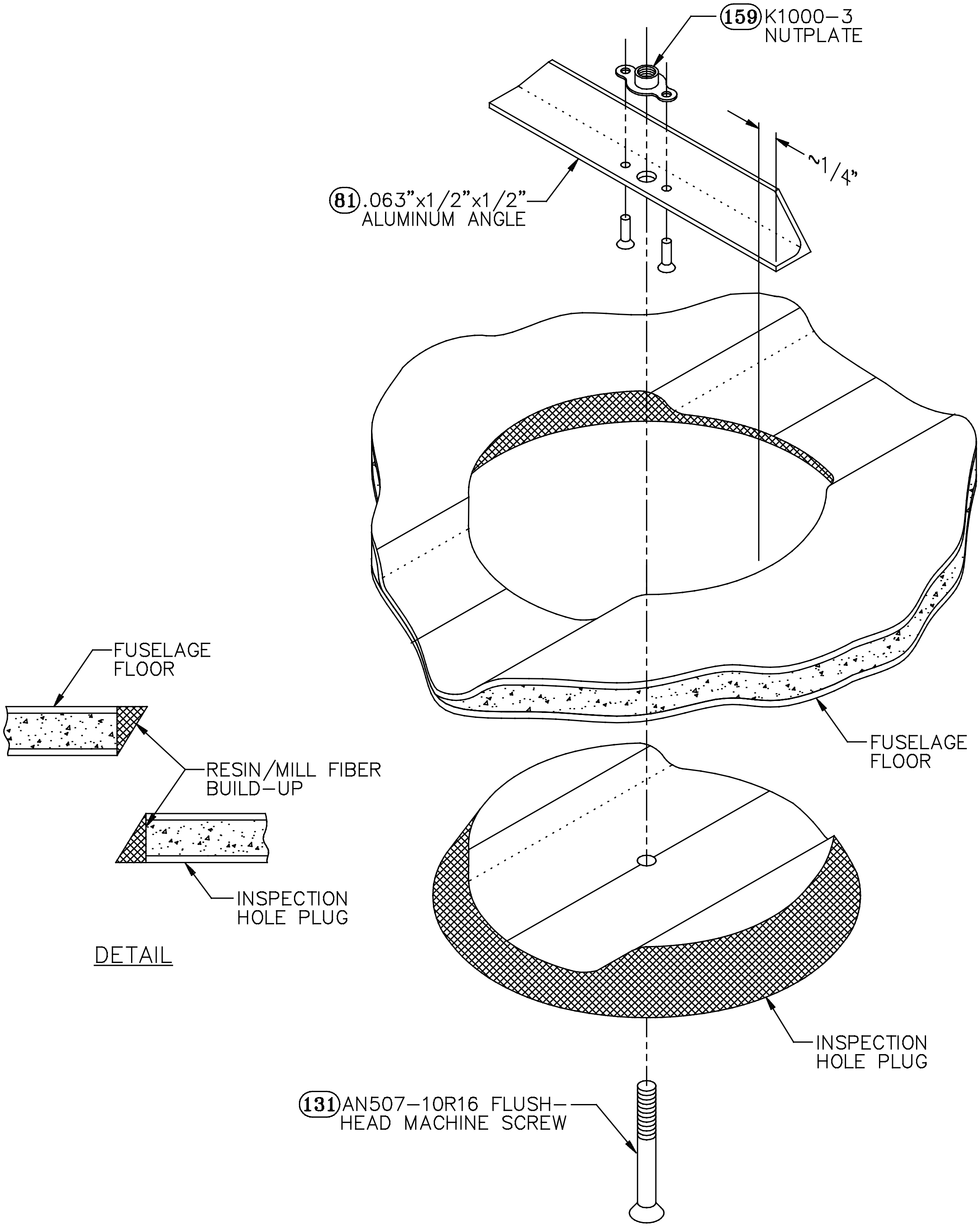

Figure 200: Fabricating the Lower Aft Fuselage Inspection Hole Cover

Step 184: Install the VOR Antenna (Optional)

Way back in "SECTION VIII: FUSELAGE ASSEMBLY" you may have installed the antenna cable in the vertical fin, reinforced the vertical fin rib and installed mounting hardware for a "cat-whisker" dipole antenna. We've waited until now to recommend finishing the installation to minimize potential damage to the antenna during the major construction work. Now it's finally time to connect the antenna to the cable and mount the antenna to the fin.

Swing the rudder as far one direction or the other as you can to expose the top of the vertical fin. Then use a single-bladed hacksaw, files and or a rotary file in a die grinder to make the necessary cutouts in the fin to accommodate the two ears of the antenna and the central disk over your mounting hardware. Connect the antenna to the cable and secure the antenna to the mounting hardware.

You may have opted for the wing tip installation of the Bob Archer VOR antenna. You may finish that installation at this time.

Warning After you have installed the VOR antenna, swing the rudder back and forth the full extent of its travel while checking for any interference or potential interference between the rudder and the antenna. There should be no gaps between any part of the rudder and the antenna or fin that is smaller than about **1/8"**. Relieve any interference or potential interference.

Completed: [ ]

Step 185: Set the Trim Tab Travel Stops (Manual Trim Only)

This step requires delicate work in an awkward location, but you're so close to the end now that we figured we could lay this on you without too much risk of revolt!

First, remove the trim gear box from the forward end of the trim cable, if it's in place. Also, remove the left and right gear box brackets from the box. (Remember to remove the screws from only one side of the box at a time to prevent the whole thing from falling apart on you!) Turn the trim wheel until the red trim position indicator bar on top of the box is centered in its slot.

Begin to replace the gear box on the cable end, just as you did in Step 116 of "SECTION IX: SYSTEMS INSTALLATION." However, before inserting the solid wire through the hole in the gear box's traveler block, insert it through one of the small, metal **cable clamps** [193] you took off the wire back in SECTION IX. Then insert the wire through the traveler block and the second cable clamp before threading the box onto the cable ferrule. As before, be sure the jam nuts and washer are in place on the ferrule, then thread the box **1/2"** onto the ferrule, stopping when the box is **upright**, and finally tighten the nuts against the box. Figure 201 shows how the parts should be arranged when you're done. However, the angle of vision in Figure 201 is probably impossible for you to achieve unless you're a lot more nimble than we are, so you'll have to confirm that everything's in the right place by touch, or use an articulated inspection mirror.

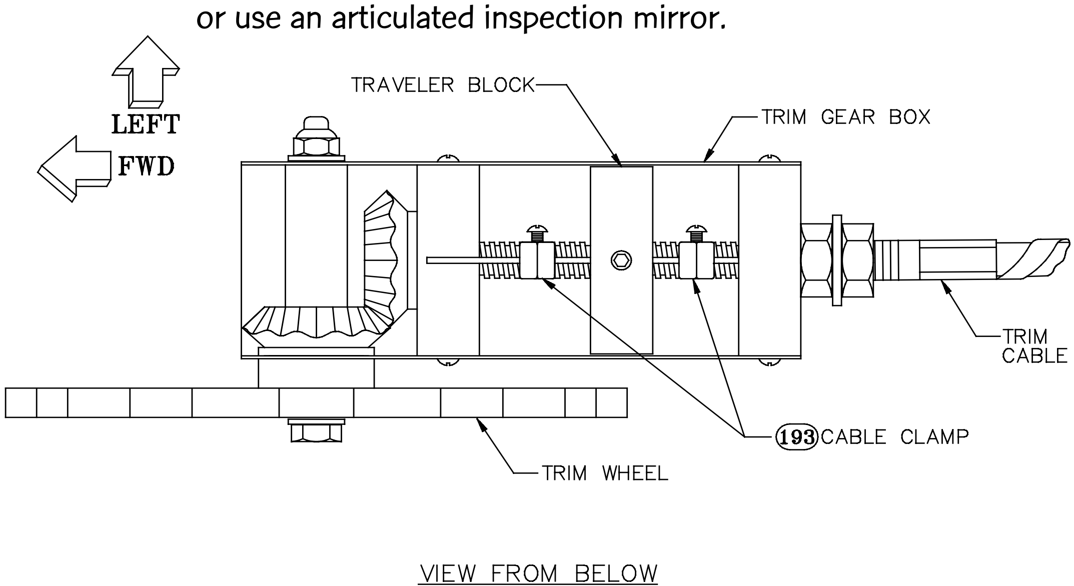

Figure 201: Arranging the Cable Clamps on the Trim Cable (Manual Trim Only)

At this point, the set screw in the traveler block should still be loose so the wire is free to move forward and aft. Before tightening the set screw, you need to secure your trim tab in its neutral position by taping some paint stirring sticks or equivalent flat slats across the gap between the tab and the elevator. Then tighten the set screw down **hard** onto the wire with a **3/32"** Allen wrench.

Next, position and tighten the two cable clamps. These clamps serve to limit the travel of the trim tab to the desired range of **1-1/4"**. To serve this function, the clamps must be positioned tight up against the traveler block on either side, as shown in Figure 202. The forward clamp will contact the forward block at the nose-up extreme, and the aft clamp will contact the aft block at the nose-down extreme. Use a stubby or an offset screwdriver to tighten them onto the wire. As with the set screw, tighten the clamp screws **firmly**.

After the clamps are set, use wire cutters to clip off the excess wire extending forward beyond the forward cable clamp. At this time, install the gear box brackets and then the control cable cover and gear box.

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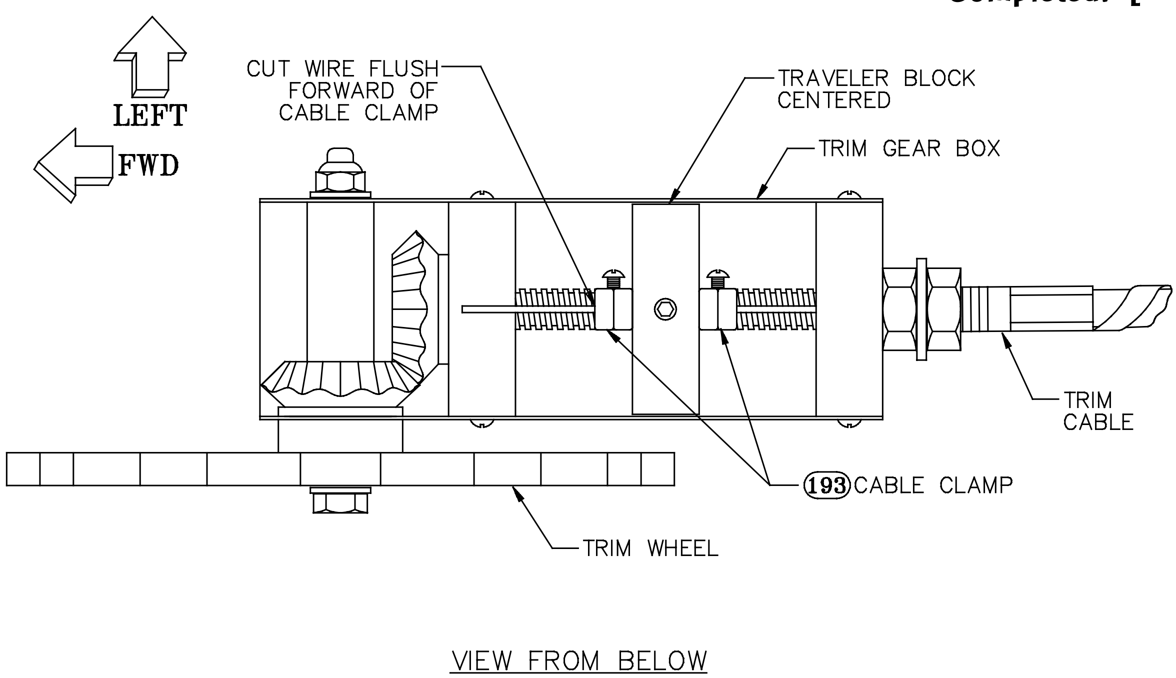

Figure 202: Positioning the Trim Tab Travel Stops (Manual Trim Only)

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Step 186: Install the Seat Belts and Shoulder Harnesses

Seat belts and shoulder harnesses are not included in the standard Sportsman kit because most builders prefer to coordinate these items with their choice of carpeting, upholstery and so on. However, **seat belts and shoulder harnesses should in no way be considered optional equipment**; both the law and common sense dictate the installation of approved aircraft belt and harness systems in your Sportsman.

Seat Belt and Shoulder Harness Option Glasair Aviation, LLC's Seat Belt and Shoulder Harness Set consists of belts and harnesses customized with the Sportsman logo. **One each are** required per aircraft; order P/N 803-00570-01/02.

The attach points for the belts and harnesses are provided in the cage structure. As shown in Figure 203, the single cross-over shoulder attach points are located on the vertical tube near the door. The attach bushings for the outboard ends of the seat belts are located on the door sill truss. The inboard ends of the belts are secured with the same bolt that secures the forward ends of the seat tracks, as described above in Step 22.

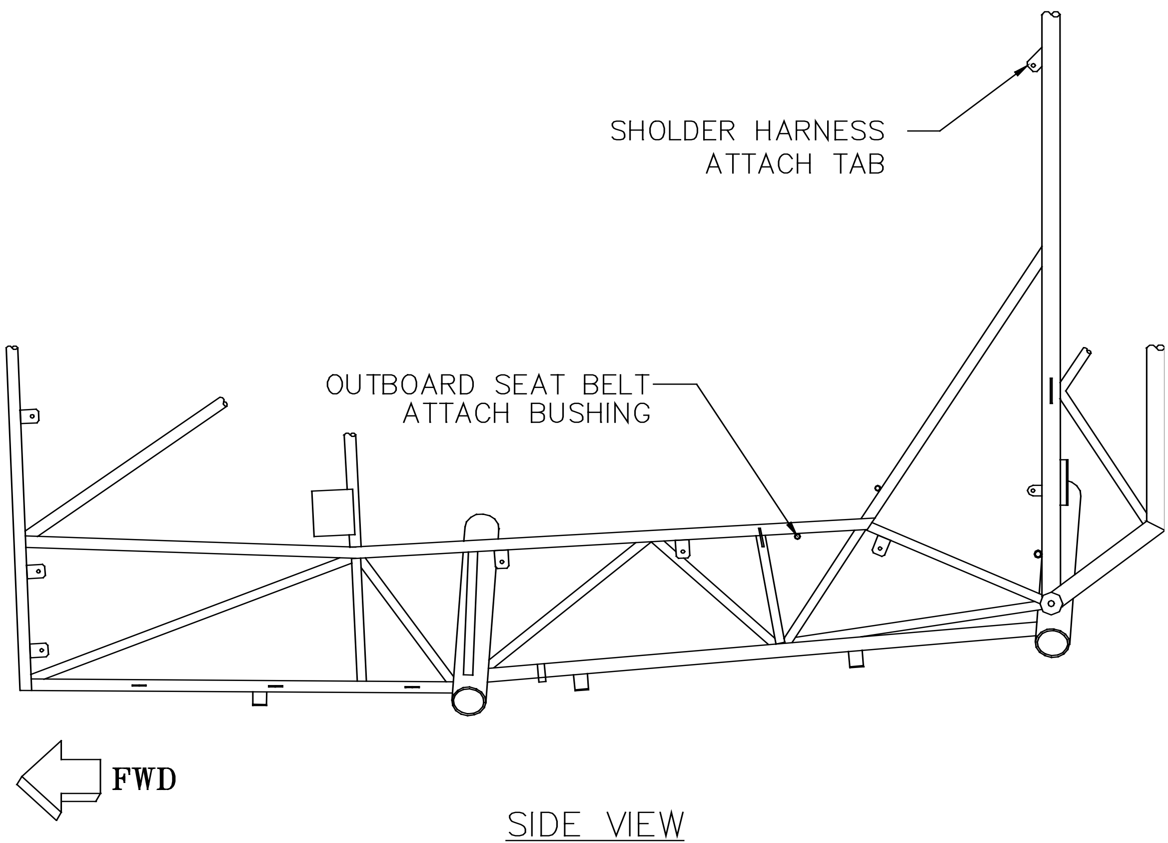

Figure 203: Seat Belt and Shoulder Harness Attach Points

The attach hardware for the belts and harnesses is included in the standard kit. Figure 204 shows the hardware used to attach the shoulder harnesses to the vertical tube by the doors: an AN4-6A **bolt** [130] through an AN970-4 large washer, and NAS43HT4-12 steel spacer, an AN960-416L thin washer and an AN365-428A nylon self-locking nut. The purpose of the spacer, which should be clamped tightly between the large washer and the cage tab, is to allow the harness attach tab to rotate freely around the attach bolt.

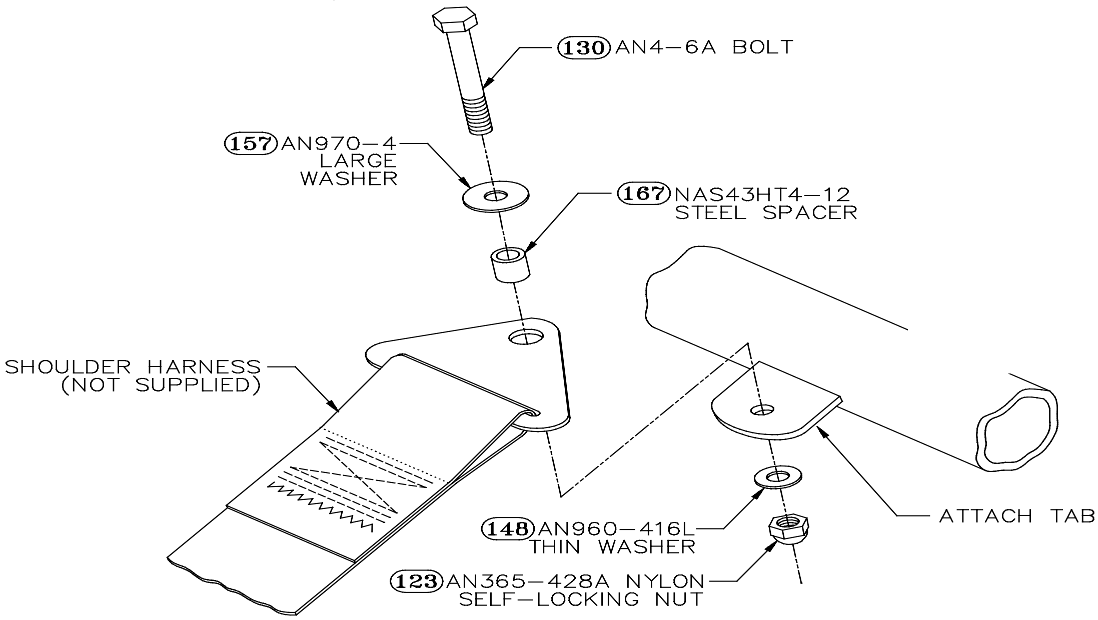

Figure 204: Shoulder Harness Attach Hardware

Figure 205 shows the seat belt attach hardware. The outboard seat belt attach tabs slide over the cage bushings and are clamped in place with AN4-14A **bolts** [126], AN960-416L thin washers and AN365-428A nylon self-locking nuts. An AN970-4 large washer should be used under each bolt head, as shown in Figure 205a.

The inboard belt attach tabs should be installed on the AN4-32A forward seat-track bolt with NAS43HT4-12 spacers and AN970-4 large washers under both the bolt head and the AN365-428A nylon self-locking nut, as shown in Figure 205b.

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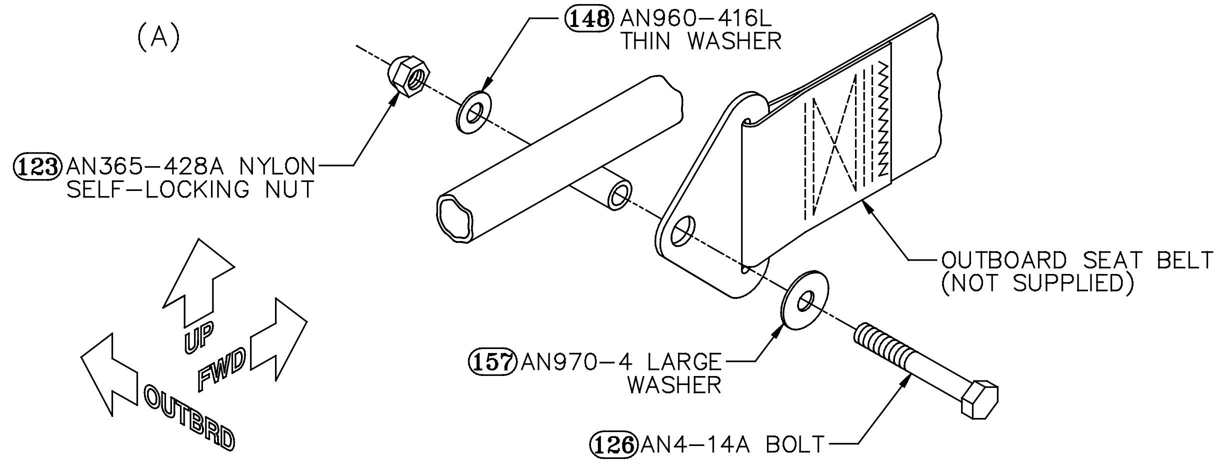
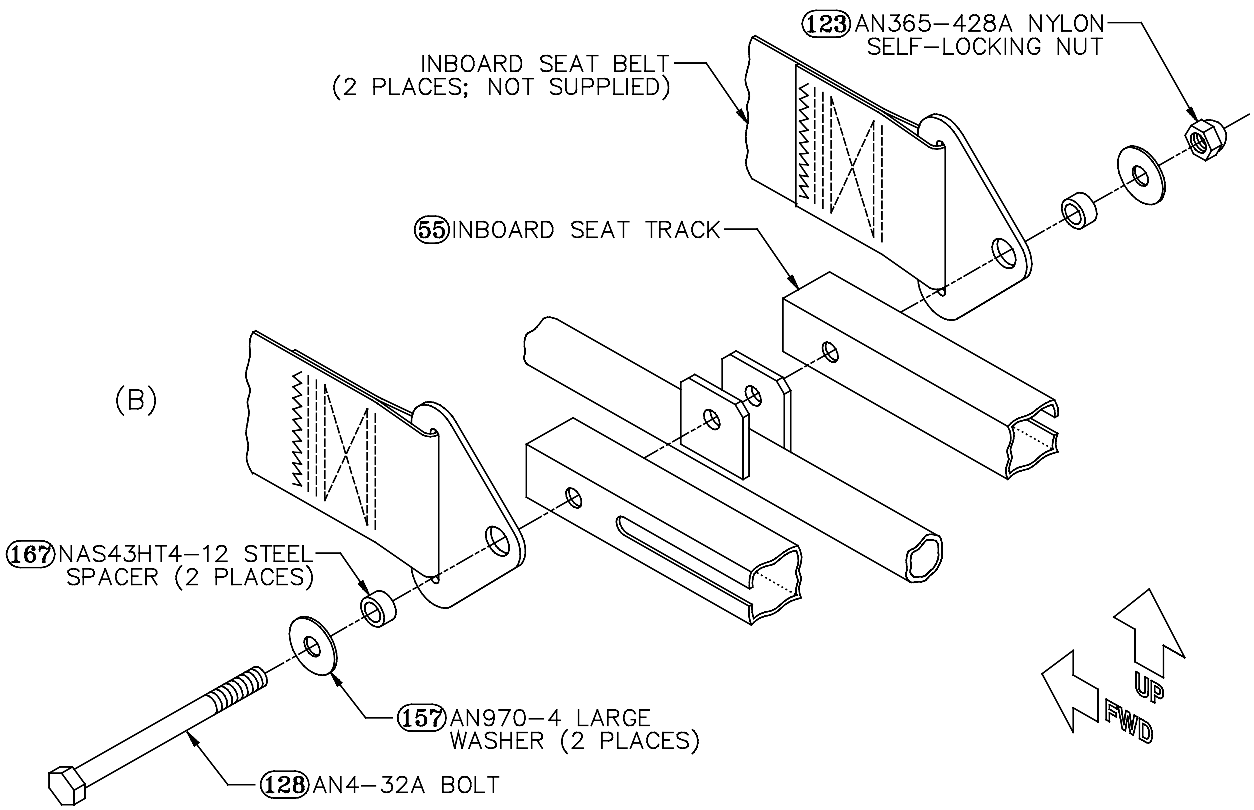


OUTBOARD SEAT BELT ATTACHMENT



INBOARD SEAT BELT ATTACHMENT

Figure 205: Seat Belt Attach Hardware

SYSTEMS CHECK-OUT

This sub-section describes an inspection of all the aircraft systems to make sure they're working properly before taxi and flight testing. The following sub-section provides a detailed checklist for inspecting all the fasteners in the airframe. Although the two subjects are treated separately, it makes sense to think of the process as one overall inspection and to check for proper fastener installation and safety as you inspect each system. So, as you complete each step in "SYSTEMS CHECK-OUT," look ahead to the appropriate step in "FASTENER INSPECTION AND SAFETYING" and check off each set of fasteners as you're sure its installation is final.

Note Before the first flight, the aircraft must be inspected and signed off by the FAA (or its equivalent for non-U.S. builders). Refer to "FAA INSPECTION AND DOCUMENTATION REQUIREMENTS" in "SECTION I: INTRODUCTION" of the *Assembly Manual* for an overview of homebuilt aircraft certification procedures.

Step 187: Inspect the Control System

Make a final check to verify that all flight control surfaces have the prescribed travel, as follows:

Ailerons: 22.5°(±2.5°) up, 17.5° down (±1°)
Elevator: 23° up, 20° down (±1°)
Rudder: 25° left and right (±1°)

Adjust the control stops, as necessary. Verify that the ailerons have the same travel on both sides, that all control surfaces respond correctly to control system inputs, and that all controls work smoothly without binding or excessive friction.

Verify that the flaps have full travel and that both flaps extend the same amount at each notch; the flaps should be fully retracted (with the flap track bearings at the ends of their slots) when the handle is in the lowest notch and fully extended when the handle is in the highest notch.

Check that all engine, propeller and accessory controls work smoothly and provide full travel (stop to stop).

Warning Make sure that none of the controls, when fully deflected, interferes with the movement of any of the other controls. In particular, check for interference between the control sticks and the throttle and mixture controls. Take steps to alleviate any unacceptable interference.

Check all control cables for proper routing and tension. All cables should contact only pulleys, fairleads, nylon guide blocks or other dedicated wear blocks. Install nylon or phenolic wear blocks if the cables rub on the fuselage cage or other parts of the airframe.

Insert a piece of wire into the inspection hole in each rod end bearing in the control system to verify that there are enough threads engaged. If the wire goes through the hole, the rod end bearing needs to be threaded further onto the control rod. Double check that all jam nuts are properly torqued (with a wrench) and witness-painted.

Make sure that the elevator, rudder, aileron and trim tab counterweights are tightly secured and do not contact any part of the airframe during any part of the control surface's range of travel.

Check the elevator trim system (regardless of whether it's electric or manual) for free travel throughout the entire range. Check to make sure that the trim position indicator registers properly when the trim tab is in the neutral position and, if necessary, adjust the indicator to achieve this.

Finally, make sure all moving parts are lubricated properly. We recommend light grease, except for rod end bearings, which should be lubricated with a greaseless spray lubricant (such as LPS).

Completed: [ ]

Step 188: Inspect the Landing Gear, Wheels and Brake System

Make a thorough inspection of the entire landing gear system. Make sure the tires are inflated properly and the main wheel axle nuts are cotter-pinned. Inspect all other fasteners for proper installation and tightness (see the following sub-section). Make sure the brake lines are adequately protected from rocks or other ground debris, and that they are routed well clear of the tires so that chafing cannot occur.

Bleed the Brakes

Aircraft brakes are bled from the bottom to the top (i.e., from the caliper to the master cylinder(s)). Use a fluid pump (such as an oil pump can) with a clear tube attached to the brake caliper bleeder fitting. Open the bleeder and pump fluid from the caliper through the master cylinder(s) to the reservoir until no air bubbles are evident in the reservoir; then, tighten the bleeder fitting. As the reservoir fills, siphon the fluid back down into the pump or some other container to prevent overflow. Repeat for both brake calipers until the brakes feel solid. Finally, drain the reservoir until it is about **7/8** full. A soft pedal means there is trapped air in a line or the master cylinder. Try loosening a fitting at the master cylinder (one at a time) while pumping from below. Also try depressing the master cylinder by pressing on the pedal will sometimes displace trapped air.

"BURN-IN" THE BRAKE LININGS

To provide maximum service life, the brake lining material must be properly broken-in by gently heat-curing the resins, as described below. However, the application of **excessive** heat before curing will carburize the lining material, lowering the coefficient of friction and reducing the service life of the linings.

It is recommended that this step be done with the wheel pants removed.

Break-in the brake lining material during initial taxi testing by performing a **minimum** of **six** full stops from a speed of **between 25 and 40 mph**, using light pedal effort and letting the brakes cool partially (about one minute) between stops. This procedure generates enough heat to cure the resins in the lining, yet will not carburize the material by heating it excessively. Once the linings are properly cured, they will provide many hours of maintenance-free service.

Completed: [ ]

Step 189: Inspect and Flush the Fuel System

Remove the fuselage fuel drain valve and flush the fuel tanks with a gallon or so of gasoline per side. Strain the draining fuel through a fine screen or cloth to check for debris, and continue flushing until no evidence of debris is seen. Then reinstall the drain valve, using a thread sealant.

Next, remove the gascolator bowl and flush the rest of the fuel system, again straining the draining fuel for foreign matter. Continue flushing until no debris is evident. Replace the gascolator bowl, and then refill the tanks with a couple gallons a side.

Check the whole system for leaks. Make sure all fittings are tight and leak-free and that there are no obstructions in the vent lines. The fuel valve should operate smoothly and correctly and be mounted in a position to prevent its being closed accidentally during flight. Check the firewall-forward fuel lines for kinks and leaks. Turn on the electric boost pump and check it for proper function.

Note After ground run-ups and taxi testing but **before** the first flight, check the gascolator screen for foreign matter. If any is found, re-flush the tanks and fuel lines.

Completed: [ ]

Step 190: Inspect the Pitot/Static System

Check to see that the pitot tube is clear and that the airspeed indicator is working before the first flight. Have a helper watch the airspeed indicator for movement while you blow near the pitot tube. If there is movement in the indicator, the lines are okay.

Caution Do not blow closer than about **2"** from the mouth of the pitot tube. Blowing directly into it may damage the airspeed indicator.

Check that the static ports are free of obstructions. Check that all pitot and static line fittings are secure and that all lines are routed to avoid chafing from moving parts of the control system. Reroute lines, if necessary, to eliminate low points where moisture could accumulate. Double check that the pitot and static lines, respectively, are connected to the proper ports on the airspeed indicator.

If you have installed a heated pitot tube, check the function of the heating element.

Note We recommend having a certified avionics shop perform a leak check on the pitot/static system. If you have a Mode C transponder installed, such a check is part of the required certification of the transponder, but it is good practice in any case.

Completed: [ ]

Step 191: Inspect the Electrical System

Check all wiring, making sure the wires are bundled neatly together and routed clear of moving parts. Nylon cable ties and/or cable clamps are required to secure wire bundles in the cockpit and engine compartment areas. Secure wire bundles with clamps and use rubber grommets for abrasion protection where the bundles penetrate panels, such as the engine baffling, or bulkheads.

Double check all switches, circuit breakers and electrical components to verify that they work properly. Replace if necessary. Make sure all switches and circuit breakers are clearly and properly labeled. Test your ELT and check to see that its battery is current.

Completed: [ ]

Step 192: Check the Function of the Avionics and Certify as Required

Check the function of all installed avionics, both with the engine off and running. If required by government regulations, have certification checks performed by a qualified avionics shop.

Completed: [ ]

Step 193: Swing the Compass and Post a Compass Correction Card

A compass correction card is required for all aircraft detailing deviations from accurate magnetic readings at 30° intervals. Use an approved compass rose and the procedures outlined in AC43.13 to swing your compass to minimize these deviations, or have an avionics shop or A&P mechanic perform this task for you.

Completed: [ ]

Step 194: Inspect the Powerplant

Check the engine mount and propeller bolts for proper torque and the installation of appropriate cotter pins. Check for secure mounting of the carburetor, alternator, propeller governor and other engine accessories. Inspect the engine baffling and induction system components for security and integrity. Check all electrical wiring and fluid lines for correct installation and security. Fill the engine crankcase to the level recommended by the engine manufacturer with the proper grade of oil. Fill the engine cooling system, if applicable. Before taxi testing, run up the engine with the cowling removed and check for fluid leaks or vibration problems. Run the engine at various power settings from idle to maximum static rpm. Check for leaks after each engine run and top-up the engine oil level as necessary.

Caution Scrupulously follow all manufacturer's instructions concerning proper engine break-in procedures. In particular, if the engine has been overhauled, check the manufacturer's recommendations for the type of break-in oil and how long to use it.

Check the function of the cabin and carburetor heat, as well as all engine-monitoring instruments.

Completed: [ ]

FASTENER INSPECTION AND SAFETYING

Before flying your Sportsman, it's imperative that you perform a systematic inspection of the entire airframe, with an emphasis on checking that each fastener is properly installed, tightened and safetied as necessary. Use the following general guidelines for your inspection:

A) Check that each bolt, screw and clevis pin has the proper grip length; if more than three washers are needed for an assembly, use the next size smaller fastener.

B) Check that all nuts are tightened firmly (unless the connection is meant to rotate) and that **at least one-and-a-half threads** show past the end of each nut.

C) Verify that all castle nuts are safetied with a cotter pin of the correct size and that both ends of each cotter pin are fully bent over.

D) Check that all clevis pins are properly cottered and that a washer is installed under each cotter pin.

E) Non-self-locking nuts that cannot be cotter-pinned to prevent rotation, such as the jam nuts that lock rod end bearings on control pushrods, should be checked for tightness. For these nuts, we recommend applying witness paint across the interface of the nut with the part it's tightened against as an inspection aid to detect rotation of the parts. Such rotation breaks the paint seal, indicating the need for corrective action. For witness paint, use a small dab of brightly colored fingernail polish or a product called "Torque Seal" made specifically for this application. Torque Seal is available direct from Glasair Aviation; order P/N 620-0642-501.

What follows is a system-by-system checklist to assist you in inspecting every fastener in the airframe. In using the checklist, keep in mind the following points:

A) **The checklist covers the components of the standard kit only**. Thus, the absence of a particular item from the checklist does not relieve you of the responsibility of verifying the safety of that item. In particular, the engine compartment should obviously be subjected to the most rigorous scrutiny.

B) The checklist covers standard aircraft fasteners only. Not included but still vital to check is the security of cable ties, loop clamps, plumbing fittings, etc. Check all plumbing and wiring for consistent use of standard installation practices. In particular, be on the lookout for any existing or potential chafing problems involving electrical wiring or fluid lines.

C) The order of items on the checklist is not necessarily the best order in which to make the inspection. The list is broken up by major system, but in some cases, inspection covers, fairings and so on from one system will have to be left off until the fasteners of a later system have been inspected. Just be certain that at the end of the process, all the items have been checked, and if you are forced to undo a fastener that you have already inspected, be sure to somehow note that it will require re-inspection later.

Step 195: Inspect the Fuselage Structure

- [ ] Fuselage shell/cage attach tab screws and nuts
- [ ] Forward shell attach fitting bolts and nuts
- [ ] Upper and lower shell attach fitting screws, bolts and nuts
- [ ] Aft shell attach fitting screws, bolts and nuts
- [ ] Fuselage strut attach fitting screws, bolts and nuts
- [ ] Wing pivot assembly bolts, nuts and cotter pins
- [ ] Engine mount bolts and nuts
- [ ] Firewall screws and nuts
- [ ] Forward inter-bulkhead shearweb bolts and nuts (after final government airworthiness inspection). Use 15 each AN3-4A bolts, AN960D10 aluminum washers and AN364-1032A nylon self-locking nuts to secure the shearweb.
- [ ] Aft inter-bulkhead shearweb bolts. Use 15 each AN3-4A bolts with AN960D10 aluminum washers threaded into the MF5000-3 nutplates.

Completed: [ ]

Step 196: Inspect the Fuselage Systems

- ☐ Instrument panel mounting bolts, screws and nuts
- ☐ Instrument panel brace mounting screws and nuts
- ☐ Brake reservoir mounting screws and nuts
- ☐ Left and right door hinge mounting screws and nuts
- ☐ Left and right door hinge pivot bolts and nuts
- ☐ Left and right door latch screws, bolts and nuts

Completed: [ ]

Step 197: Inspect the Main Landing Gear

- ☐ Left and right main gear leg bolts and nuts
- ☐ Left and right brake mounting flange bolts and nuts
- ☐ Left and right brake torque plate bolts and nuts
- ☐ Left and right brake caliper assembly bolts and nuts
- ☐ Left and right main wheel assembly bolts and nuts
- ☐ Left and right axle nuts and cotter pins

Completed: [ ]

Step 198: Inspect the Nose Gear (Tricycle Gear Only)

> **Taildragger Options** If your Sportsman has taildragger landing gear, **skip this step.**

- ☐ Nose gear trunnion bolts, nuts and cotter pins
- ☐ Nose gear leg bolt and nut
- ☐ Nose gear stop assembly bolt and nuts
- ☐ Nose fork axle nut and cotter pin
- ☐ Nose wheel assembly bolts and nuts
- ☐ Nose wheel axle bolt, nuts and cotter pin
- ☐ Nose wheel pant mounting bracket retention screws and nuts

Completed: [ ]

Step 199: Inspect the Tailwheel Installation

Tricycle Gear Option If your Sportsman has tricycle landing gear, **skip this step.**

- ☐ Forward spring attach bracket mounting bolts and nuts
- ☐ Aft spring block retainer screw and nut
- ☐ Spring stack screw and nut
- ☐ Forward spring attach bolt and nut
- ☐ Aft spring attach bracket mounting bolts and nuts
- ☐ Aft spring attach bracket cross bolt and nut
- ☐ Tailwheel assembly mounting bolt and nut
- ☐ Tailwheel steering cable clevis pins and cotter pins

Completed: [ ]

Step 200: Inspect the Wing Structure

- ☐ Left and right forward spar attach pins and locking clips
- ☐ Left and right aft spar attach bolts, nuts and cotter pins
- ☐ Left and right strut beam bolts and nuts (some of these are inaccessible for tightening; check the ones you can.)
- ☐ Left and right outboard wing strut attach bolts and nuts
- ☐ Left and right inboard wing strut attach bolts and nuts
- ☐ Left and right fuselage/wing strut attach fitting bolts, nuts and cotter pins

Completed: [ ]

Step 201: Inspect the Empennage Structure

- ☐ Horizontal stabilizer forward attach bracket bolts and nuts
- ☐ Horizontal stabilizer aft attach bracket bolts
- ☐ Elevator hinge pin retainers
- ☐ Trim tab hinge pin retainer
- ☐ Elevator counterweight screws and nuts

- [ ] Trim tab counterweight bolts and nuts (manual trim only)
- [ ] Lower rudder hinge bolts and nuts
- [ ] Upper rudder hinge bolts (check both fin-side and rudder-side hinge halves)
- [ ] Upper and lower rudder hinge pivot bolts, nuts and cotter pins
- [ ] Rudder counterweight screws

Completed: [ ]

Step 202: Inspect the Rudder Control System

- [ ] Rudder control support bracket screws and nuts
- [ ] Brake master cylinder mounting bracket screws and nuts
- [ ] Rudder control pivot push nuts
- [ ] Rudder pedal pivot bolts, nuts and cotter pins
- [ ] Brake master cylinder bolts, nuts and cotter pins
- [ ] Rudder spring shackle clevis pins and cotter pins (early kits only)
- [ ] Forward rudder cable clevis pins and cotter pins
- [ ] Forward pulley group pivot bolts, nuts and cotter pins
- [ ] Forward pulley group cable guard pins and cotter pins
- [ ] Rudder cable turnbuckles (safety wire or clip)
- [ ] Bulkhead A pulley pivot bolts, nuts and cotter pins
- [ ] Bulkhead A pulley bracket cable guard pins
- [ ] Aft rudder cable clevis pins and cotter pins

Completed: [ ]

Step 203: Inspect the Elevator Control System

- [ ] Elevator/aileron control yoke bearing block bolts and nuts
- [ ] Forward elevator cable clevis pins and cotter pins
- [ ] Elevator cable turnbuckles (safety wire or clip)
- [ ] Aft elevator cable bolts, nuts, clevis pins and cotter pins
- [ ] Bellcrank mounting bracket bolts and nuts
- [ ] Bellcrank pivot bolt, nut and cotter pin
- [ ] Pushrod/bellcrank bolt, nut and cotter pin
- [ ] Pushrod/control horn bolt, nut and cotter pin

- [ ] Pushrod rod end jam nuts (witness paint)
- [ ] Trim tab cable end or pushrod/control horn bolt, nut and cotter pin
- [ ] Trim tab cable end or pushrod rod end jam nuts (witness paint)

Completed: [ ]

Step 204: Inspect the Aileron Control System

- [ ] Left and right control stick pivot bracket pivot bolts, nuts and cotter pins
- [ ] Left and right control stick mounting bolts and nuts
- [ ] Left and right primary actuation cable clevis pins and cotter pins
- [ ] Left and right forward aileron pulley pivot bolts, nuts and cotter pins
- [ ] Left and right forward aileron pulley guard straps
- [ ] Left and right aft aileron pulley pivot bolts, nuts and cotter pins
- [ ] Left and right aft aileron pulley guard straps
- [ ] Left and right crossover pulley pivot bolts, nuts and cotter pins
- [ ] Left and right aft wing spar aileron guide-pulley bracket bolts and nuts
- [ ] Left and right aft wing spar aileron guide-pulley pivot bolts, nuts and cotter pins
- [ ] Left and right aft wing spar aileron guide-pulley guard straps
- [ ] Left and right bellcrank/cable bolts, nuts, clevis pins and cotter pins
- [ ] Left and right bellcrank pivot bolts, nuts and cotter pins
- [ ] Left and right bellcrank/pushrod bolts, nuts and cotter pins
- [ ] Left and right pushrod rod end jam nuts (witness paint)
- [ ] Left and right pushrod/aileron bolts and safety wire
- [ ] Left and right hinge bolts and safety wire
- [ ] Aileron cable turnbuckles (safety wire or clip)
- [ ] Aileron servotab hardware (nuts, bolts and cotter pins)
- [ ] Left and right counterweight attach bolts

Completed: [ ]

Step 205: Inspect the Flap Control System

- [ ] Flap handle pivot bolt and nut
- [ ] Flap ratchet plate mounting bolts and nuts

- ☐ Flap ratchet plate roll pin
- ☐ Flap handle/cable bolt, nut, clevis pins and cotter pins
- ☐ Left and right center flap pulley pivot bolts, nuts and cotter pins
- ☐ Left and right center flap pulley cable guard pins
- ☐ Left and right outboard flap pulley pivot bolts, nuts and cotter pins
- ☐ Left and right aft wing spar flap guide-pulley pivot bolts, nuts and cotter pins
- ☐ Left and right aft wing spar flap guide-pulley cable guard pins
- ☐ Left and right bellcrank cable-retainer clip mounting bolts and nuts
- ☐ Left and right bellcrank pivot bolts, nuts and cotter pins
- ☐ Left and right bellcrank/pushrod bolts, nuts and cotter pins
- ☐ Left and right pushrod rod end jam nuts (witness paint)
- ☐ Left and right pushrod/flap bolts, nuts and cotter pins
- ☐ Left and right flap-track bearing mounting bolts, nuts and cotter pins
- ☐ Flap cable turnbuckles (safety wire or clip)

Completed: [ ]

Step 206: Inspect the Manual Trim System

> **Electric Trim Option** If you've installed the electric trim system, **skip this step.**
> ☟

- ☐ Forward trim cable jam nuts (witness paint)
- ☐ Gear box traveler block set screw (witness paint)
- ☐ Travel stop cable clamps (witness paint)
- ☐ Mounting bracket/cage screws
- ☐ Gear box/mounting bracket screws
- ☐ Aft cable retainer clip screws

Completed: [ ]

Step 207: Secure and Inspect the Cabin Interior

The items in this step and the following step should be secured and inspected after the final government airworthiness inspection.

- [ ] Bulkhead A close-out mounting screws
- [ ] Forward and aft control cable cover mounting screws
- [ ] Floorboard mounting screws
- [ ] Glare shield mounting screws
- [ ] Seat track mounting bolts and nuts
- [ ] Seat slider mounting bolts
- [ ] Seat back pivot bolts and nuts
- [ ] Seat belt and shoulder harness mounting bolts and nuts

Completed: [ ]

Step 208: Secure and Inspect the Fairings and Inspection Hole Covers

- [ ] Rudder base fairing mounting screws (AN526-8R8s)
- [ ] Tailcone mounting screws
- [ ] Rudder tip fairing mounting screws
- [ ] Left and right horizontal stabilizer tip fairing mounting screws
- [ ] Left and right elevator tip fairing mounting screws
- [ ] Left and right wingtip fairing mounting screws
- [ ] Left and right main wheel pant mounting screws (if installed)
- [ ] Left and right main gear leg fairing stiffener block screws
- [ ] Nose wheel pant seam screws (tricycle gear only)
- [ ] Nose wheel pant mounting screws (tricycle gear only)
- [ ] Nose gear leg fairing mounting screws (tricycle gear only)
- [ ] Nose gear leg fairing hinge pin safety wire (tricycle gear only)
- [ ] Wing-fold hatch mounting screws (or optional Camlocs)
- [ ] Wing inspection hole cover screws (AN526-8R6s)
- [ ] Aileron inspection hole cover screws (AN526-8R6s)
- [ ] Lower aft fuselage inspection hole cover screw

Completed: [ ]

WEIGHT AND BALANCE

> **Warning** To operate the Sportsman (or any other aircraft) safely, it must be flown within specified center of gravity (CG) limits. These limits must be **strictly** observed. Flight in either a nose-heavy or tail-heavy airplane is unsafe and can result in loss of control.

Because every Sportsman is different, you must determine the CG for **your** airplane in both empty and loaded configurations in order to establish safe loading criteria. This final sub-section of the *Assembly Manual* is devoted to these tasks. The sub-section concludes with instructions for constructing a battery tray. This task is left until the very end so that the battery location can be adjusted if necessary to achieve a more desirable empty weight CG. However, the aircraft should be **totally completed** in every other respect before proceeding with the steps in this sub-section. This means all firewall-forward installations should be complete (including the propeller, spinner and cowling), the instruments and avionics should be installed, the interior finishing (including upholstery) should be completed, and the aircraft should be painted (if you intend to paint it at all).

What follows are some general definitions and data useful in calculating the CG of your airplane. The specific steps required are detailed below.

Step 209: General Definitions

ARM (OR MOMENT ARM) – the horizontal distance in inches from the datum to the center of gravity of a particular item.

CENTER OF GRAVITY (CG) – the point at which an object would balance if suspended in space. The CG of a particular part of the airplane or its load is typically expressed as a horizontal distance from the datum, while the CG of the aircraft as a whole is expressed as a percentage of the mean aerodynamic chord (see below).

DATUM – an imaginary vertical plane from which all moment arms are measured for weight and balance purposes. The datum is perpendicular to the waterline plane when the aircraft is in level-flight attitude.

MEAN AERODYNAMIC CHORD (MAC) – a chord is the straight-line distance from the leading edge to the trailing edge of an airfoil section. The MAC is the average chord across the entire wingspan. The MAC of a straight, constant-chord wing like the Sportsman's is the same as the actual chord at any point in the span. Aircraft CG locations are specified as percentages of MAC; these distances are measured from the leading edge of the wing.

MOMENT – the product of an item's weight multiplied by its arm.

STATION – a horizontal distance from the reference datum given in inches.

Step 210: Generic Sportsman Weight and Balance Data

The following generic data are needed for the weight and balance calculations:

DATUM..58" forward of the cowling mounting flange joggle

MEAN AERODYNAMIC CHORD (MAC) ....44"

MAXIMUM ALLOWABLE GROSS WEIGHT ....2,350 lbs.

CG LIMITS

Forward .... 14.0% MAC (Station 95.6)
Aft ....32.0% MAC (Station 103.5)

VARIOUS MOMENTS ARMS

Datum ....Station 0.0
Cowling mounting flange joggle ....Station 58.0
Firewall ....Station 60.5
Wing leading edge ....Station 89.4
Pilot and passenger...Station 101.0
Fuel ....Station 108.0
Baggage, forward zone...Station 136.0
Baggage, aft zone ....Station 160.0

Note Step 10 of this "FINAL ASSEMBLY" section includes a description of the two different baggage zones. The dividing line between the two zones is located **25" forward** of Bulkhead A or just forward of the baggage door, as shown in Figures 206 and 207 below.

Step 211: Determine the Stations of the Landing Gear

The empty weight CG of the airplane must be determined before any additional CG calculations can be made. The first step in determining the empty weight CG is to measure the distances from the datum to the landing gear. These distances will vary slightly among Sportsmans.

First, with the airplane supported with the wings and the waterline level, use a plumb bob to mark the location of the cowling mounting flange joggle (the cowling/fuselage split line) on the floor.

Note If you made the permanent waterline reference marks as recommended in the Hint at the end of Step 33 in "SECTION VIII: FUSELAGE ASSEMBLY," use them to level the waterline. To level a tricycle-geared airplane, position blocks under either the nose wheel or the main wheels (or partially deflate one or more of the tires). To level a taildragger, prop the tailwheel on a support of some kind and block it up to the appropriate height.

Measure forward **58"** from the cowling joggle mark and mark a line on the floor at this point perpendicular to the longitudinal centerline of the airplane. This line represents the intersection of a plane in space with the floor. This plane is defined as the reference datum (Station 0.0) from which all moment arms are measured.

The next steps vary slightly depending on whether your Sportsman has tricycle or taildragger landing gear. Follow the instructions specific to your configuration.

TRICYCLE GEAR

For a **tricycle-geared** Sportsman, measure and record the horizontal distances "X" and "Y" from the datum to the centers of the nose and main wheel axles, respectively. See Figure 206.

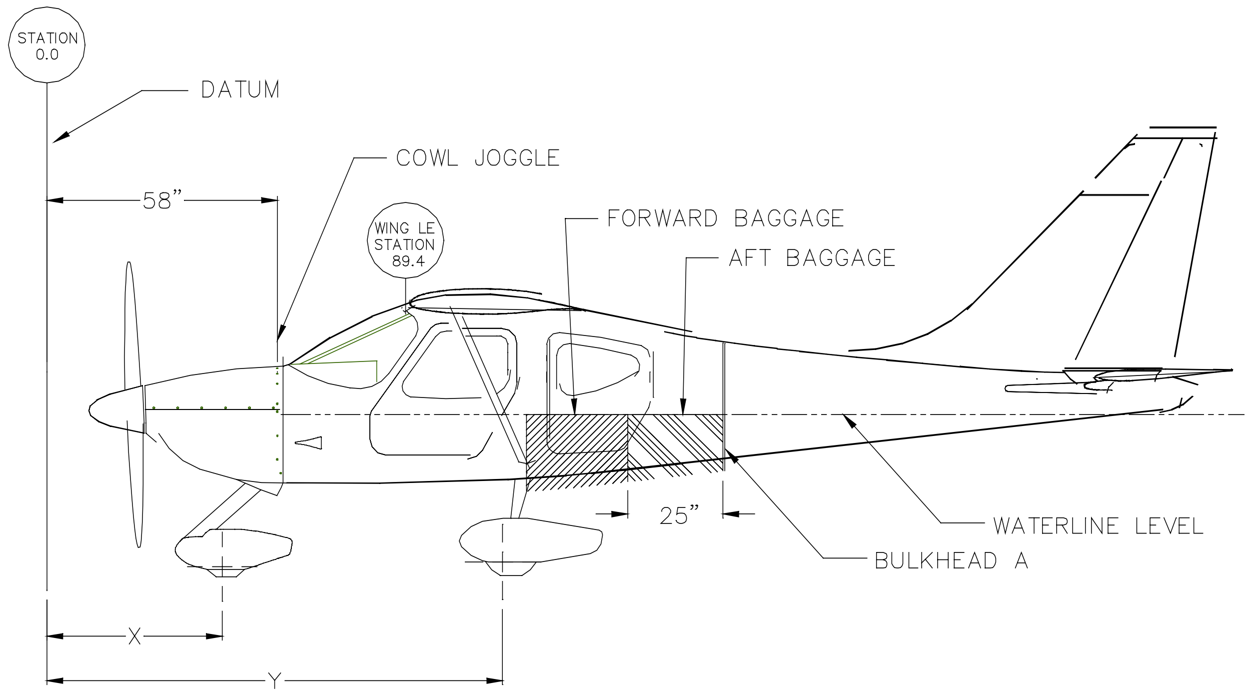


Figure 206: Measuring the Landing Gear Stations (Tricycle Gear Only)

Enter the results of your measurements here:

NOSE WHEEL (X) ___________

MAIN GEAR (Y) ___________

TAILDRAGGER

For a **taildragger**, measure and record the horizontal distances "X" and "Y" from the datum to the centers of the main and tailwheel axles, respectively. See Figure 207.

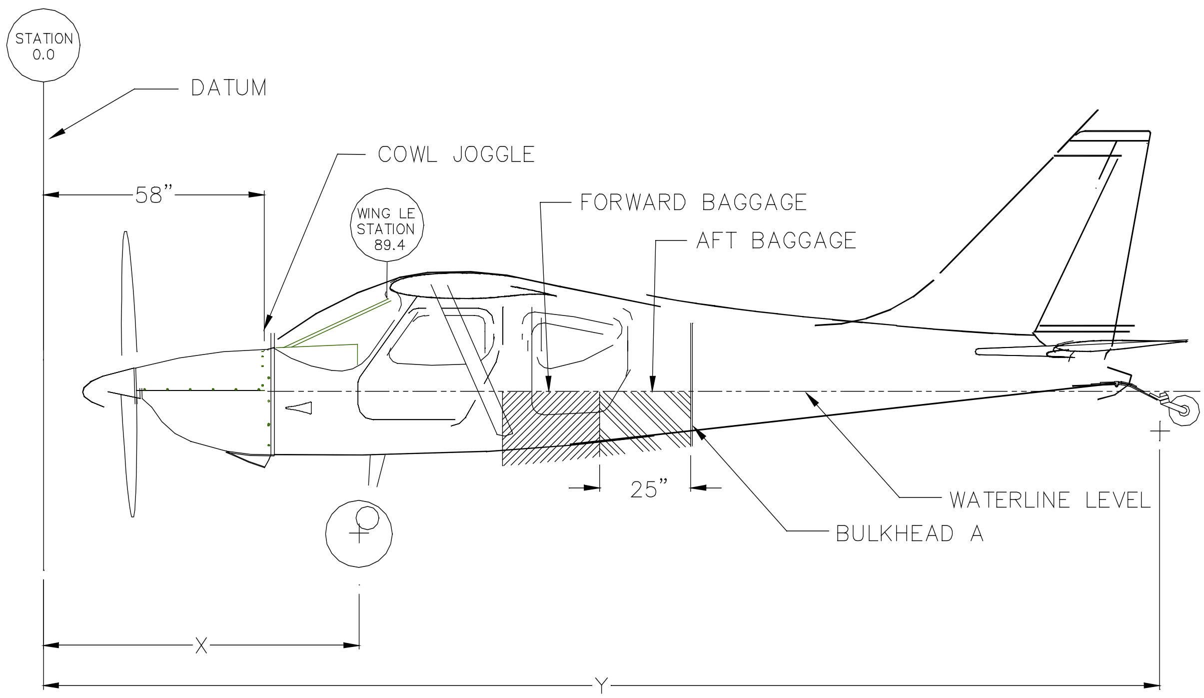


Figure 207: Measuring the Landing Gear Stations (Taildragger Only)

Enter the results of your measurements here:

MAIN GEAR (X) ___________

TAILWHEEL (Y) ___________

Completed: [ ]

Step 212: Weigh the Aircraft

Now it's time to weigh the airplane. This requires three scales—one under each wheel. The scales should each be capable of handling at least 600 lbs. Most builders will find it worthwhile to hire a professional shop to do this job, but if you can lay your hands on suitable scales, have at it.

For this measurement, the fuel tanks should be empty, but the engine should be full of oil and—if it's a liquid-cooled engine—coolant. While weighing the airplane, block up the wheels as necessary to bring the waterline and the wings level. Be sure to subtract the tare weight of any blocks or wheel chocks used from the scale readings.

Note For initial CG calculation, set the aircraft battery on the fuselage floor immediately behind Bulkhead A. This is the most desirable location for the battery from an access standpoint, and so if you can come up with an acceptable CG range with the battery there, that's all to the good. If, on the other hand, you need to move weight aft, you can always do that later.

Also note that you need to record the weights registered by each scale individually—not just the total weight.

Enter the results of your initial weighing here:

	SCALE READING	–	TARE WEIGHT	=	WEIGHT
LEFT MAIN GEAR	___________	–	___________	=	___________
RIGHT MAIN GEAR	___________	–	___________	=	___________
NOSE GEAR/TAILWHEEL	___________	–	___________	=	___________
TOTAL AIRCRAFT	___________	–	___________	=	___________

Step 213: Calculate the Station of the Empty Weight CG

TRICYCLE GEAR

For a **tricycle-geared** Sportsman, use the following formula to calculate the station of the empty weight CG:

$$\text{Empty Wt. CG} = \frac{(\text{Nose Gear Wt.})\ (\text{X}) + (\text{R. Main Wt.} + \text{L. Main Wt.})\ (\text{Y})}{\text{Total Aircraft Wt.}}$$

Note "X" and "Y" in the above formula are the stations of the nose and main gear axles, respectively. Refer to Figure 206.

Following is a **sample** empty weight CG calculation, using the formula above and the data from the tricycle-geared Sportsman prototype. The prototype's empty weight with a Lycoming O-360, a Hartzell compact-hub constant speed propeller is 1,410 lbs., divided as follows:

Nose gear .... 401 lbs., Station 45.1
Left main gear .... 503 lbs., Station 117
Right main gear .... 506 lbs., Station 117

$$\text{Empty Wt. CG} = \frac{(401 \text{ lbs. X } 45.1 \text{ in.}) + (503 + 506 \text{ lbs})\ (117 \text{ in})}{1410 \text{ lbs}}$$

$$= \frac{136138 \text{ in-lbs}}{1410 \text{ lbs}}$$

$$= \text{Station } 96.5 \text{ in}$$

Enter the results of your empty weight CG calculation here:

EMPTY WEIGHT CG STATION ____________

TAILDRAGGER

For a Sportsman **taildragger**, use the following formula to calculate the station of the empty weight CG:

$$\textbf{Empty Wt. CG} = \frac{\textbf{(Tailwheel Wt.) (Y) + (R. Main Wt. + L. Main Wt.) (X)}}{\textbf{Total Aircraft Wt.}}$$

> **Note** "X" and "Y" in the above formula are the stations of the main and tailwheel axles, respectively. Refer to Figure 207.

Following is a **sample** empty weight CG calculation, using the above formula and data from the taildragger Sportsman prototype. The prototype's empty weight with a Lycoming O-360, a Hartzell compact-hub constant speed propeller is 1,429 lbs. and on 23" tires, divided as follows:

Left main gear .... 660 lbs., Station 81.2
Right main gear... 662 lbs., Station 81.2
Tailwheel.. 107 lbs., Station 291.0

$$\textbf{Empty Wt. CG} = \frac{\textbf{(107 lbs. X 291 in.) + (660 + 662 lbs) (81.2 in)}}{\textbf{1429 lbs}}$$

$$= \frac{\textbf{138483 in-lbs}}{\textbf{1429 lbs}}$$

= Station 96.9 in

Enter the results of your empty weight CG calculation here:

EMPTY WEIGHT CG STATION ____________

Completed: [ ]

Step 214: Perform the CG Limit Checks

In this step, you'll perform checks to see where the CG of your Sportsman in "worst-case" loading scenarios—extreme forward and extreme aft CG conditions—falls relative to the acceptable CG range. The results of these calculations will give you information about where best to position your battery in the final step of this sub-section, as well as establishing guidelines for safely loading your Sportsman for flight.

To perform the forward and rearward CG limit checks, tabulate the weights, stations and moments, as shown in the following examples. Add the weights and moments and divide the total moment by the total weight to obtain the station of the CG. Once you have that figure, use the following formula to calculate the CG as a percentage of MAC:

$$CG_{\%MAC} = \frac{\text{Station of the CG - Station of the Wing Leading Edge}}{\text{MAC}} \times 100$$

. . . in which the station of the wing leading edge is **89.4**, and the MAC is **44.0"**.

The following examples are based on the empty weight and empty-weight CG of the tricycle-geared Sportsman prototype; **your numbers will vary!**

Note For all weight-and-balance calculations, note that gasoline weighs 6 pounds per gallon.

FORWARD LIMIT CHECK

The FARs specify that the forward limit check should be performed using the **maximum** weights of items located **forward** of the forward CG limit and the **minimum** weights of items located **aft** of the forward CG limit. In the

Sportsman, all items of variable weight—pilot and passenger, fuel and baggage—are located aft of the forward CG limit (Station 95.6), so the forward limit check conditions are: **no passenger, minimum fuel** and **no baggage**.

The FAA standard pilot weighs **170 lbs**. The standard formula for calculating minimum fuel is as follows:

$$\textbf{Minimum Fuel} = \frac{\textbf{Engine HP}}{\textbf{12}}$$

Thus, for our prototype with a 180 HP engine, the minimum fuel is **15 gal**. Calculate a minimum fuel figure for your Sportsman and enter the result here:

MINIMUM FUEL ___________

Note If you weigh **less** than 170 lbs., you have the **option** of using your own weight to perform the forward and rearward CG limit checks. However, the converse is **not** true; if you weigh more than 170 lbs., you **must** use the 170-lb. standard weight.

ITEM	WEIGHT (LBS.)	STATION (IN.)	MOMENT (IN.-LBS.)
Empty Sportsman	1,410.0	96.5	136,138.0
Pilot	170.0	101.0	17,170.0
Passenger	0.0	101.0	0.0
Fuel (15)	90	108.0	9,720
Forward baggage	0.0	136.0	0.0
Aft baggage	0.0	160.0	0.0
TOTAL	**1,670**	—	**163,028**

Table 2: Sample Forward Limit Check

$$CG = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{163{,}028 \text{ in-lb}}{1{,}670} = \text{Station } 97.6$$

$$CG_{\%MAC} = \frac{97.6 - 89.4}{44} \times 100 = 18.7\% \text{ MAC}$$

Lay out a table like Table 2 for your Sportsman and perform your own forward limit check. Enter your result here:

FORWARD LIMIT CHECK — STATION ___________

If your forward limit check comes out forward of the forward CG limit, you have two options: 1) you can placard the airplane, prohibiting flight under loading conditions that would exceed the forward CG limit, or 2) you can shift the battery aft in an attempt to bring the forward-most CG aft of the forward limit. Option #2 is probably more attractive to most builders, and will be further discussed below.

In the example used above, the empty weight was already aft of the forward limit. Everything that is loaded in the airplane for a flight moves the CG aft because the loading arms are all aft of the empty CG arm.

If your airplane empty CG is forward of the 14% limit, then your forward limit check is more critical when checking for light pilots and minimal fuel.

!

Warning The preceding example illustrates that, as a result of the Sportsman's ability to carry so much baggage, its forward-CG limit is somewhat more sensitive than in some other aircraft when the baggage compartment is empty, especially when equipped with a relatively heavy engine and prop. Be particularly aware of your weight and balance condition when you fly with little or no baggage and low fuel, especially if you are flying solo.

REARWARD LIMIT CHECK

In contrast to the forward limit check, the rearward limit check must be performed using the **minimum** weights of items located **forward** of the aft CG limit and the **maximum** weights of items located **aft** of the aft CG limit. The aft CG limit in the Sportsman is at Station 103.5, so the rearward limit check conditions are: **no passenger, maximum fuel** and **maximum baggage**.

Maximum standard fuel capacity in the Sportsman is **50 gal**., and the maximum total baggage capacity is **300 lbs**.

ITEM	WEIGHT (LBS.)	STATION (IN.)	MOMENT (IN.-LBS.)
Empty Sportsman	1,410.0	96.5	136,138.0
Pilot	170.0	101.0	17,170.0
Passenger	0.0	101.0	0.0
Fuel (50 gal.)	300.0	108.0	32,400
Forward baggage	0.0	136.0	0.0
Aft baggage	300.0	160.0	48,000.0
TOTAL	**2,180.0**	**—**	**233,708.0**

Table 3: Sample Aft CG Limit Check

$$CG = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{233{,}708 \text{ in-lb}}{2{,}180 \text{ lb}} = \text{Station } 107.2$$

$$CG_{\%MAC} = \frac{107.2 - 89.4}{44} \times 100 = 40\% \text{ MAC}$$

LW_{fwd} = the total moment of the aircraft at forward limit check

In this case, although the airplane is under gross weight, the loading exceeds the aft CG limit. Of course, this is not surprising, since we're trying to load 300 lbs. of baggage allowance into the aft zone of the baggage compartment. The solution to this dilemma is to divide the baggage up between the two zones and recalculate. By trial-and-error, you should determine an acceptable load distribution for the forward zone and in the aft zone to bring the CG exactly to the aft limit. This loading represents the aft-most approved loading condition, and **the airplane must be placarded to indicate this**.

This example shows how the empty weight CG here could be moved forward to a point closer to or even slightly forward of the forward limit. We would still satisfy the forward limit and have a bigger range on the aft CG limit.

REARWARD LIMIT CHECK — STATION ___________

Perform a rearward limit check for your Sportsman, using a table like Table 3. If your Sportsman exceeds the aft limit, as it most likely will, determine how the maximum baggage load must be redistributed to bring the CG within limits, and then placard the compartment with the results.

Baggage compartment restrictions — Forward zone ___________

Aft zone ___________

MOVING THE BATTERY

As we saw in the example of the forward CG limit check above, our prototype Sportsman with the 180 HP Lycoming O-360 engine and heavy metal prop can easily be forward or near the forward CG limit. With a relatively heavy engine and prop combination, the empty weight CG could be too far forward to be balanced by the pilot and minimum fuel alone. If your Sportsman weight and balance are out of range, turn to your battery for help!

Because they're heavy, compact and relatively mobile, aircraft batteries make great CG adjustment devices. Very small changes in battery location can have large effects on CG! The ideal location of an empty CG is right at the forward limit, since all loading will drive the CG aft.

Use the following formula to determine where the battery should be placed:

$$BS_{new} = \frac{(CG_{desired} \times LW_{fwd}) - TM_{fwd} + BW\,(172.5\text{in.} + (BL/2))}{BW}$$

where,

BS_{new}	=	the station of the new battery location,
$CG_{desired}$	=	the desired station of the CG at forward limit check,
LW_{fwd}	=	the loaded weight of the aircraft at forward limit check,
BW	=	the weight of the battery,
BL	=	the length of the battery, and
TM_{fwd}	=	the total moment of the aircraft at forward limit check.

The value of $CG_{desired}$ will generally be just forward CG limit, **Station 95.6**. The figure of **172.5 in.** in the equation is the station of Bulkhead A; this station plus half the length of the battery equals the original station of the battery when you performed your initial forward limit check.

Work through the formula above using the values from your own forward limit check and enter the result here:

NEW BATTERY LOCATION — STATION ___________

> **Warning** Any future modifications to the aircraft that add, subtract or shift weight will change the location of the empty weight CG. If any such modifications are made, you must recalculate the empty weight CG and re-perform the forward and rearward limit checks.

Completed: [ ]

Step 215: Install the Battery Tray

Now that you know where it should go, you can finish installing the battery. Construct a battery tray as shown in Figure 208.

> **Warning** The battery tray design detailed on the following pages is suitable for a **sealed battery only**. Traditional-style lead acid batteries with removable caps require a sealed, vented battery box. The example given is also only for batteries being installed aft of the baggage bulkhead. Batteries mounted on the firewall frame are also an option as shown by the Figures 211 and 212.

Begin by cutting out a floor and sidewall for the tray from the two remaining pieces of 1/2" X 12" X 12" 5-lb. density foam. Size the pieces to fit your particular battery: as shown in Figure 208, make the floor **3" longer** and **3" wider** than the base of the battery. The sidewall should be the same length as the floor. Its height will depend on the curvature of the fuselage shell at your battery location; size it to support the tray floor in a horizontal position, as shown.

After you have cut the foam pieces to size, cut **four** pieces of bi-directional cloth on the 45° bias big enough to cover **each** foam piece (i.e., **eight** pieces of cloth in total). Then apply a sealing layer of thin-mixture resin and Q-cell, followed by two layers of cloth to both faces of both foam pieces. When the laminates reach green cure, trim them even with the edges of the foam cores with a sharp utility knife.

While the laminates are curing, apply mold-release wax or equivalent to the lower **2–3"** of the **sides** of the **battery** all the way around. Allow the wax to lap over an inch or so onto the **bottom** of the battery case as well. When the laminates have fully cured, position the battery in the center of the floor laminate as shown in Figure 208, **1-1/2"** from all four edges of the laminate.

With the battery thus waxed and positioned, you will now use it as a form to lay up the retention angles that will hold it in place. As shown in Figure 208, each angle is laid up of two layers of DBM cloth lapped equally onto the floor laminate and the battery case. Begin by cutting **four** strips of DBM that are equal in length to the battery's length and **four** strips equal to the battery's width. Laminate these strips in place as shown in the figure and let them cure thoroughly (trimming them even with the edges of the floor piece at the green-cure stage). When they are fully cured, remove the battery and file or sand the edges of the laminated angles smooth. Radius the corners slightly as well.

The next step is to drill two **1/4"** holes for the hold-down bolts. As Figure 208 shows, these holes should be drilled **1"** from each end of the floor laminate. The left-and-right positioning of the holes should be determined by the configuration of your particular battery. Choose a location as near the middle of the floor laminate as possible but check to make sure that the **1"-wide** hold-down strap that will run between the bolts will clear any terminals or other projections on top of the battery.

After both hold-down bolt holes have been drilled, use standard practices to install a pair of K1000-4 **nutplates** [160] (the **last** two nutplates!) on the underside of the floor laminate. As shown in Figure 208, use 3/32" aluminum blind rivets for this application.

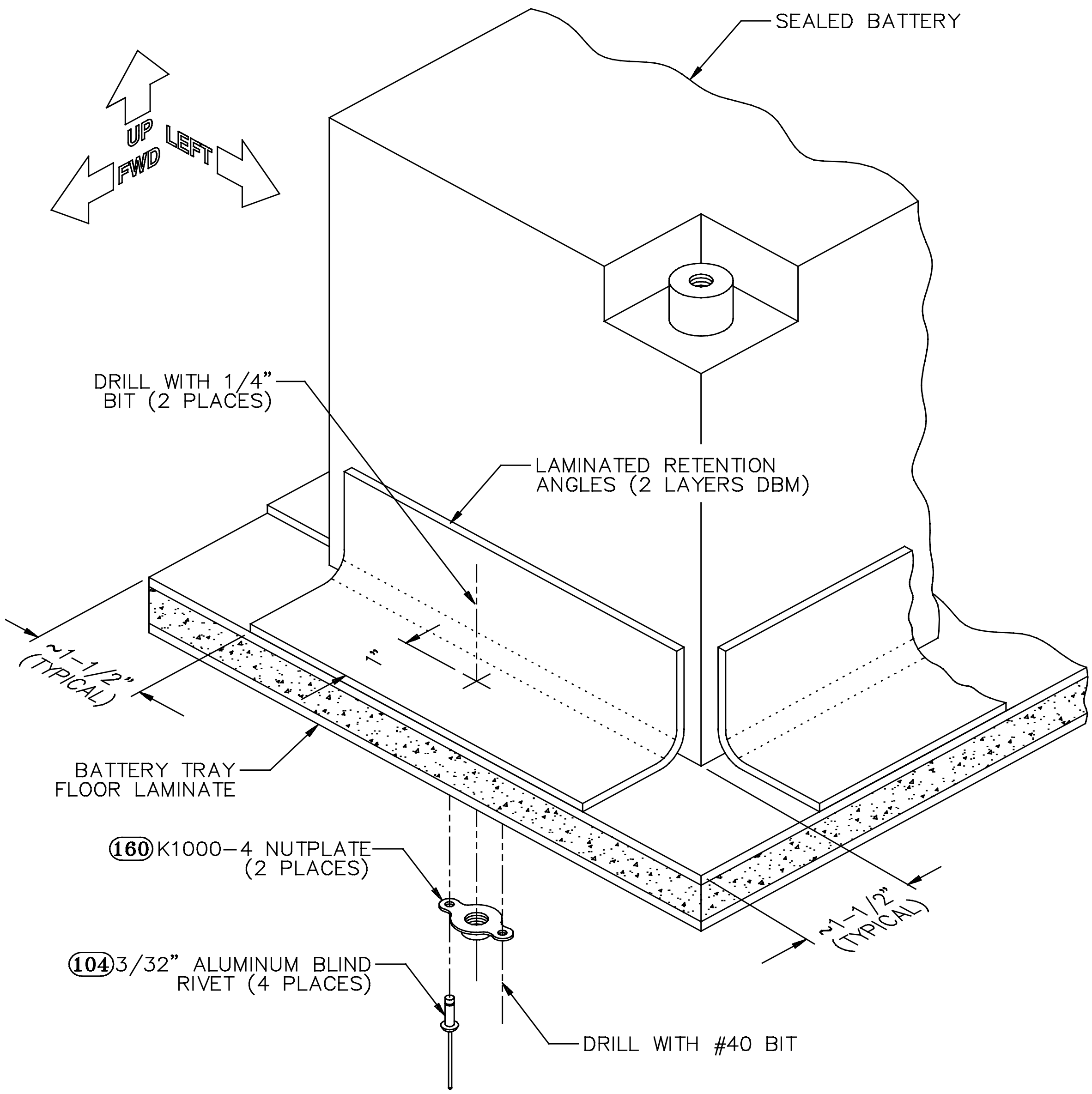


Figure 208: Constructing the Battery Tray (Sealed Battery Only)

The final step before actually installing the floor laminate is to cut and install the two hold-down bolts. These are cut from the **1/4"-28 threaded steel rod** [60], of which 18" is included in the kit. Size your bolts to be **1-1/2" longer** than your battery is high, and cut them to length with a hacksaw. Use a 1/4"-28 die to clean up the threads as necessary, and then thread the bolts into the nutplates at either end of the floor laminate, as shown in Figure 209. Since the threads in the middle of the rods will never be used, you can go ahead and grip them there with a pair of pliers in order to thread them all the way into the nutplates.

Now you're ready to final fit the floor and sidewall laminates for installation in the aft fuselage. As shown in Figure 209, the laminates must be beveled to fit against their adjacent laminates. Use a long sanding block to accomplish this. Bevel the outboard edge of the floor laminate to match the curvature of the fuselage sidewall, the inboard edge of the floor laminate to match the upper edge of the sidewall laminate, and the lower edge of the sidewall laminate to match the floor of the fuselage. Note that you should aim for about a **45°** angle between the floor and sidewall laminates, but this isn't too critical.

Note Figure 209 and 210 show the battery tray installed on the left side of the aircraft, but the right side works just as well.

When you're satisfied with the fit of the parts, mix a small batch of thick-mix resin and Q-cell and bond the parts in place. Leave a finger's-width fillet of Q-cell around the seams between the fuselage side and the top of the floor laminate and between the fuselage floor and the inboard face of the sidewall laminate.

Finish the installation by applying **two** layers of bi-directional cloth cut on the 45° bias to each of seams you just filleted, as well as to the top of the seam between the floor and sidewall laminates (see Figure 209). Each of these layers should run the full length of the seam and should lap **at least 1"** onto each side of the seam.

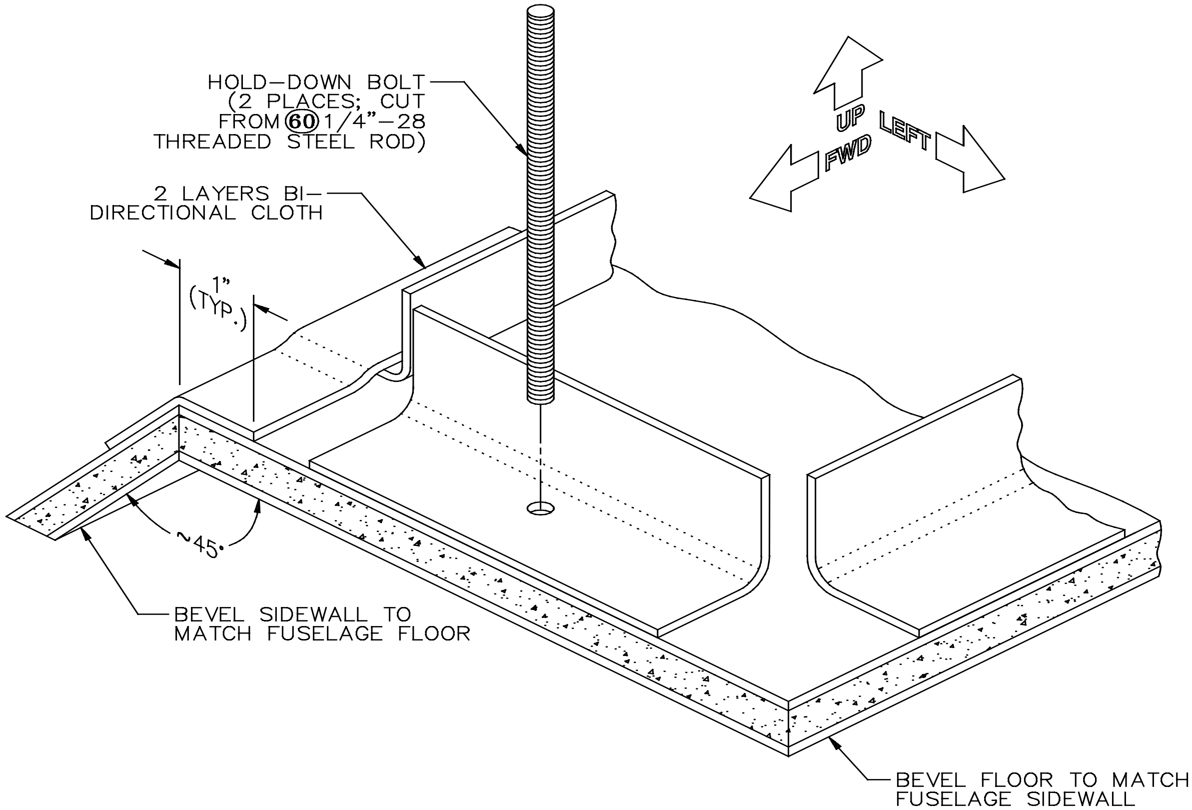


Figure 209: Installing the Battery Tray (Sealed Battery Only)

Finally, fabricate and install a hold-down strap over the battery. As Figure 210 shows, the strap is made of .063" X 1" X 1" aluminum angle stock. Measure the distance between the centers of your hold-down bolts and cut the strap **3/4"** longer than that. This provides the **3/8"** edge margin between the ends of the strap and the bolt holes shown in the figure. Bevel the ends of the vertical flange, as shown, and then drill and deburr the **1/4"** bolt holes. Corrosion-proof the strap as you see fit.

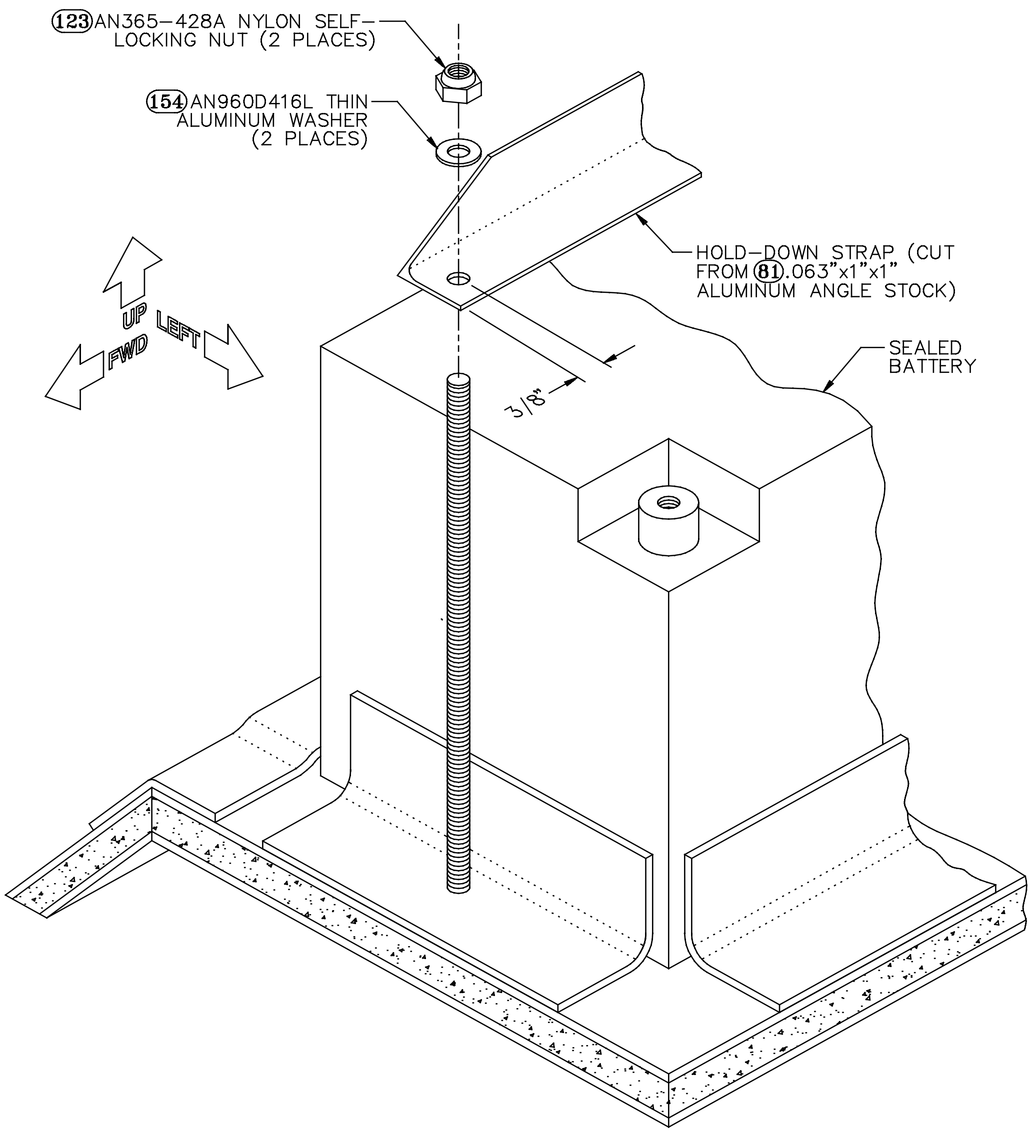


Figure 210: Installing the Battery Hold-Down Strap (Sealed Battery Only)

Set the battery in place inside the retention angles and install the hold-down strap with AN960D416L thin aluminum washers and AN365-428A nylon self-locking nuts. Tighten the nuts firmly but no tighter; your goal is not to crush the battery case!

Completed: [ ]

Step 216: Battery Installations on the Firewall

The following figures show a battery mounted on the firewall of the Sportsman prototype. The angles are not included in your kit due to the wide range of battery sizes and mounting configurations. Figure 211 shows how the batter rack, mounted on the forward side of the firewall, is tied into the oil cooler frame installation. The vertical angle on the far left side of the rack is bolted into tabs on the cage frame.

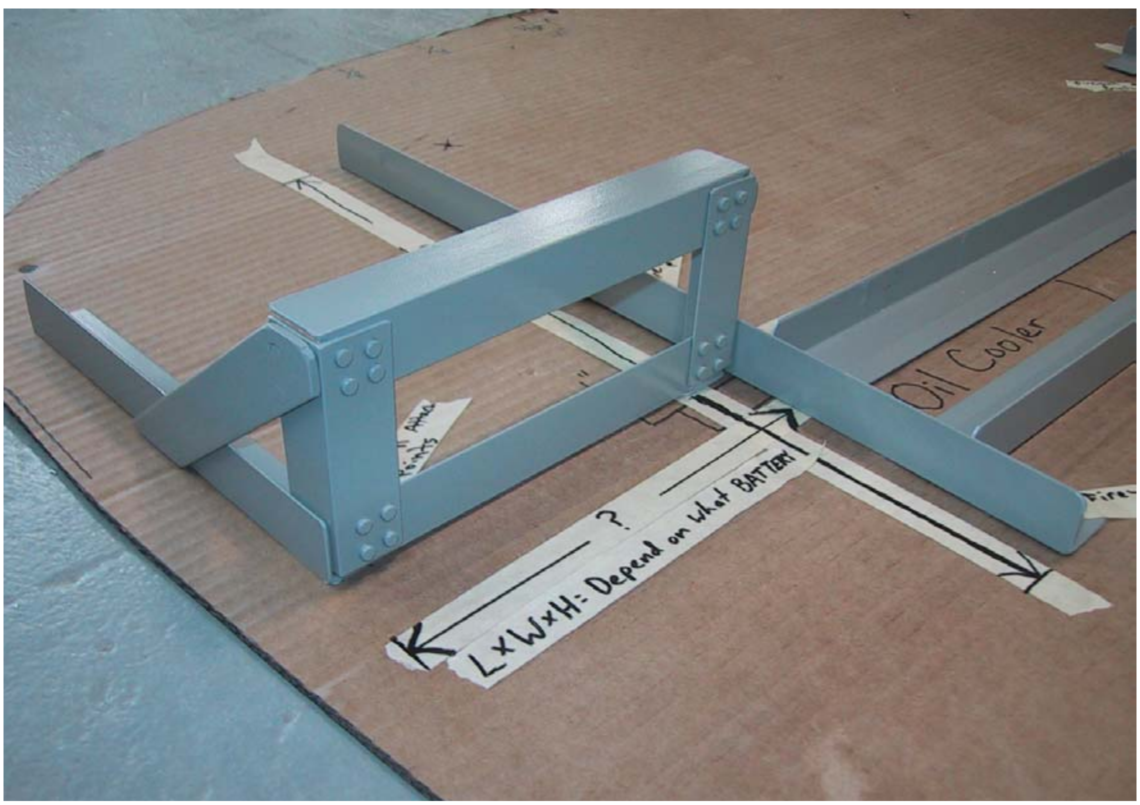


Figure 211: Battery Mounted on the Firewall

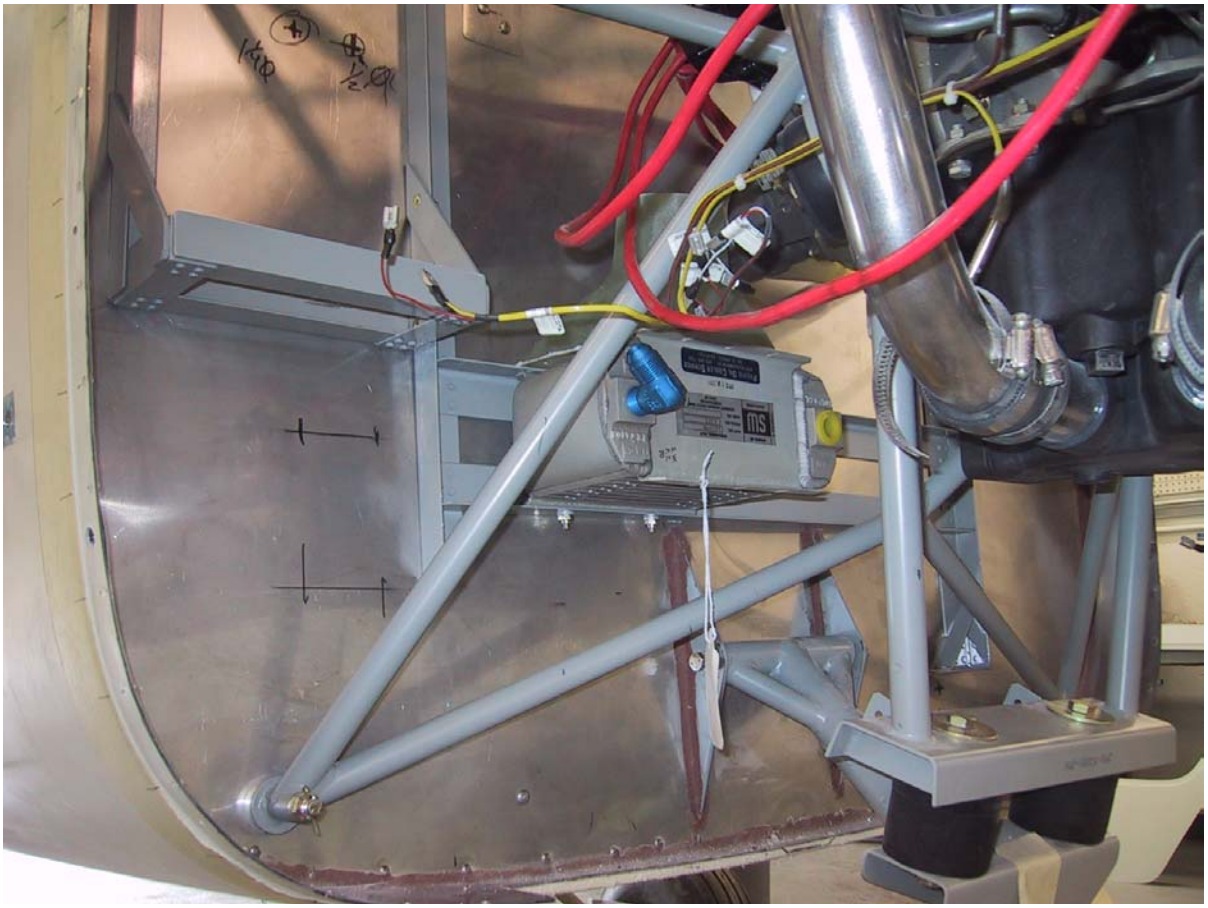


Figure 212: Battery Mounted on the Firewall.

Step 217: Complete the Final Weight and Balance Statement

Now that the battery and tray are installed in the aircraft, you need to recalculate the new weight and balance in order to complete the weight and balance statement required by the FARs. Begin with Step 212, weighing the aircraft, and proceed through the steps calculating the empty weight CG and performing forward and rearward limit checks. Enter the results of these measurements and calculations on a sheet to be permanently carried aboard the aircraft.

Completed: [ ]

CONGRATULATIONS!

You did it! Through all the construction challenges and the *Manual*'s bad jokes, you persevered, and now you've got a rugged, fast, versatile, beautiful airplane to show for it! Which reminds us that we forgot **one last step**:

Step 218: Go Have a Ball!

Never to be completed . . .

This section contains pictures and illustrations of various assembly steps that were not included in the written portion of the manual.

Figure A: Picture showing the taping details during the window installation process.

Figure B: Installation procedure for the wingnut Clecos

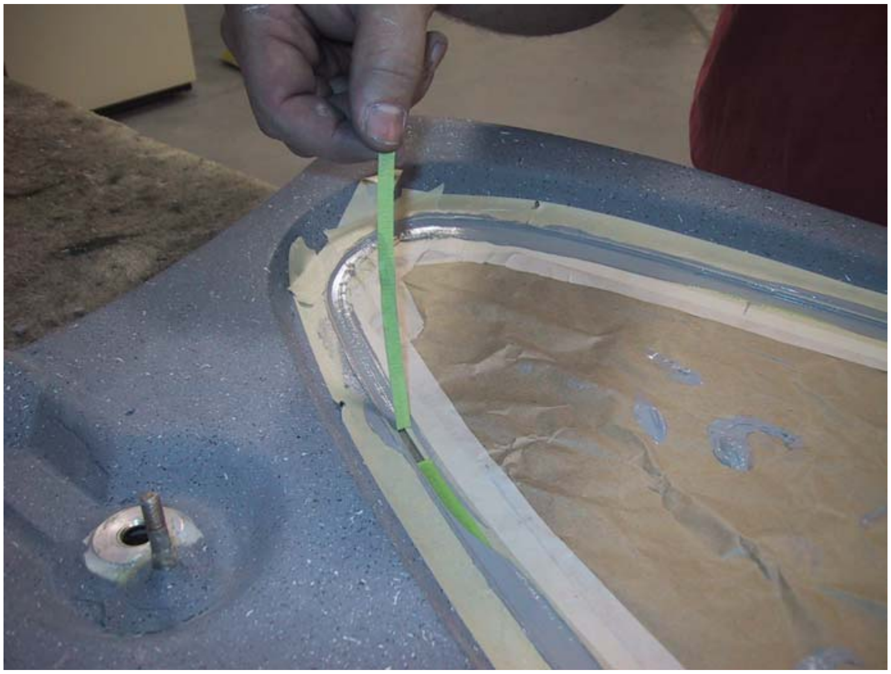


Figure C: Pulling the #2 1/4" masking tape from the window after bonding to the door.

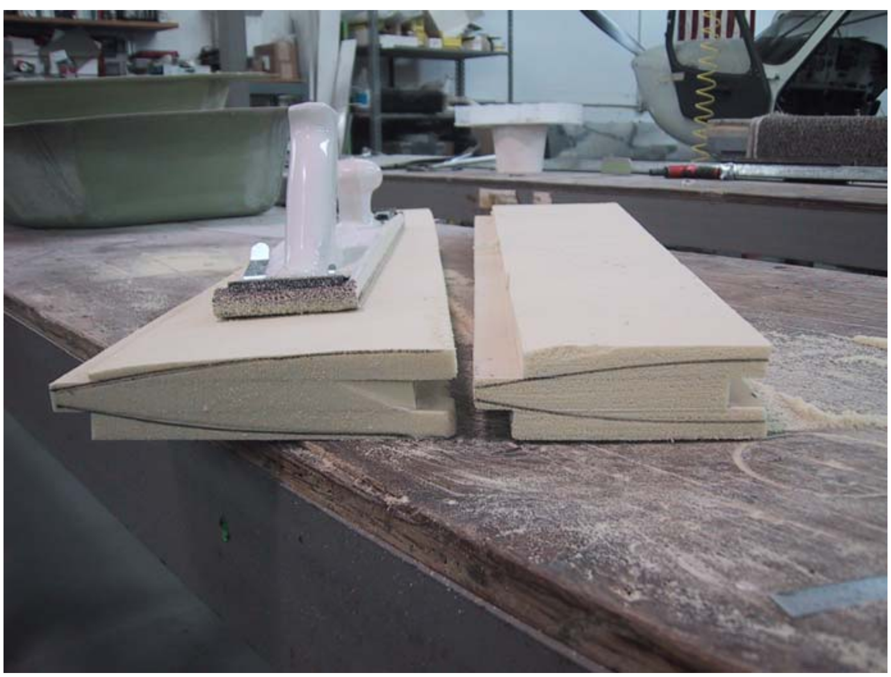


Figure C: Shaping the foam for the main gear strut fairings. The left side shows the lower end, the right side shows the upper end.

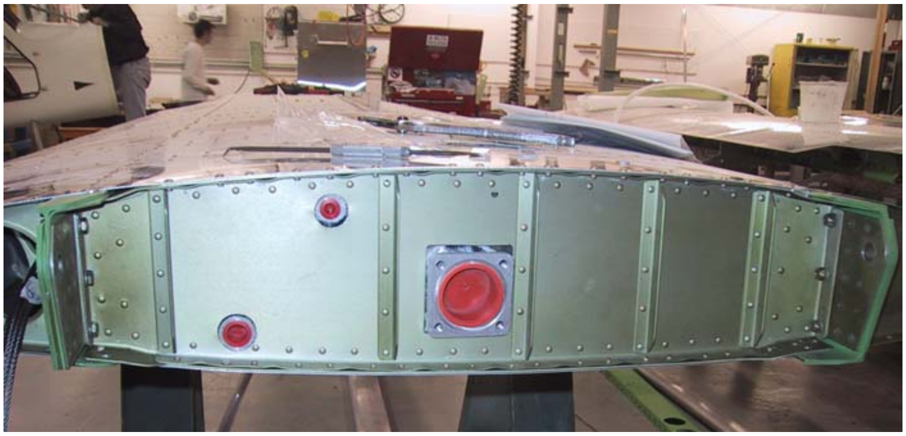


Figure D: Final Trim of root rib for tank installation.

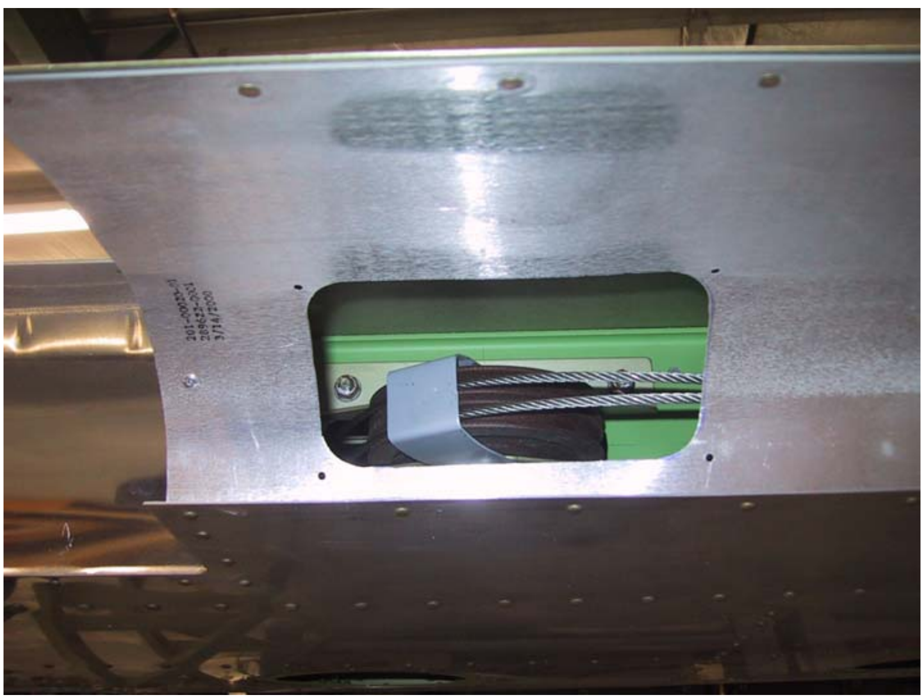


Figure E: Inspection access to the pulleys in the flap cove skin.

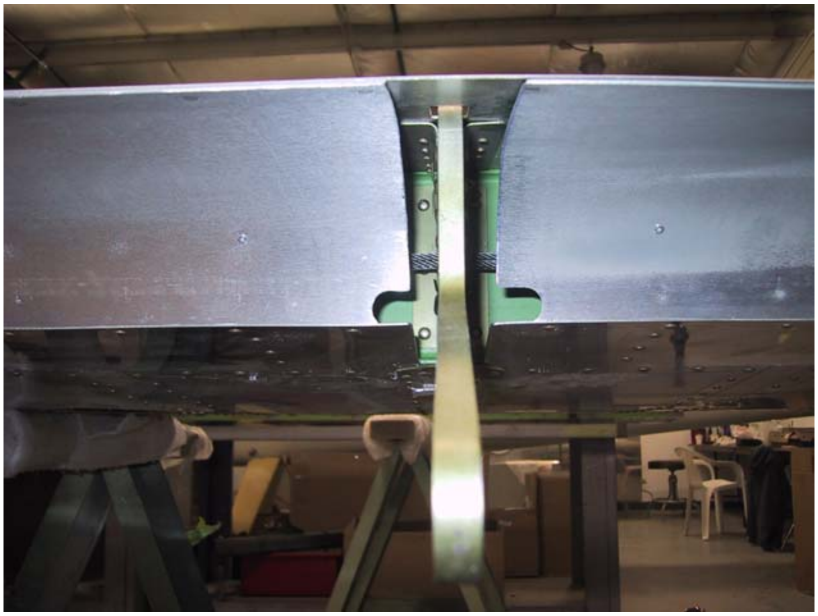


Figure F: Additional cove skin details around the flap tracks.

Figure G: Inspection access to pulleys at BL 69.

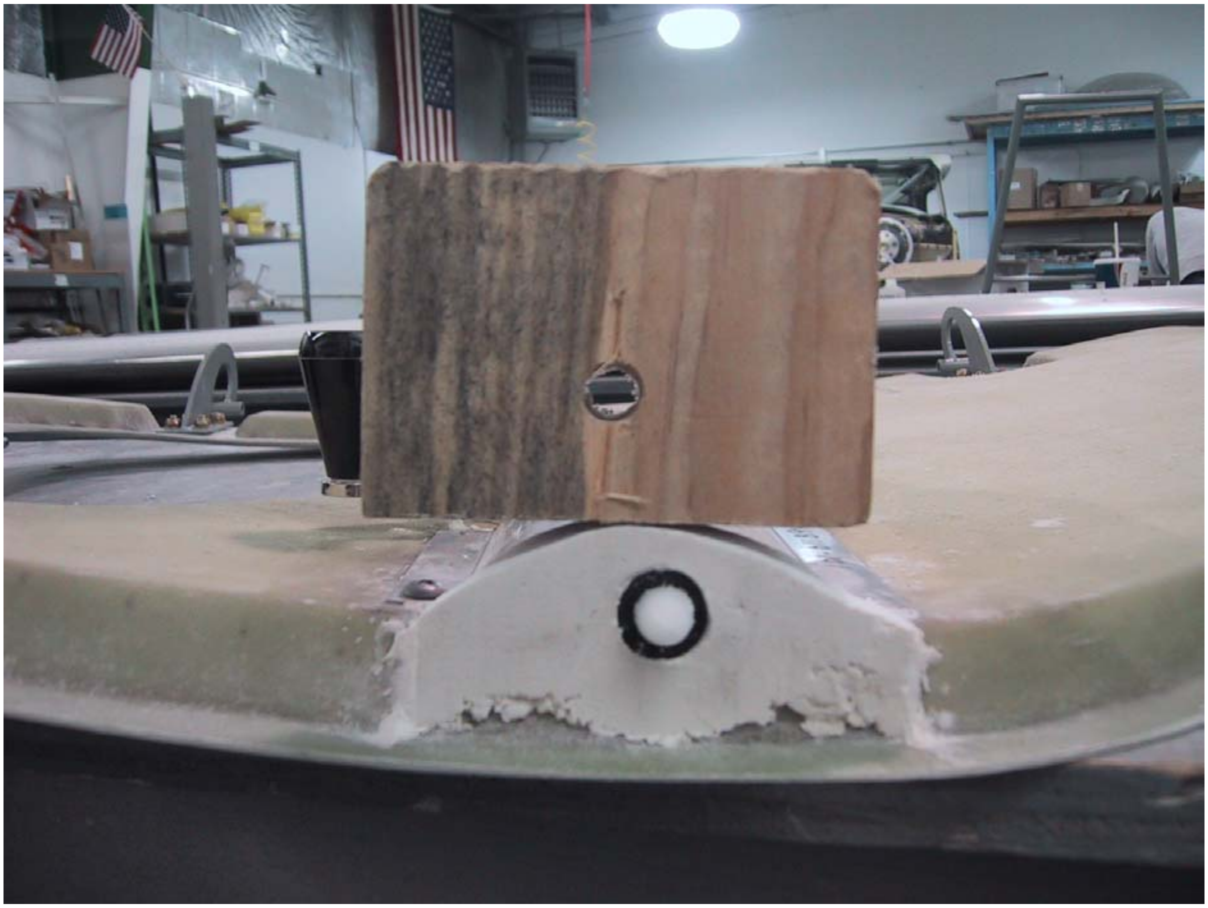


Figure H: Method of damming the structural pour for the baggage door latch pin.

sides to the 6 rivet holes should be adjusted to 3/8" to better clear the inside fillet. Additionally, the 6 rivets (forward of the hinge bolts) shown in Figure 9, are no longer needed.

Section VIII: Fuselage Assembly

Page 82: The third paragraph in Step 43 will be revised as follows: Begin by marking a water line around the vertical fin that measures 59" above the trailing edge joggle, which is water line 156.38. Using a long sanding block, sand as necessary in the directions shown in Figure 49 to make the shell edges parallel and even with this water line.

The first sentence in the first note will be deleted: ~~Remove as little material from the shells as possible, but be sure that you at least get rid of any mold lip, as described earlier in this section.~~

Page 86: The note on the top of the page and the first paragraph should both reference Figure 52, not 51.

Page 111: Figure 72 is not full size and the full size note will be removed from the description. All the dimensions are correct.

Page 112: The following sentence will be added at the end of the first paragraph in Step 61: By rotating the aileron left and right, you can verify if the stop plate is centered correctly on the weldment. It should contact the bulkhead at approximately the same rotation point**.**

Page 121: The sentence in the last paragraph in Step 68 will be changed to: "When satisfied, remove the brackets from Bulkhead C and drill each marked location on the angles with a #30 bit. Then, reinstall the bracket assembly and drill through both the bracket and Bulkhead C with a #10 bit.

Page 125: The following comment will be added after the first sentence: There is no reason why the elevator control stop cannot me made now and assembled with the bellcrank and bracket assembly.

Page 165: The fasteners in the note at the bottom of the page will be changed to AN509-10R16 from the AN507-10R16. There is not a need to change these fasteners over to AN509-10R16 if you have already installed the AN507-10R16. The change is made to keep all these fasteners used on the fuselage attach brackets of a common type.

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Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

Page 23: In the third paragraph, you should drill #10 diameter holes and not 1/4" diameter for the control bracket hardware.

Page 36: The last sentence in Step 7 will be revised to: This pivot tube centerline should be approximately 5" aft of the aft face of the 5/8" diameter firewall tubes.

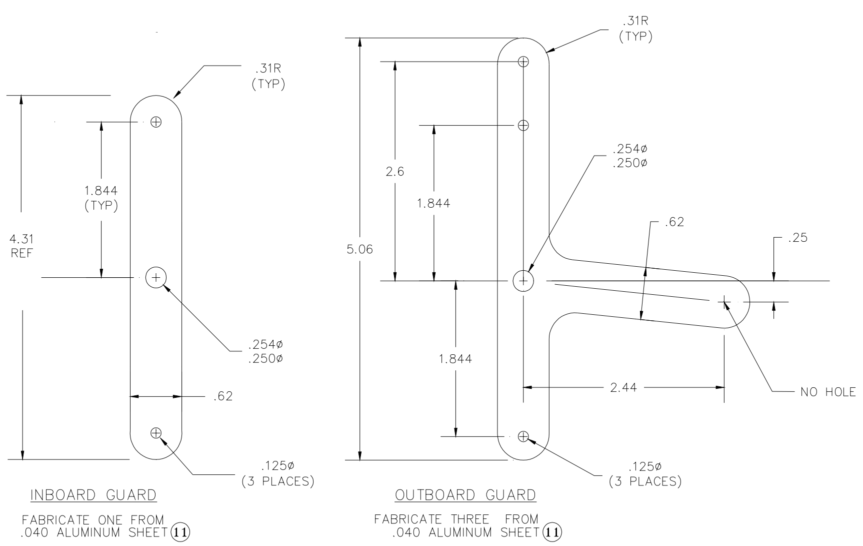
Page 42: The reference to a #10 bit in the first sentence will be changed to a #12 bit, which is slightly smaller in diameter.

Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

Page 54: The first sentence will change to make (3) outboard pulley guards. The sentence 'The second hole at 2.60" on the third pulley guard can be trimmed off as shown in the left side of Figure 23' will be added to the first paragraph.



The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Section IX: Systems Installation

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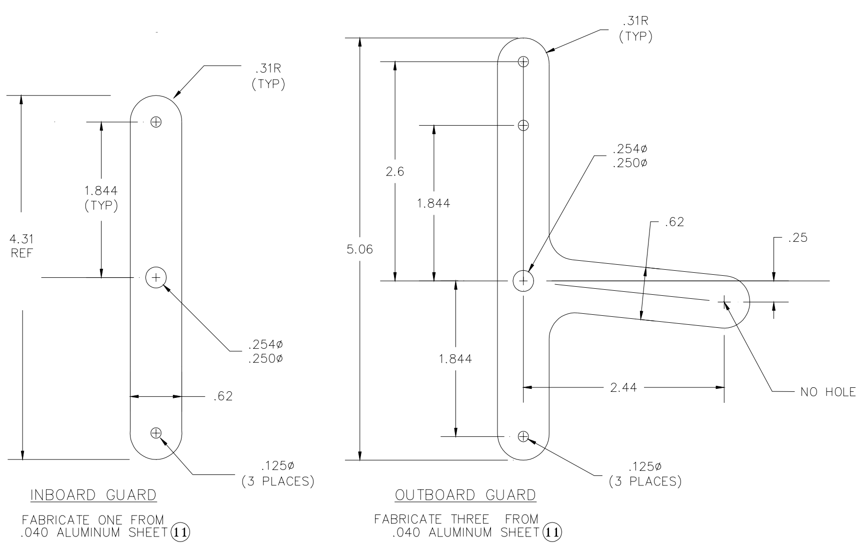

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

Page 23: In the third paragraph, you should drill #10 diameter holes and not 1/4" diameter for the control bracket hardware.

Page 36: The last sentence in Step 7 will be revised to: This pivot tube centerline should be approximately 5" aft of the aft face of the 5/8" diameter firewall tubes.

Page 42: The reference to a #10 bit in the first sentence will be changed to a #12 bit, which is slightly smaller in diameter.

Page 44-46: In kits delivered after September 2005, self locking nuts have been welded to the inside of the control stick mounting brackets on the cage. This makes it much easier to install the control assembly. The AN960-10 washers and the AN365-1032A nuts are not needed on those cages. The two tabs on control yoke may need to be bent inboard toward the nylon bearing blocks should any lateral play exist. This will cause a loose or sloppy feel to the aileron control.

Page 52: The square tube in the picture will be identified as [51] 1/2" square aluminum tube.

Page 53: Early cages had some variation between the bushings and tabs for the forward pulley group. A few cages may need longer bolts, namely an AN4-56 and AN4-47. The forward left pulley in figure 23 will be labeled as "elevator reversing pulley", the small center pulley is the "left rudder cable pulley" and the far right pulley is the "flap reversing pulley".

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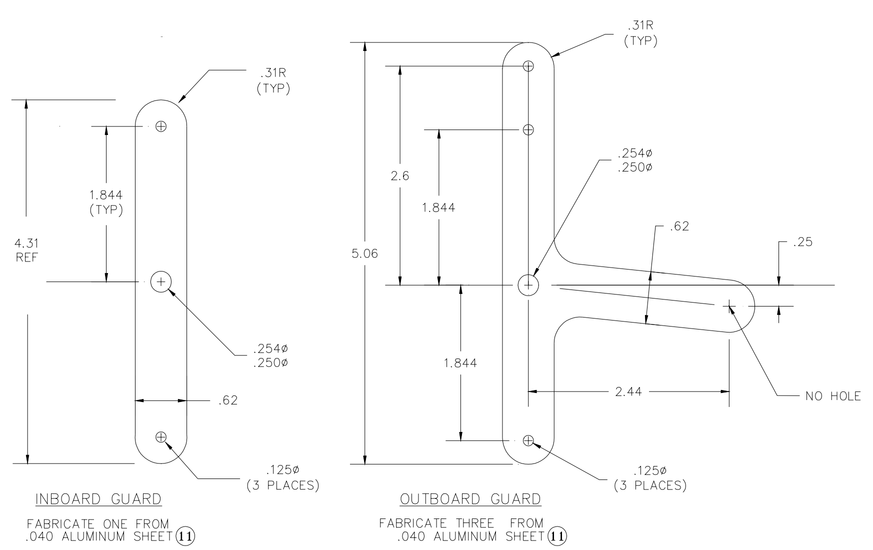

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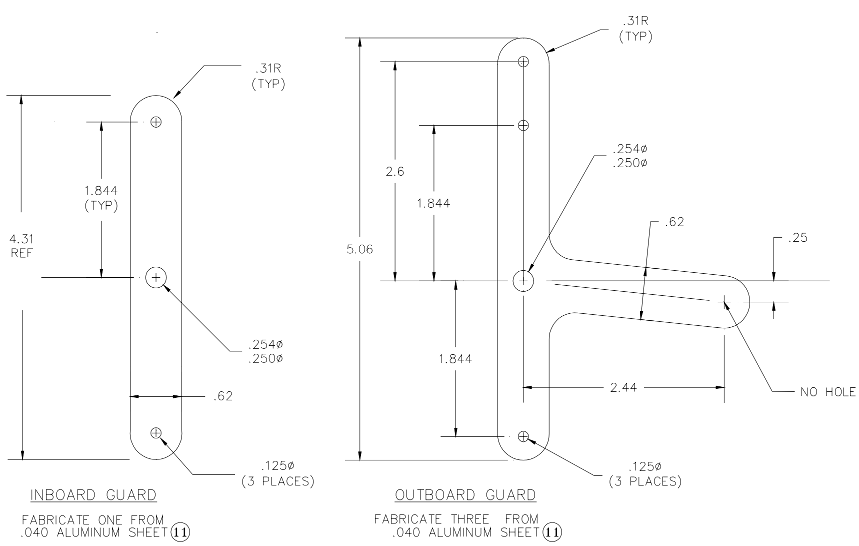

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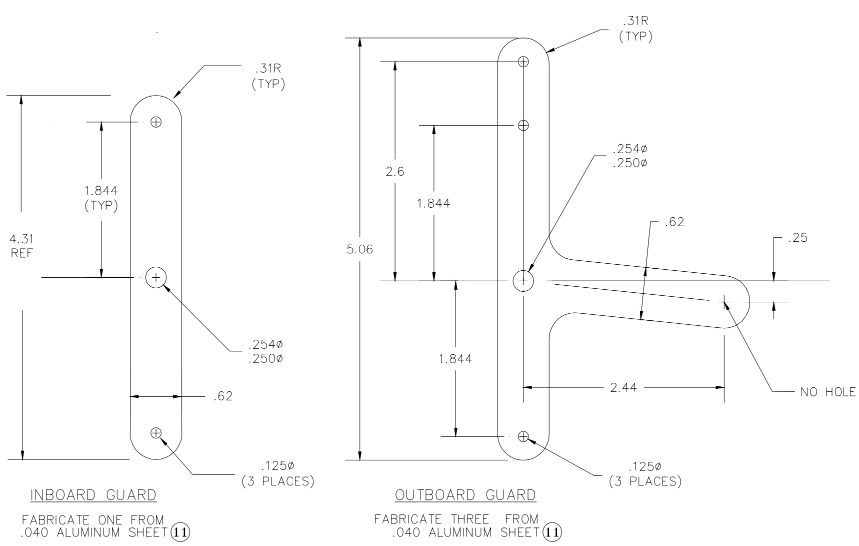

The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Page 155: Figure 83 was updated, the overall length of the flap track reinforcement was added 3.25.

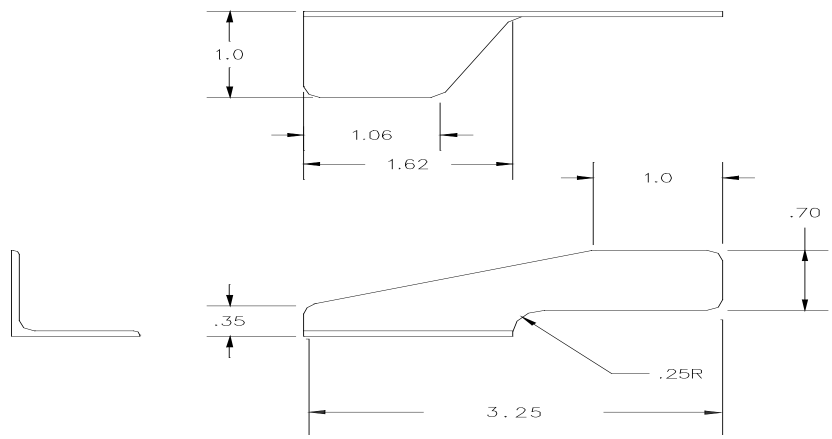

Figure 83: Flap Track Reinforcement Angles

Section IX Systems Installation

Main Parts List: Part number 450-[42]

Page 48: Press the ~~3/16" X ½" roll pin [42]~~ **pan-head screw** #10 X 7/16 [167.1] and **the self-locking nut**, 10-32 [108] into the hole at the upper end of the flap handle ratchet plate; this pin serves as a limit stop for the flap handle.

Page 49: Figure 20, Flap Handle Assembly, the text changed on figure to reflect the new parts listed above. (42 was modified)

Page 155: Figure 83 was updated, the overall length of the flap track reinforcement was added 3.25.

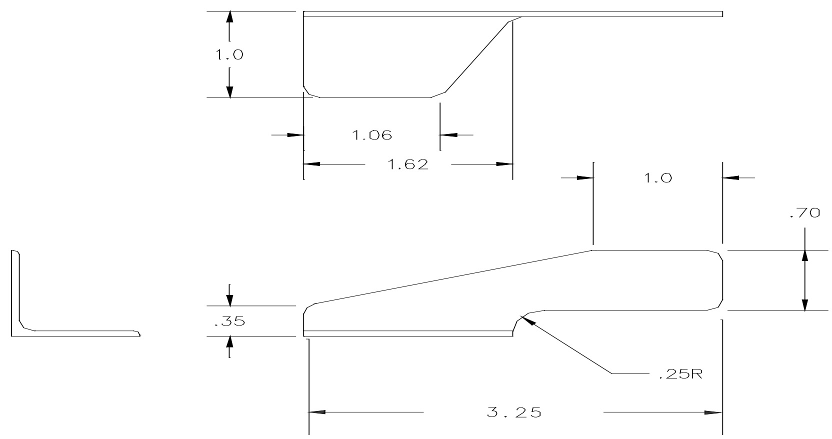

Figure 83: Flap Track Reinforcement Angles

Section IX Systems Installation

Main Parts List: Part number 450-[42]

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Page 49: Figure 20, Flap Handle Assembly, the text changed on figure to reflect the new parts listed above. (42 was modified)

Section IX: Systems Installation

Page 2: The [44] cable retainer strap should be 600-00001-02, not 600-00001-01.

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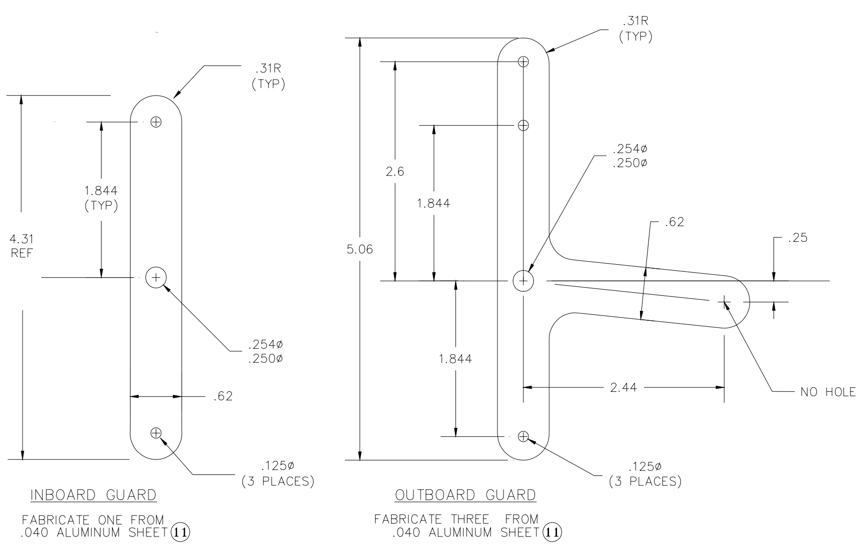

Section IX: Systems Installation

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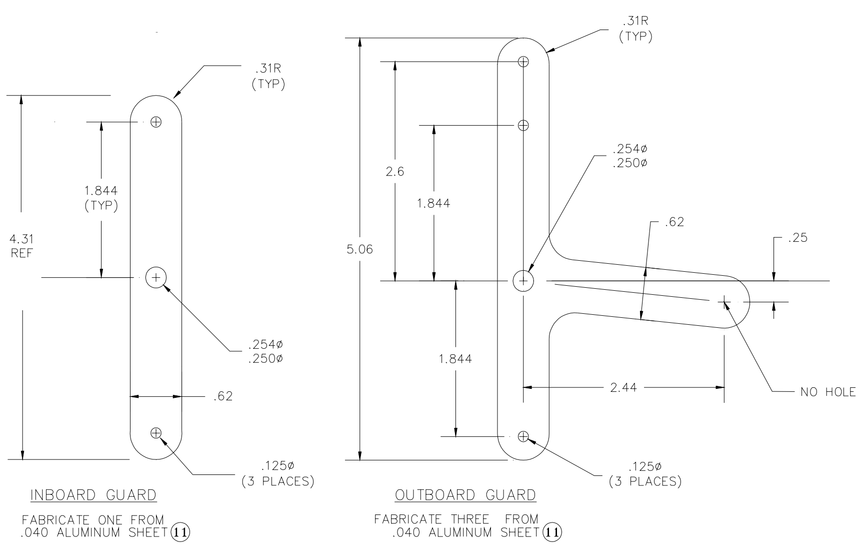

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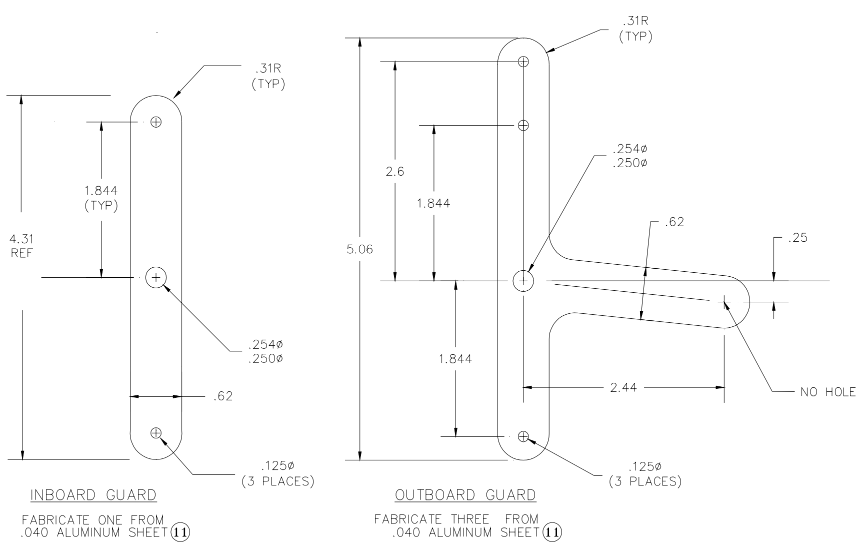
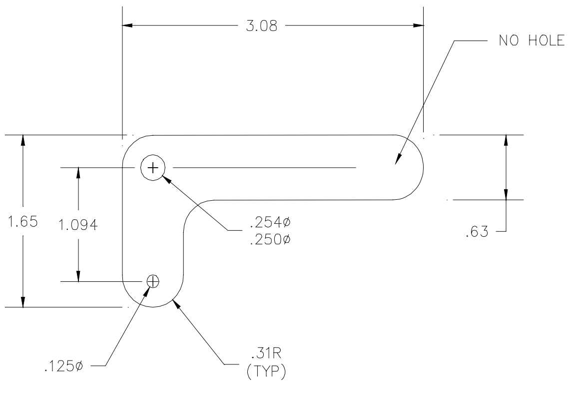


The 1-27/32 dimension in the note will be changed to 1.844 for consistence with the figure. The shapes of the guards have changed and Figure 24 will be revised as follows:

Page 55: The top figure in Figure 25 will be deleted and the reference to this cable guard in the paragraph will revised. (If you have already made your pulley guards per the steps defined in Revision A, the guards are acceptable. These newer revised guards are oriented a little better in the pulley cluster.) Figure 25 will be revised as shown:



RUDDER CABLE GUIDE PULLEY GUARD

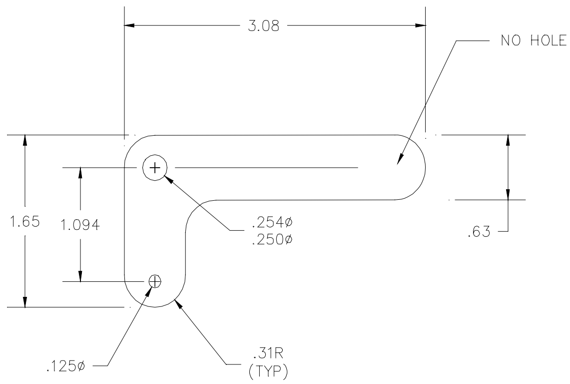
FABRICATE TWO FROM
.040 ALUMINUM SHEET 11

Page 56-58: The reference to "drill this up up to 1/4" diameter" in the first paragraph will be changed to "drill to 1/4" diameter". A general procedure note of how to drill the holes in the square tube will be as follows. Mark a centerline on the 1/2" square tube. Using a drill press, drill a 1/4" diameter hole on end located 1-1/4" in from the end. Insert the forward pulley bolt through the cage bushing and then through the tube and across to the other bushing. Install the AN4-45 bolt through the tabs on the cage. Swing the tube up until it contacts the AN-45 bolt and mark this location on the tube. (Note: the bolt path would actually be an arc centered about the AN4-53 bolt, so the projected contact point with the centerline of the 1/2" tube will be slightly aft of this mark by about .015".) Use a drill press to drill this hole. It is also OK to open these holes up to .265 diameter if necessary. Set the tube back in the cage (off to one side of the aft center tab and install both bolts. Use the tab to drill the tube at this location.
With regards to pulley cable retainers, the stiffer the retainer is, the more clearance you may allow between the retainer the edge of the pulley. Cotter pins and the welded brackets are your stiffest kinds. The aluminum straps should be held closer since the thin aluminum strap may deflect more that others.

Page 79-80: In Step 21, the following note will be added to the end of the first paragraph; "Note: Do not worry that the cables do not meet the rudder arms on the same angular plane." The note on the bottom of page 80 should refer to Step 7 and not step 8

Page 100-102: If you plan on folding the wings on the Sportsman, the lower trailing edge of the wing strut will need to be cut back more to clear the side of the composite fuselage. These dimensions can vary somewhat between aircraft. The two dimensions given in Figure 54 on page 102 will be changed to 4-1/2" and 1-5/8". When folding the wings for the first time take note of the clearance between the strut and the fuselage.

Page 55: The top figure in Figure 25 will be deleted and the reference to this cable guard in the paragraph will revised. (If you have already made your pulley guards per the steps defined in Revision A, the guards are acceptable. These newer revised guards are oriented a little better in the pulley cluster.) Figure 25 will be revised as shown:



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Page 100-102: If you plan on folding the wings on the Sportsman, the lower trailing edge of the wing strut will need to be cut back more to clear the side of the composite fuselage. These dimensions can vary somewhat between aircraft. The two dimensions given in Figure 54 on page 102 will be changed to 4-1/2" and 1-5/8". When folding the wings for the first time take note of the clearance between the strut and the fuselage.

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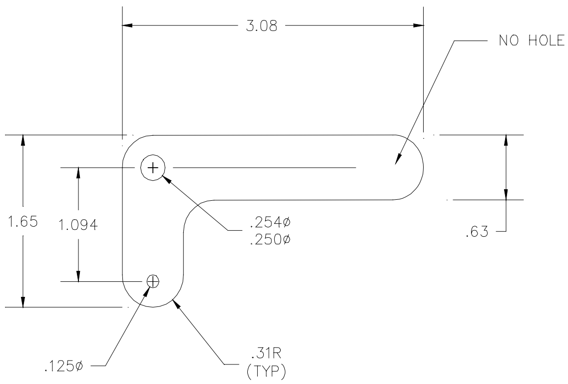

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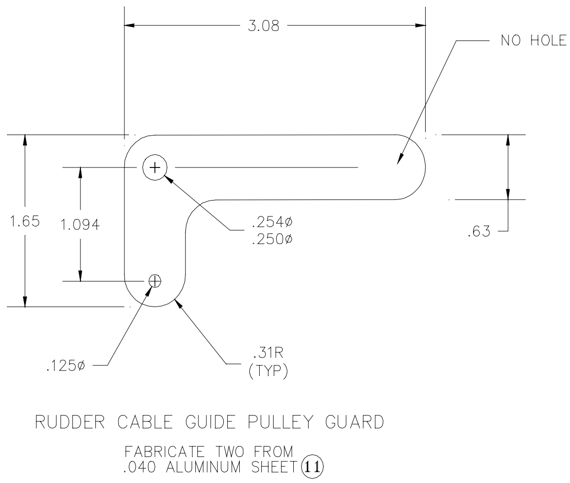

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Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

Page 199: Step 63 will be expanded to include the following: If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to gently pry up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the bottom of the cap and the skin.

Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

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618-01015-01 RH Aileron Crossover: 155-13/16

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Page 201: There was a variation in the manufacturing of the auxiliary tanks that moved the two sump locations **forward** 1/2" from those shown in Figure 114. You should verify your tank sump locations before drilling. Tanks delivered after the Spring of 2005 should use (but verify) 12-9/16 and 3-5/8 in lieu of the12-1/16 and 3-5/16 dimensions shown in Figure 114.

Page 202: The nutplate location in Step 66 will be changed to 2-1/4" in from the skin edge. Drill out the existing rivet at this location (third rivet in from the skin edge; BL 26.25), and open up the hole with a #11 bit. Do not worry about the dimple in the skin. Install the K1000-3 as described.

Page 158: Effective immediately, the following new cable lengths will take affect for the four aileron crossover cables.

The affected section of the manual is Systems Installation (IX), pages 154-165. Please follow new cable lengths for proper installation. Refer to the tools and techniques section of the manual for fabricating the aileron crossover cable assemblies. After many hours of rigging of the flight controls in the Customer Assembly Center (CAC), the left and right aileron crossover cables and the left and right aileron secondary crossover cables, can be pre-fabricated prior to installation. For assistance, contact the Technical Support department Monday through Thursday, 2pm –4pm Pacific Standard Time (PST).

618-01014-01 LH Aileron Crossover: 140-1/4

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 176 3/4

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 140: In the second paragraph, the reference to (these are the pulleys in Figure 36) will be changed to Figures 32, 34 & 35.

Page 154-165: After doing numerous cable installations and the rigging of flight controls at the Customer Assembly Center, we are confident that the left and right aileron secondary cables and the left and right aileron crossover cables can be pre-assembled prior to installation in the aircraft. You should read pages 154-165 to become familiar with the installation. The dimensions given are from the end of the threads on the swaged threaded studs to the center of the clevis pin shown in Figure 91. Refer to the tools and technique section of the manual for fabricating cable assemblies.

618-01014-01 LH Aileron Crossover: 139-1/8"

618-01015-01 RH Aileron Crossover: 155-13/16

618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

Page 173: When drilling the sump holes in your lower skins as described in Step 51 and Figure 97, be sure to measure the location of the sump as you slide it in the wing. The sump location can vary from tank to tank and from installation to installation. Do not assume the dimensions shown in Figure 97 fit your tanks without checking first.

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618-01013-01 LH Aileron Secondary: 177-13/16

618-01013-02 RH Aileron Secondary: 176-1/8 (made from the second 618-01013-01 cable)

Page 166: A hint will be added to the end of Step 46 giving the builder options for securing the guide blocks to the ribs. Hint: If necessary, counterbore the back side of the guide where the tail of the rivet will be if you find your rivets are not long enough. If you do not want to rivet them, you can also use cotterpins to hold them in position or use some #6 or #8 screws to secure the guides to the ribs.

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618-01013-01 LH Aileron Secondary: 177-13/16

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ADVANCE NOTICE OF REVISION

Page 201: The dimensions for the fuel sump drain holes were relocated to match fuel tank sumps; Figure 114 has been revised as follows: Drain hole locations with hole saw: changed from 3/4” to 1”. B+D Trike changed from 12-1/6” to 12.45”, A+C changed from 3-5/8” to 3.7”. Step 65, the text changed in the last paragraph, 2nd sentence - Mark one or both of the hole locations and drill a ~~3/4"~~ 1" hole using either a piloted hole saw or a Unibit.

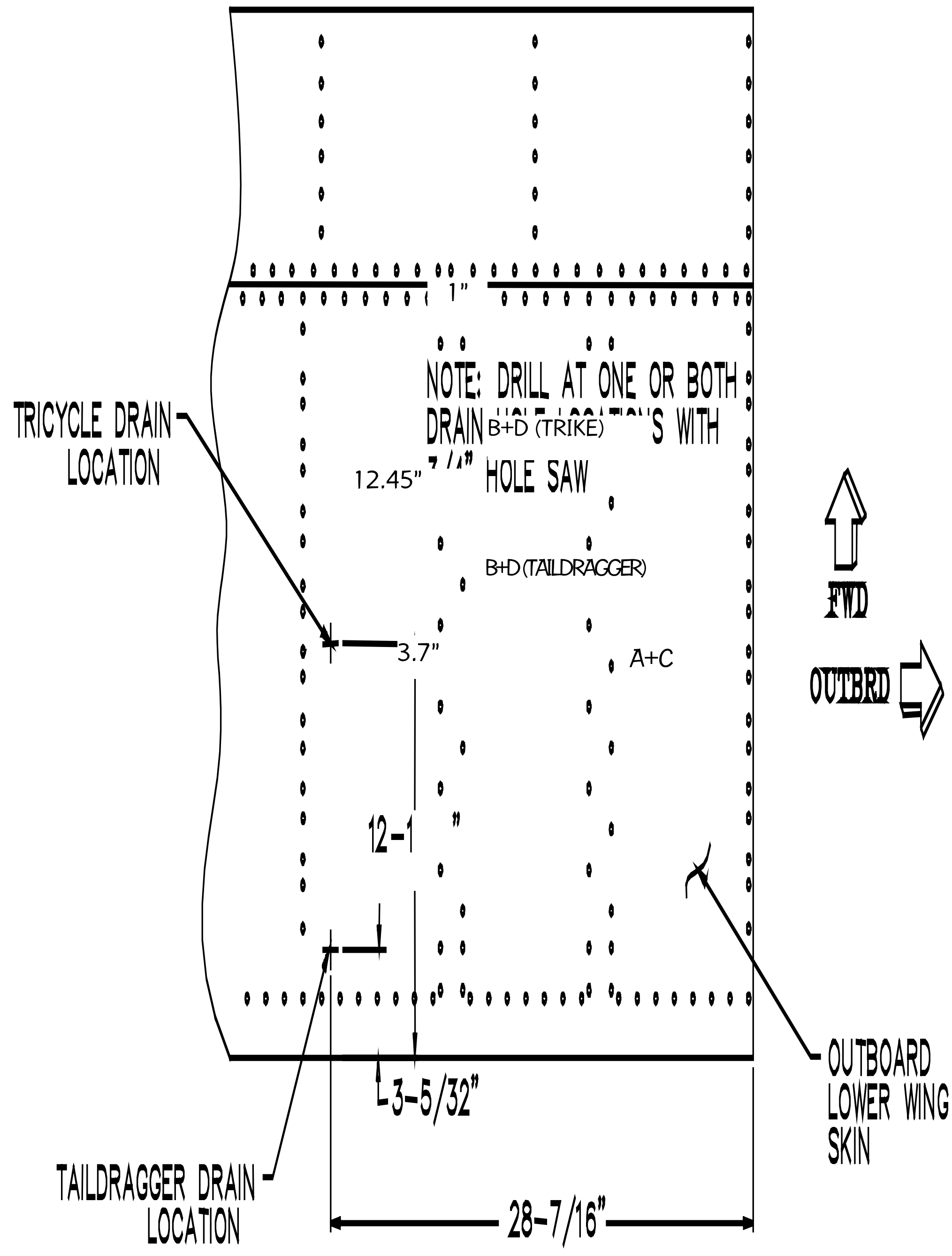

Figure 114: Preliminary Sump Drain Hole Locations

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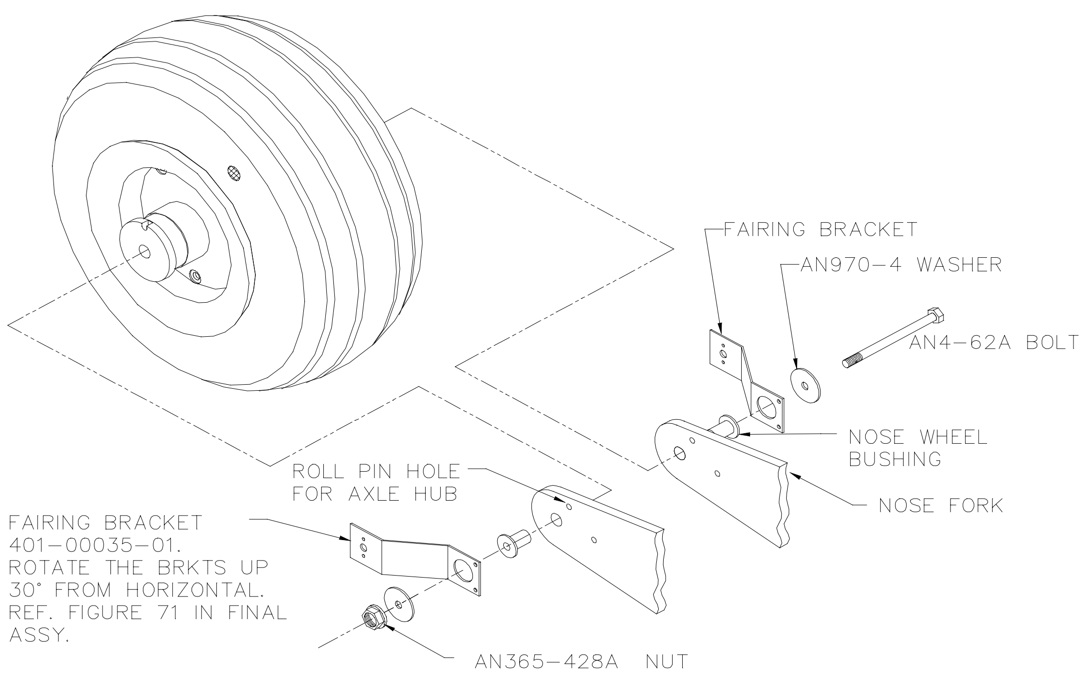
Page 221-222: Reference to the seven degree clocking will be revised to better define what it is you are trying to achieve. The narrow two holes (identified at the one and eleven o-clock position on the brake flange) should be centered about the gear leg. Achieve this by inserting two 3/8" bolts through these holes and let the shank of the bolt center the flange about the gear leg. Keep these bolts installed during the drilling process. This applies for either the FT or TD gear. As long as you are set up for drilling, you may want to drill the cotter pin hole in the end of the axle as defined on page 232. Use a #21 drill instead of the #30 bit.

Page 272-277: In the Brake System Plumbing section, (10) 032-00310-01 Brake Line Inserts will be included in future kits. These inserts help prevent the ferrule from getting crooked and causing leaks. The small metal sleeve stiffens and supports the brake line internally and keeps the ferrule straight because it has a flat, flared end. It also keeps the brake line from collapsing. An additional (6) are required for dual brake installations.

Page 244-246: A new method will be used to install the nose wheel pant to the nose wheel fork, which has made the installation easier. This will require a longer axle bolt AN4-62A, two brackets 401-00035-01 and two AN970-4 washers. These will be included in later kits. Step 85 will be reworded to install the two brackets and larger washer. The bracket is oriented on the nose fork with the aft end up 30 degrees to horizontal per Figure 71 in Final Assembly. Drill one 1/8 diameter hole through each bracket and into the nose fork arms. Install (1) 1/8"diameter x 1/2" roll pin 450-0070-002 in each bracket. Figure 138 will be revised as follows:



Page 247: The last sentence should refer to AN960-416 steel washers, not AN960PD416.

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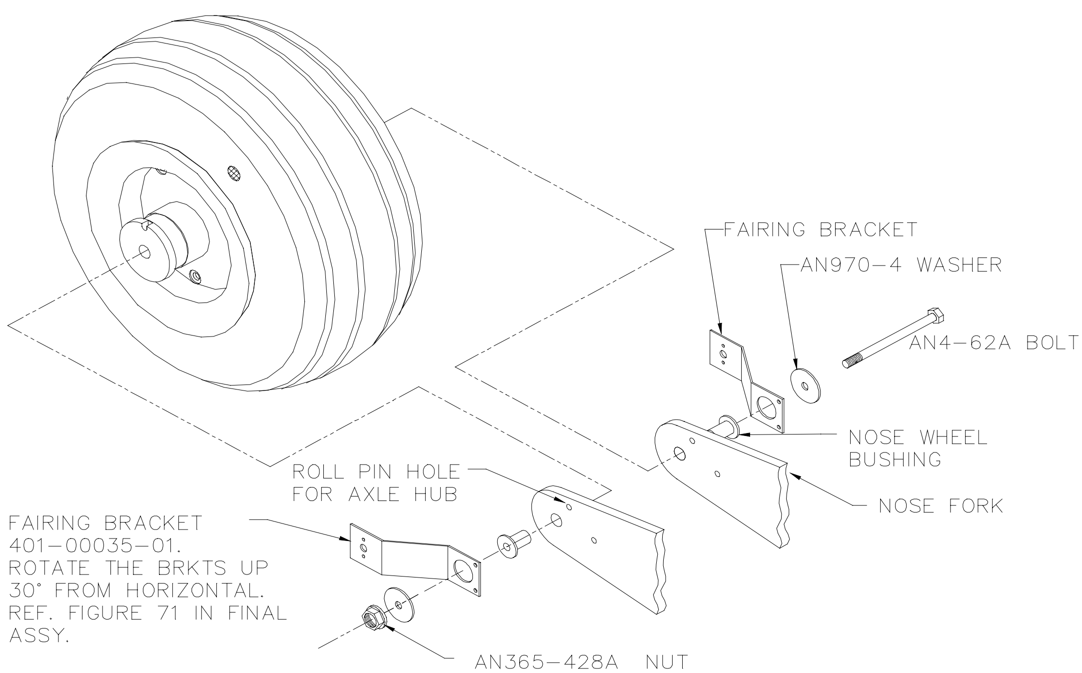

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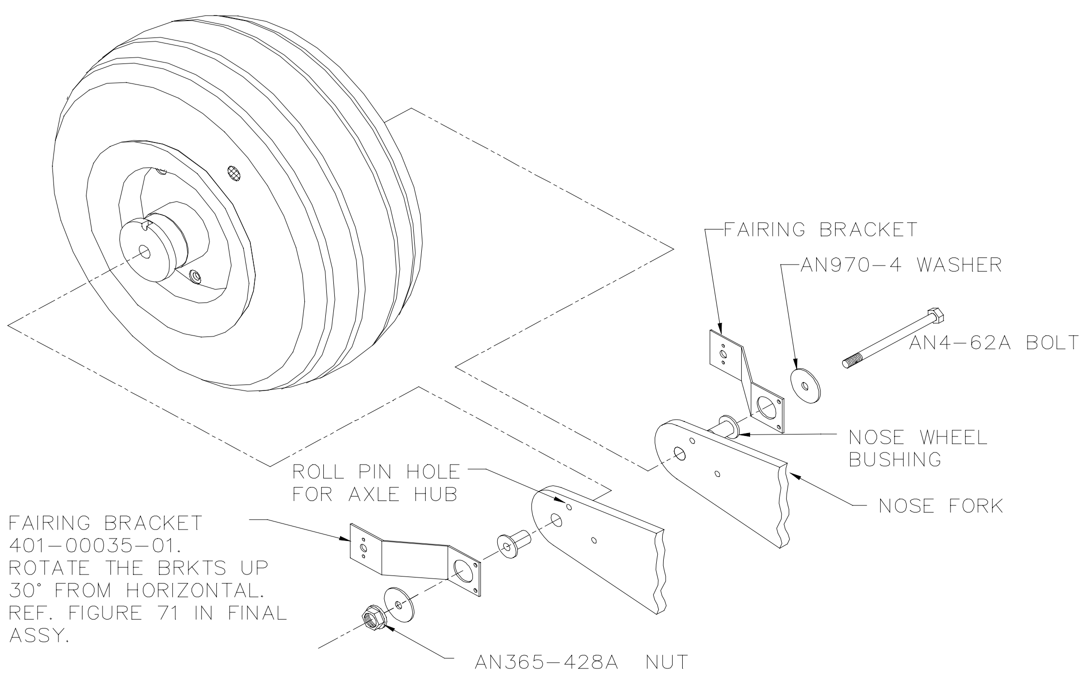

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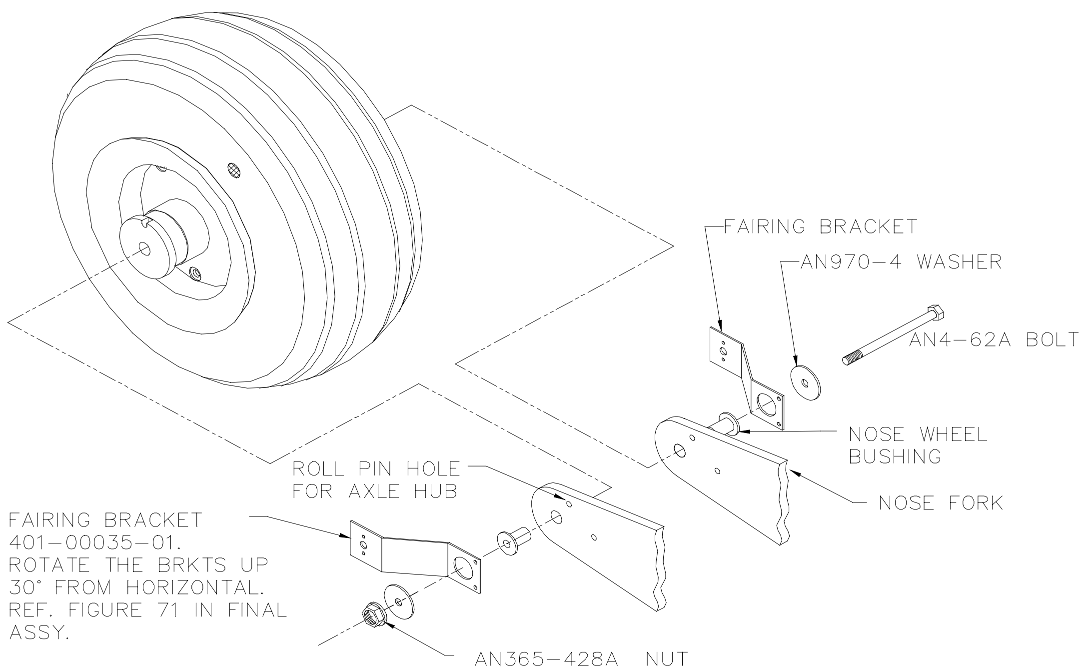


Page 247: The last sentence should refer to AN960-416 steel washers, not AN960PD416.

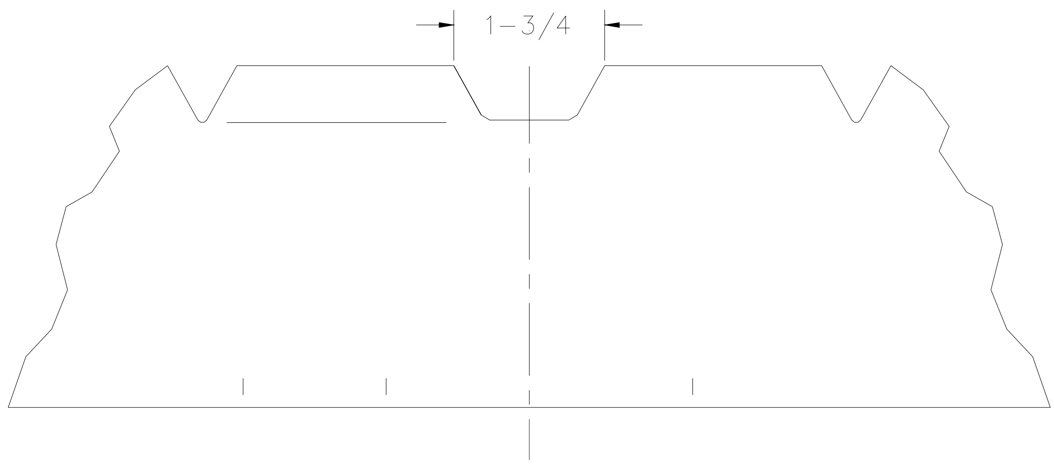
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33, the following options will be added/revised in the options table.:

<u>**Sportsman Option**</u>	<u>**Part Number**</u>
Induction System, O-360	**922-07050-01** ~~**922-07000-01**~~
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

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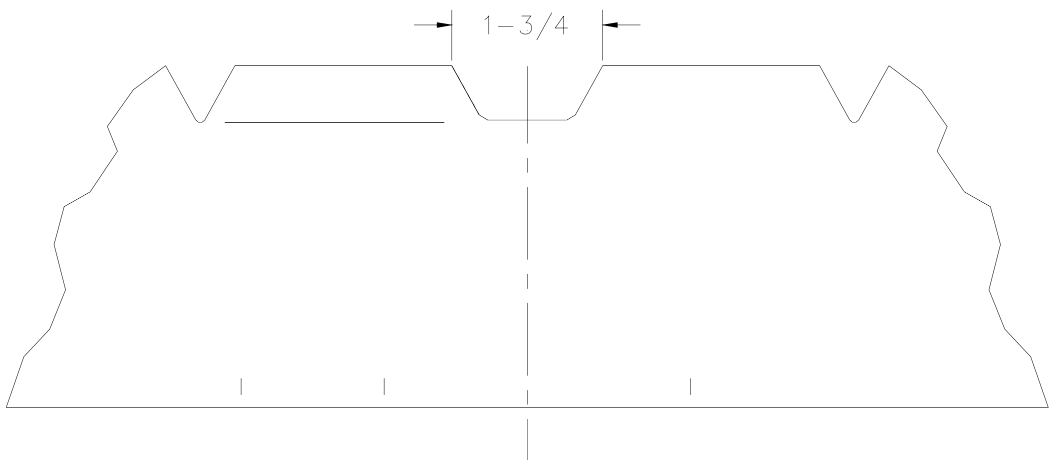

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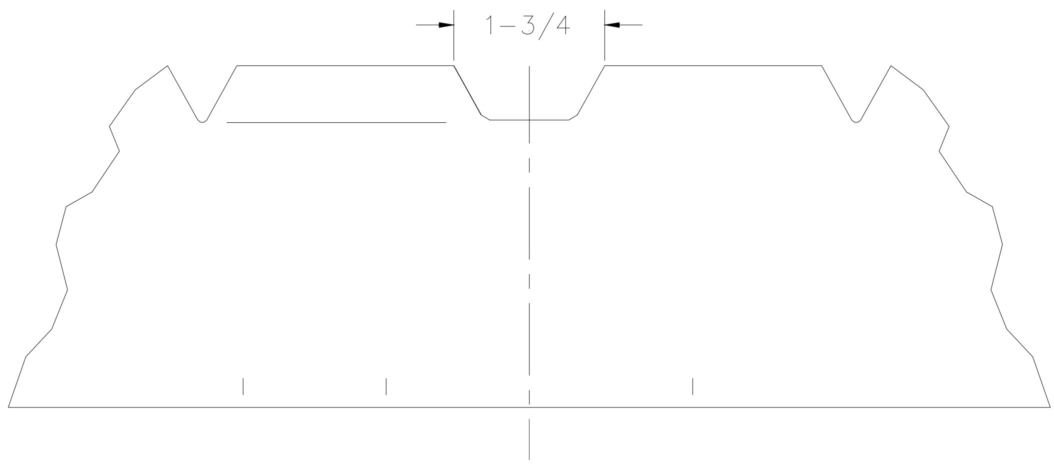

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Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

~~**recess cover** [233] over the flange. The covers come with a slight curvature to them, which approximates the curvature of the fuselage. The cover needs to be trimmed to shape and then it attaches to the recessed flange (forward side) using one AN507-8R8 screw and one K1000-8 nutplate. Refer also to the instructions included in the wing fold brace kit regarding the installation of the recess cups on the inside of the fuselage.~~

~~If you decide **not** to fold your wings, you can fill in the recess with a structural fill and then body finish over that. You may also chose to install the cover as described above.~~

~~**Completed: [ ]**~~

Page 9, Parts list-part removed.

194	~~Flap track recess cover~~ Part Removed	~~2~~	~~101-00040-01~~

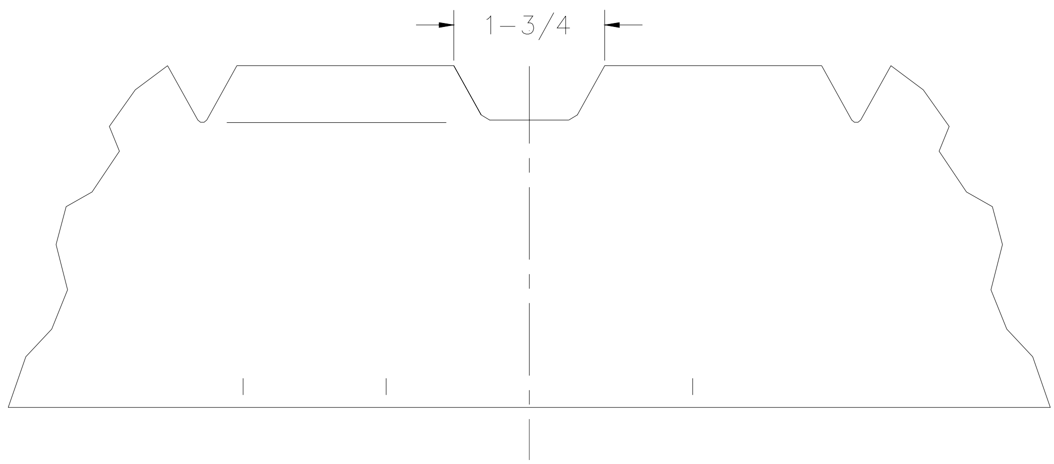
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



Page 33, the following options will be added/revised in the options table.:

Sportsman Option	Part Number
Induction System, O-360	**922-07050-01 ~~922-07000-01~~**
Induction System, IO-360	**922-07100-01**
Engine Controls Bracket, IO-360 / IO-390	**922-08500-01**
Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

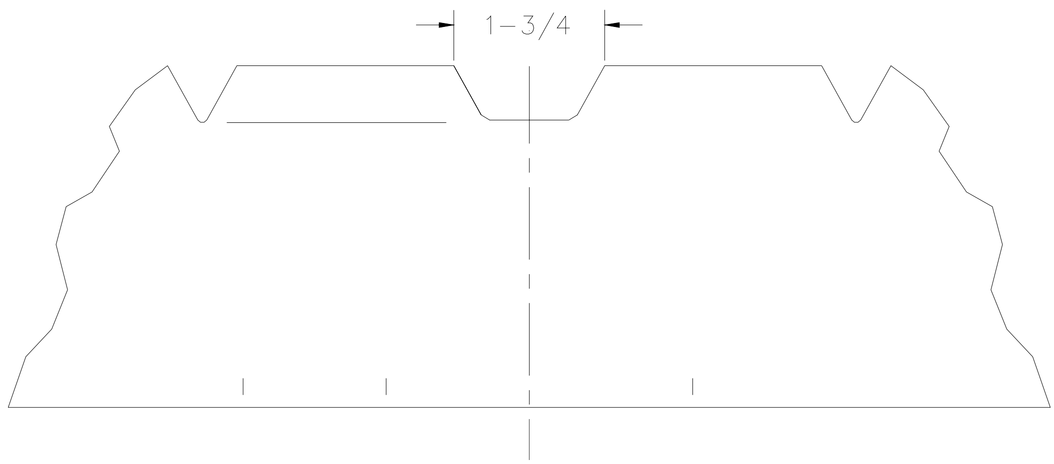
Page 285: Two MS21919WDG10 Adel clamps will be added to the list to be used on the upper part of the tank.

Page 286: Very few fuel lines are visible within the cabin and the following sentence will be added: The fuel lines shown in figure 165 are the only fuel lines visible within the cabin. You may want to paint these lines cage gray prior to final installation.

Section X: Final Assembly

Page 1: Key number 24 will become part number 101-14003-03, Window, Baggage door.

Page 21: The upper and lower flanges in Figure 3 will be changed to include a 1-3/4" wide notch located on the centerline as shown in the figure below. This notch allows for a better fit around the top center engine mount washer and bushing.



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Induction System, IO-360	**922-07100-01**
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Pre-fabricated door dogs	**940-07100-01**
Stainless Steel Braided Brake Line Upgrade	**991-03000-201**

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

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Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

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The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

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Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

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The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.

Figure 71 will be revised as shown:

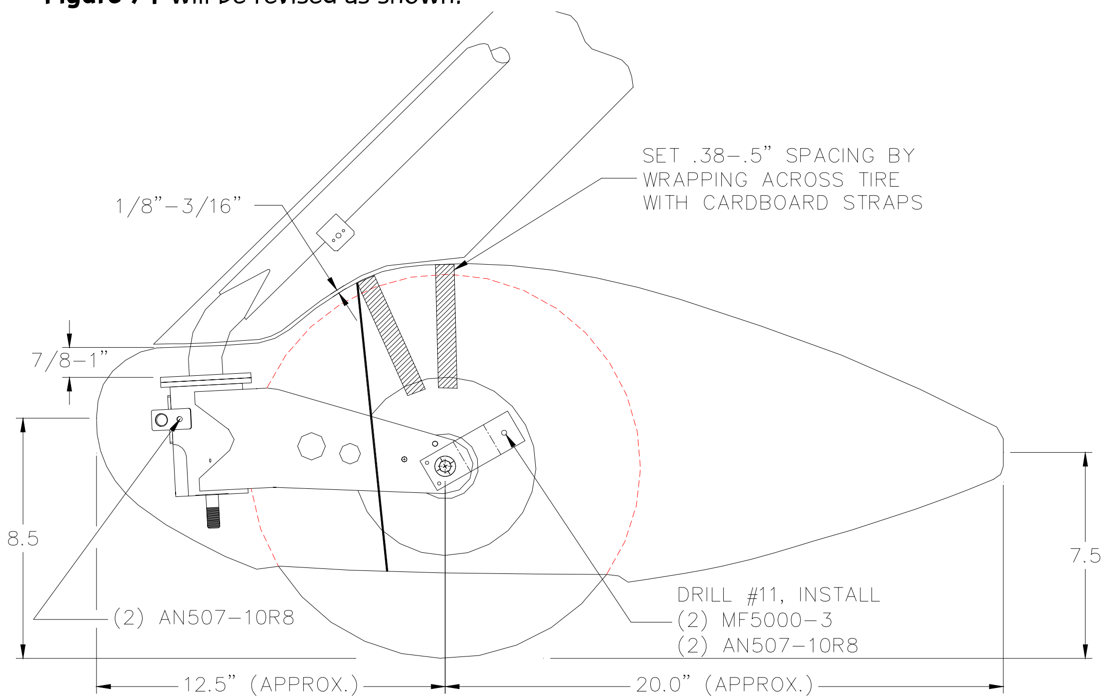
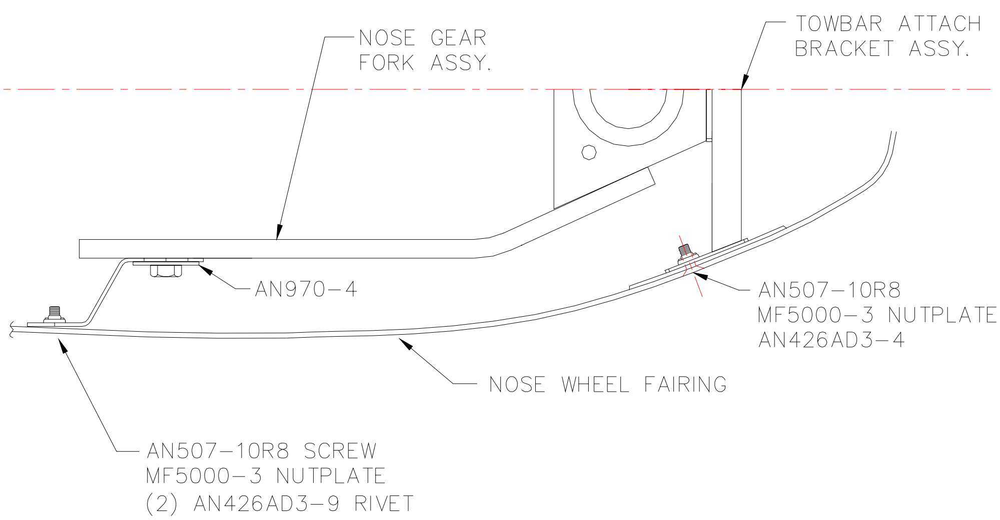


Figure 71.2 will be deleted.

Figure 72 will be revised to show the bracket installed on the nose fork.



Page 155: Step 76 will be expanded to include the following information:

If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to lift up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the cap and the skin.

Page 157-167: An optional method of installing the trailing edge skins will be provided, and these pages will be expanded.

Page 157: The note on the top of page 157 will be changed to read as follows:

The following several steps can be accomplished with the wing in or out of the jig, at your convenience. Our experience is that most of these procedures are probably easier if the wing is upside down and supported on a table. There are two methods of installing the cove skins on the fuselage. One is to rivet the rivet the cove skins to the wing as has been traditionally done. The second method, which is used at our Customer Assembly Center, involves using a structural adhesive to bond the trailing edge doublers to the skins and using only a few rivets at the end of each cove skin. This second method is described as an optional method.

Figures 80-83 will be added to the instructions, which define the layout and trimming of all the cove skins.

The last sentence in the third paragraph will changed to read as follows: The aft tab on the flap cove ribs may also be removed if necessary as shown in Figure 85. Revision A mistakenly mentioned the center tab.

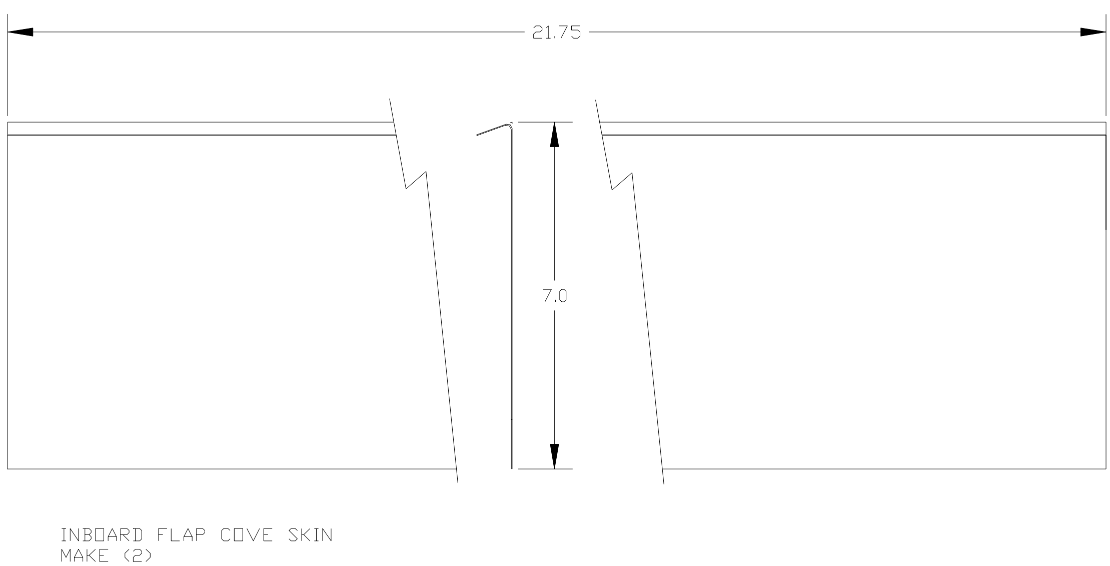


Figure 80: Inboard flap cove skins

Page 155: Step 76 will be expanded to include the following information:

If you need to raise (or realign) the level of the filler neck in order to get a better clearance fit between the standard fuel cap (tractor style) and the skin, you can gently pull up on the filler neck or fashion a slide hammer to lift up on the fuel tank threaded boss. Attempt to achieve a minimum 1/16" clearance between the cap and the skin.

Page 157-167: An optional method of installing the trailing edge skins will be provided, and these pages will be expanded.

Page 157: The note on the top of page 157 will be changed to read as follows:

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Figures 80-83 will be added to the instructions, which define the layout and trimming of all the cove skins.

The last sentence in the third paragraph will changed to read as follows: The aft tab on the flap cove ribs may also be removed if necessary as shown in Figure 85. Revision A mistakenly mentioned the center tab.

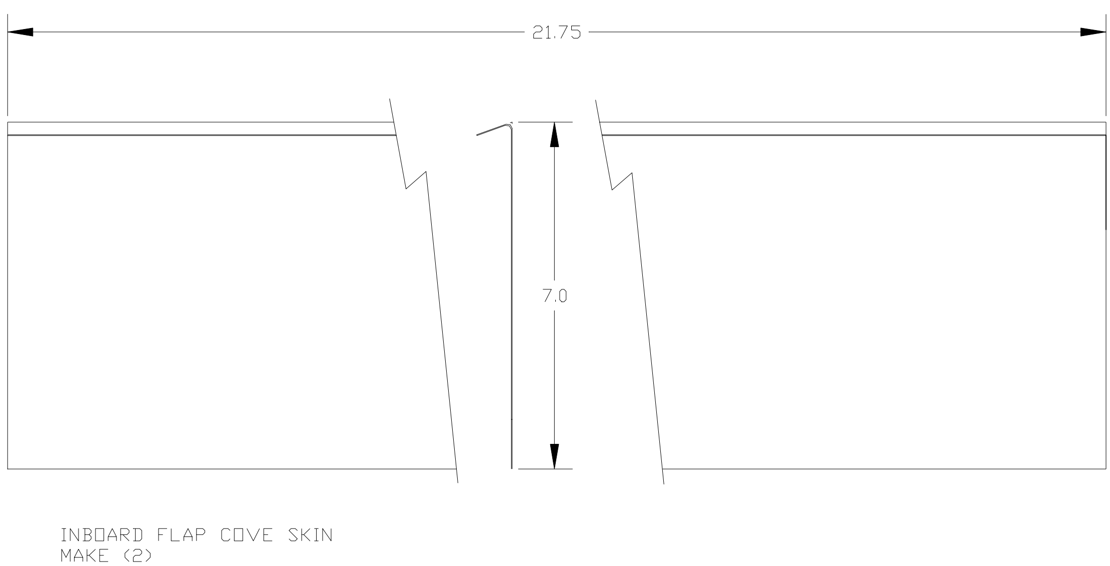


Figure 80: Inboard flap cove skins

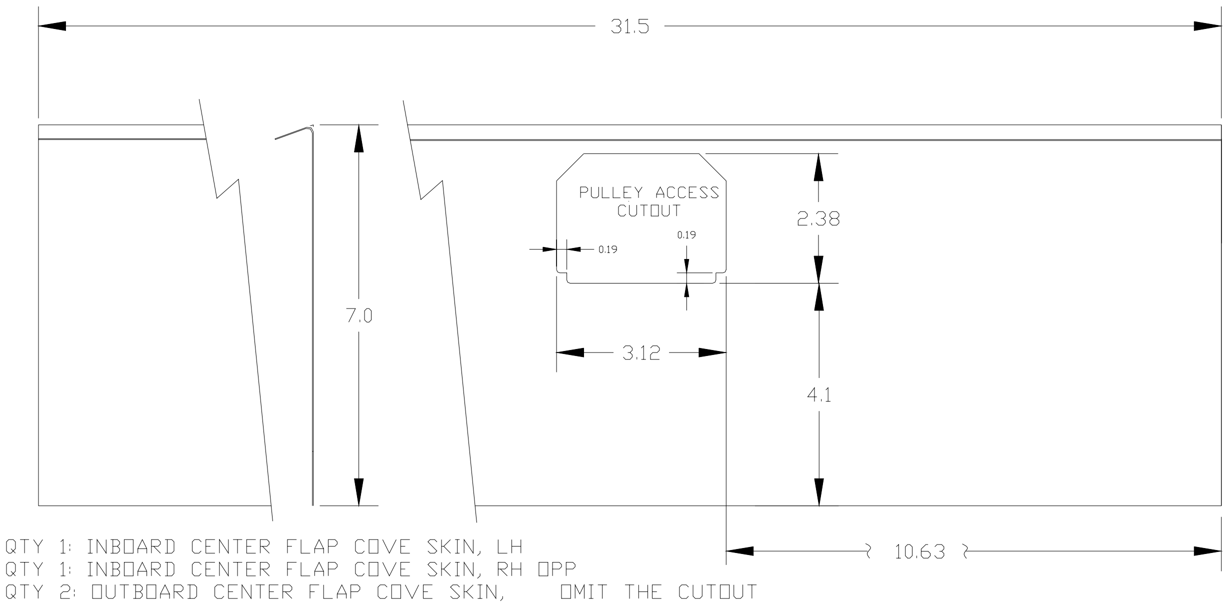


Figure 81: Center flap cove skins

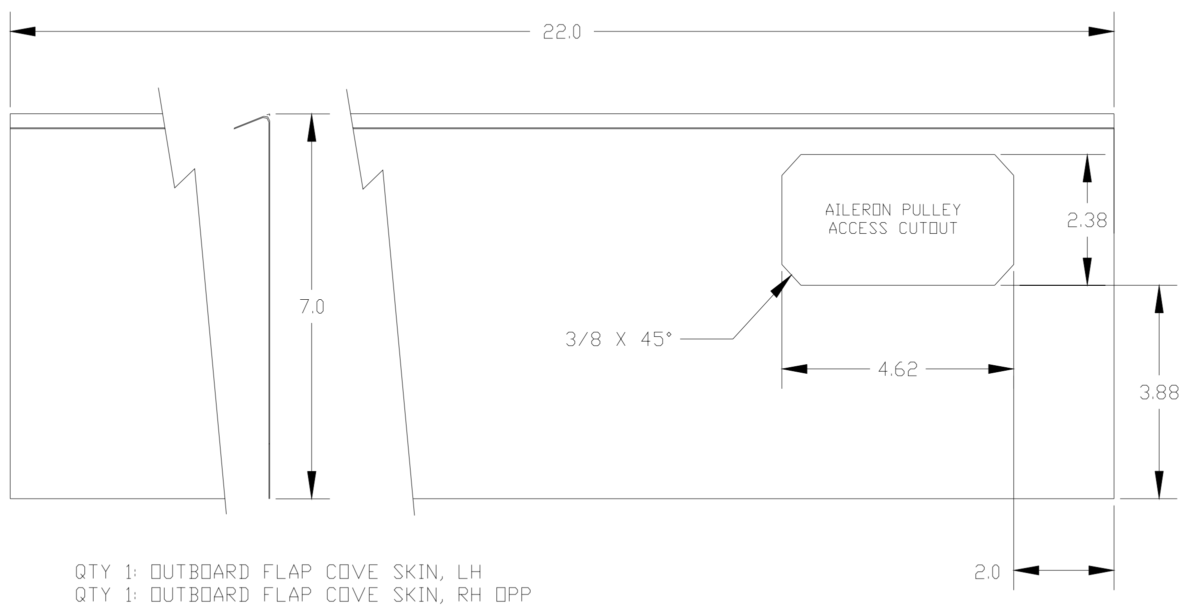


Figure 82: Outboard flap cove skins

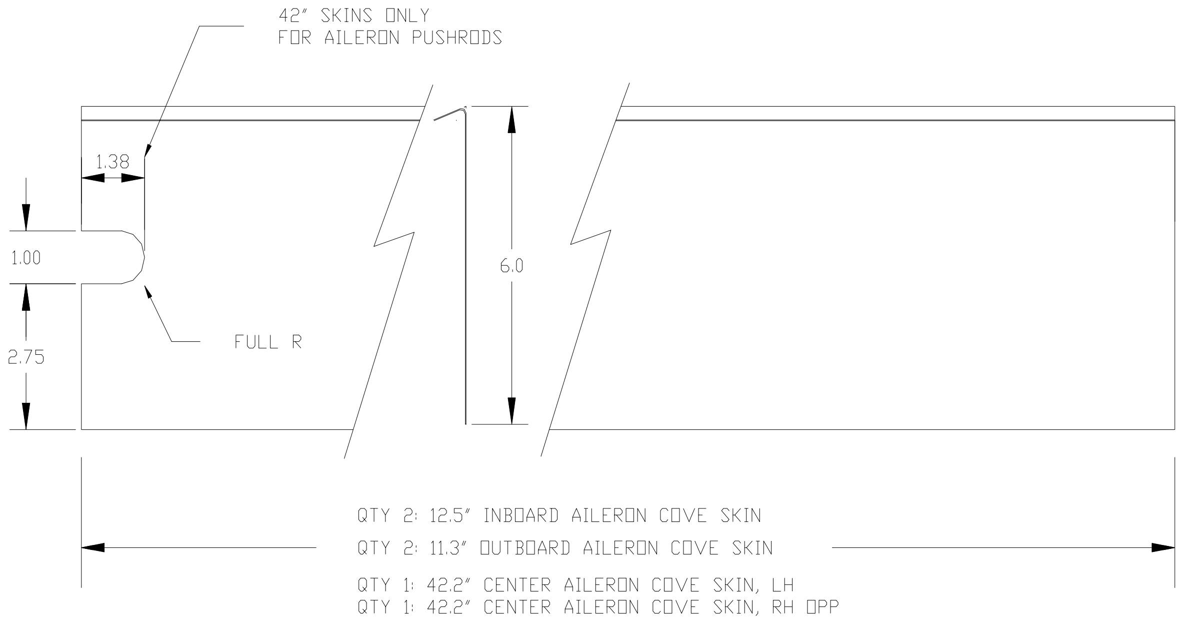
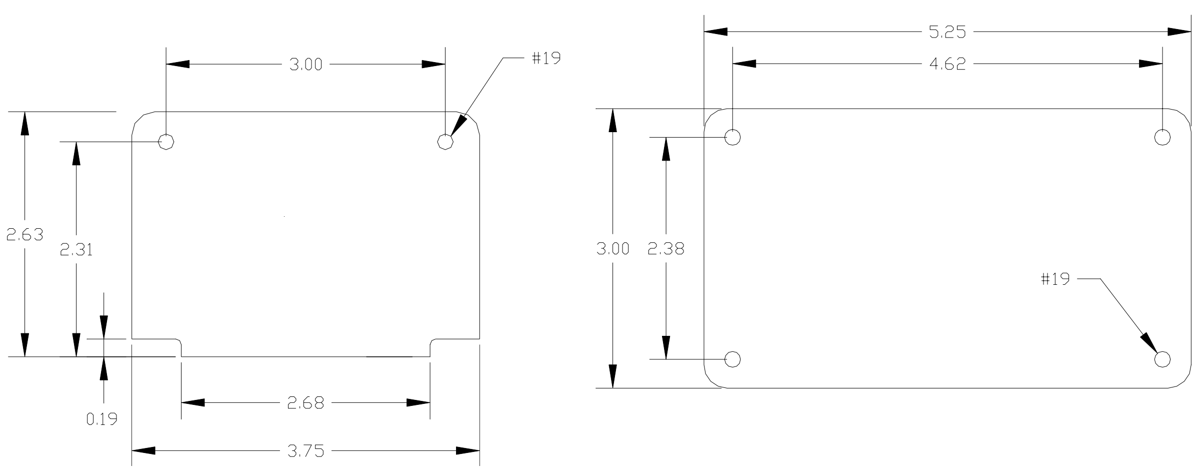
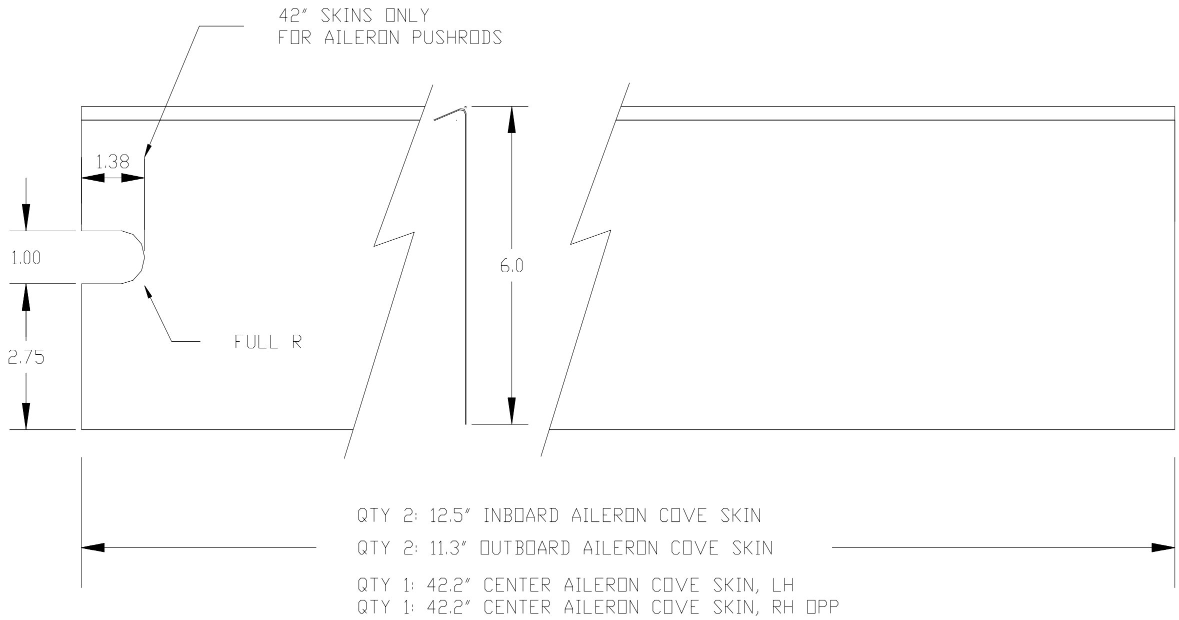


Figure 83: Aileron cove skins

Page 160: Step 79.1 will be added describing the fabrication of the cove access hole covers. Hardware for the covers is already included in your kit. The covers can be made from any .016, .020 or .025 aluminum and are used for the inboard and outboard flap cove skin pulley cutouts. Secure the covers using (12) 450-0211-081 nutclips and (12) AN526-8R6 pan head screws.



The following will be added to Step 80: It is acceptable to trim the aft end of the cove rib to within 2*d from the last skin rivet if it interferes with the doubler. Alternatively, you may sand down the width of the doubler at the location of the rib if necessary.



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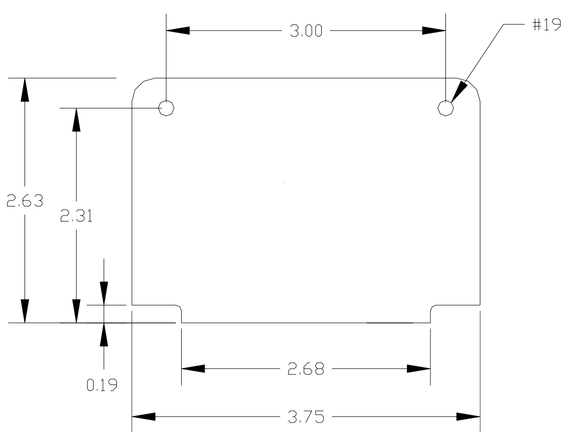
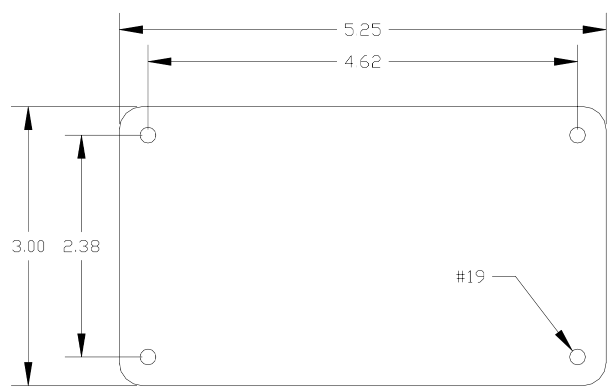




The following will be added to Step 80: It is acceptable to trim the aft end of the cove rib to within 2*d from the last skin rivet if it interferes with the doubler. Alternatively, you may sand down the width of the doubler at the location of the rib if necessary.

The following page and Step will be added:

Page 161.1: Step 80.1: Alternative Method to Bond the Cove Skins to the Wing

After many wing installations, we have found that very small variations in the flap track installation, (even using assembly jigs that set the flap track angles and spacing) can make the flaps tight in the cove. One of the cove rib tabs that is particularly tight is the first tab forward of the trailing edge (the highest one when the wing is in flight attitude.) If this tab is removed, it allows more clearance. Also, we have discovered that a bonded trailing edge, rather than a riveted one, will make for a cleaner installation. You still rivet the lower skin to the cove skin and the first rib tab to the cove skin. We have found the Loctite product H3151 Structural Adhesive P/N 83015 to be an excellent adhesive for the trailing edge. You will need a mixing gun P/N 98472 and some mixing tips.

With the wing upside down on the table, install the flaps and deploy them in and out to see if there are any tight spots that should be addressed. Remove the tab on the cove rib if necessary. The lower trailing edge skin may need to be trimmed as well to provide for an even flap clearance.

Position and fit the cove skins and trailing edge doublers as described in Steps 80 and 81. Make sure you push the lower formed corner of the skin as far forward as possible, which will allow for more rivet room. Drill the lower skin trailing edge and the cove rib tabs, but do not drill the upper skin trailing edge rivets.

Prepare the cove skins for riveting by deburring any drilled holes. Prepare the surfaces for bonding by scuffing up all the bonding surfaces with 36 grit sand paper, and then cleaning with acetone. The bonding surfaces are the inside of the upper skin, both sides of the doubler, and the inside trailing surface of the cove skin.

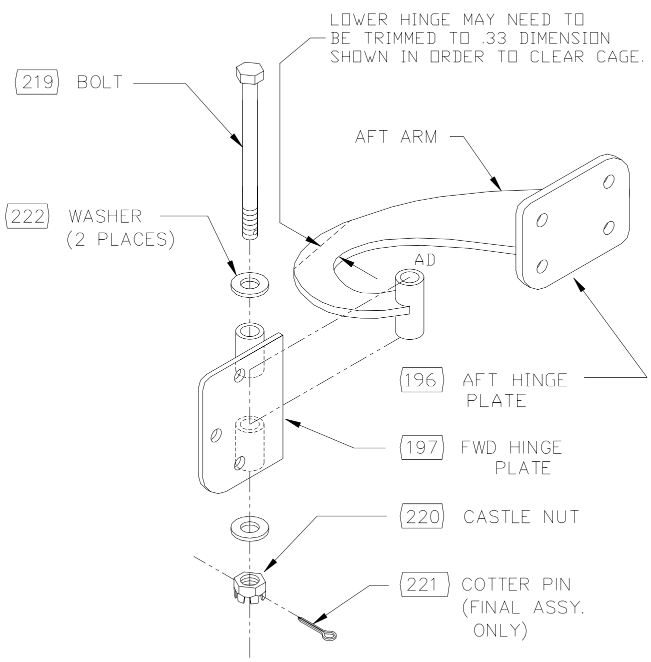
You will need to clamp the skins and the doublers together with two long straight edges. For best results, these need to be stiff enough to provide a clamping pressure between any c-clamps used to hold the two together. Angle stock or some other stiff and straight bar is preferred. With the wing upside down, the weight of the clamps and bar cannot be too great, otherwise it may pull the bonding edges too far from the desired location. Remember though, the flap clearance is tight, so some deflection (~1/16") of the entire upper skin trailing edge in the upward direction is advised.

The Loctite has a 35 minute working life and a 3 hour cure at 70 degrees. Lay a small zig zag bead on one of the surfaces, and Cleco the lower skin edges together as well as any of the rib tabs. Insert the trailing edge doubler between the skins and clamp together. After the adhesive has cured, remove the clamps. Then drill one 3/32" rivet hole thru the upper skin and cove skin on the end of each cove skin. This will act as a rip stop. Countersink from the bottom and insert one flush rivet with the head inside the cove and the tail on the upper surface. Squeeze these rivets, don't drive them.

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.

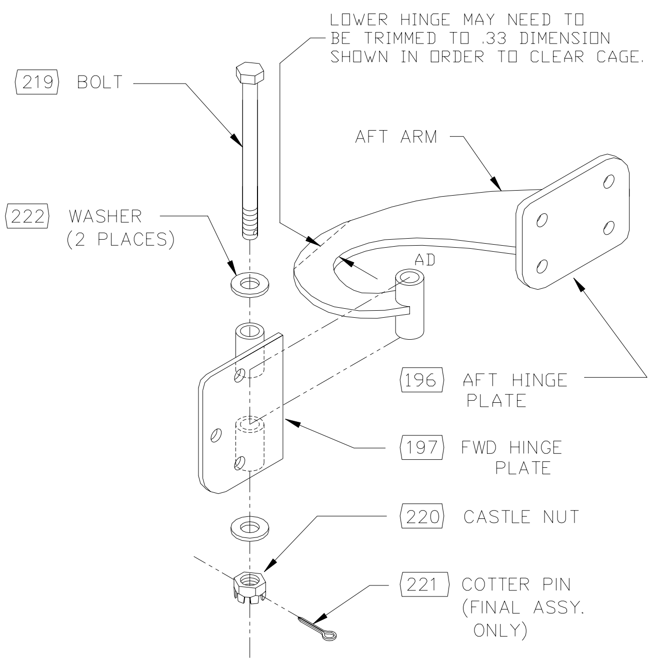


Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.



Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

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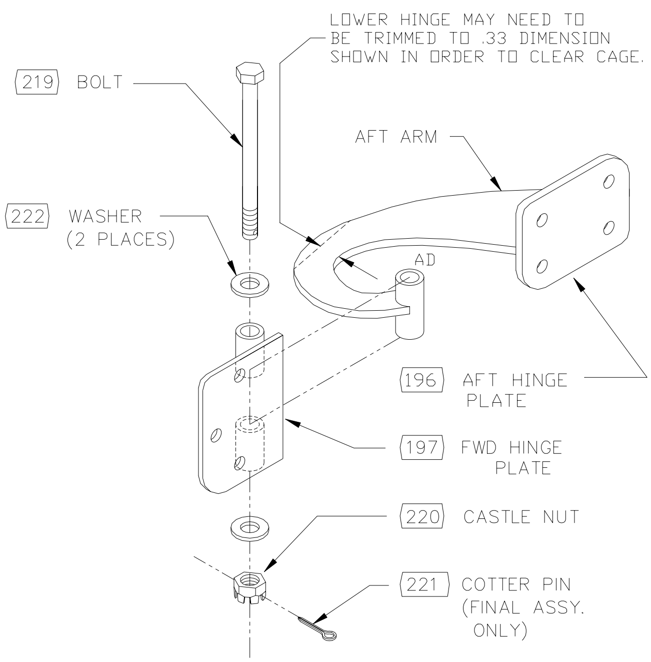
Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.



Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

ADVANCE NOTICE OF REVISION

Section X: Final Assembly

Page 240: Figure 133.1 dimensions changed from 1.30 to 1.40, 1.25 to 1.30, 1.81 to 1.90. The text changed in Step 124 - Keep them connected to each other with the 24" rod. The important dimension is the ~~1.30/1.25~~ 1.40/1.35, but since you must drill from the inside you must measure from the edge of the 1/2" flange, resulting in a ~~1.8"~~ 1.90"

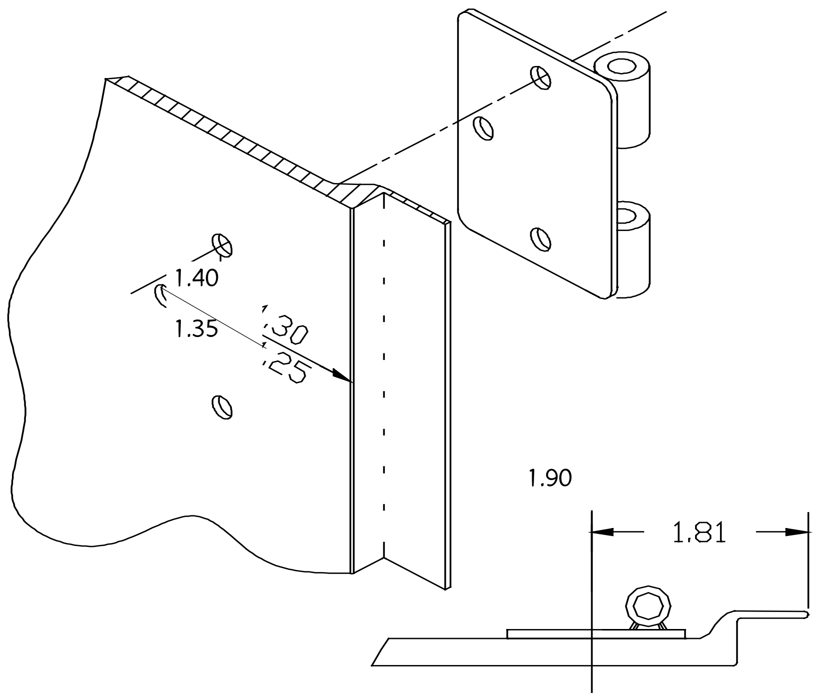


Figure 133.1: Location of the Forward Hinge Half on the Fuselage

Page 268: all text removed for Step 137.1

~~Step 137.1: Wing Fold Recess Covers~~

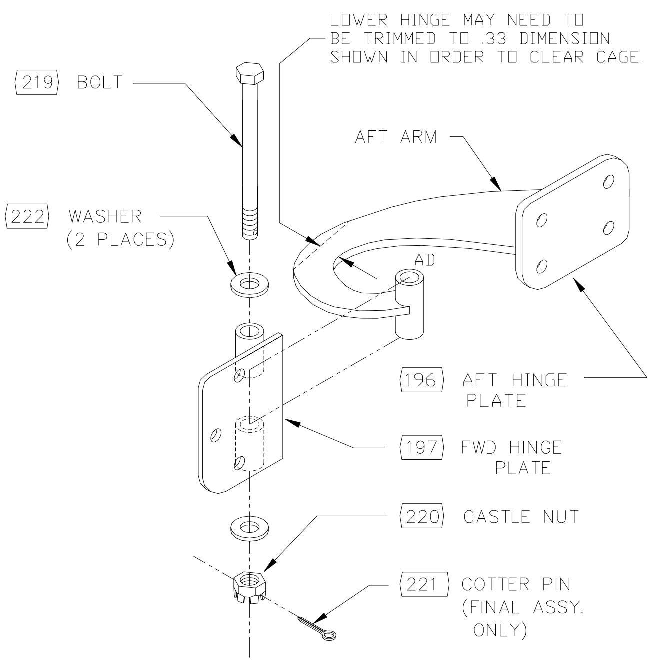
~~Before you go and fold your wings, be advised that the inboard flap tracks will contact the fuselage before the wings can be fully folded. For this reason there is a recessed flange on the outer fuselage surface just forward of the upper aft strut attach arm as referenced in Figure 119 in the Systems section of the manual.~~

~~In order to fold the wings, you must trim the inside of the recess until you have approximately 5/8" flange left. This will make room for the flap track to pass through the shell and allow the wings to be folded to their full extent. Then install the **flap track**~~

Page 168: Because the hose clamp is a tight fit on this hose, the last paragraph in Step 83 will be revised as follows: Slide a **7/32"–5/8" hose clamp [99]** over the aluminum elbow, and then push the hose over the elbow nipple as far as it will go (i.e., all the way to the shoulder of the fitting, as shown in the cross-sectional view of Figure 91). Position the hose clamp roughly 5/8" from the end of the hose and tighten it. The lower end of this hose is inserted over the fitting in the header tank.

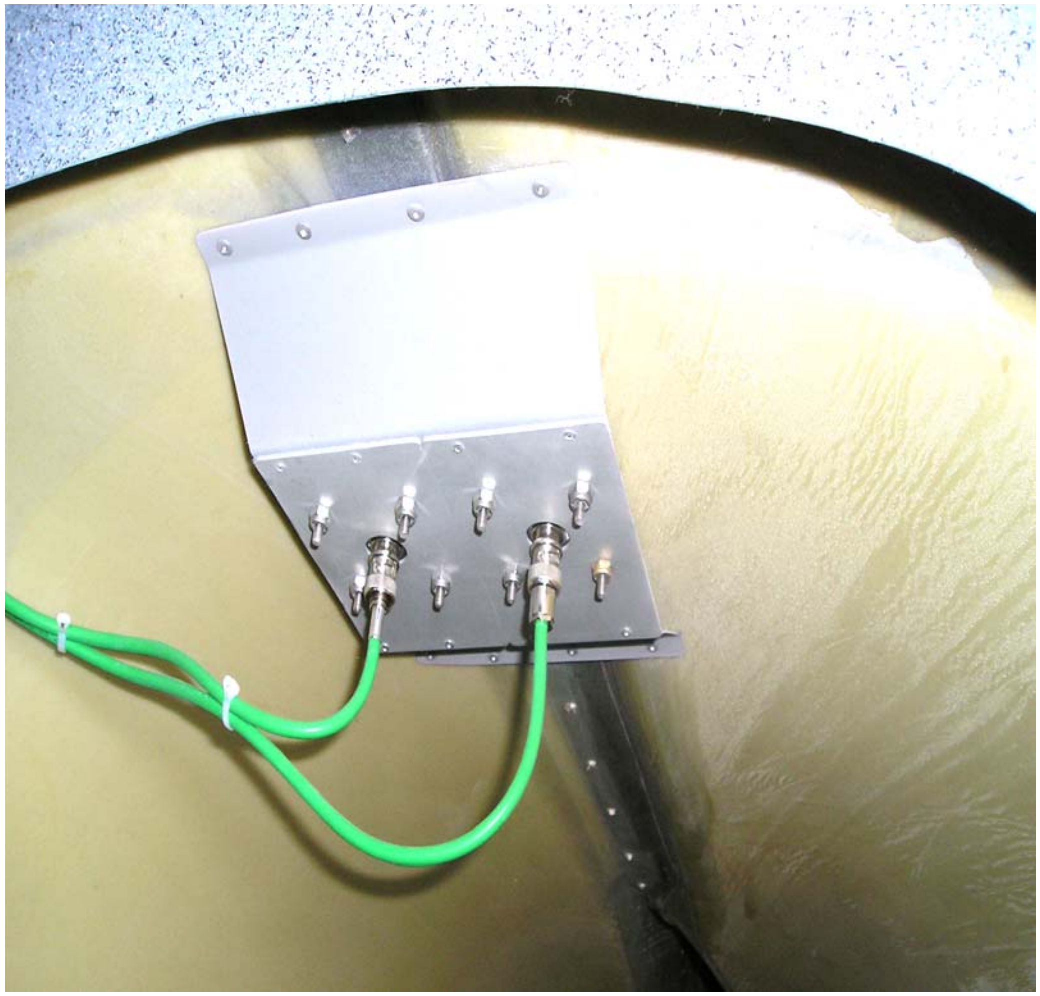
Page 220: A note will be added stating to use AN507-10R7 screws for the installation of the door hinges into the Shur-lok nuts.

Page 239-242: The lower baggage door hinge has very little clearance to the cage tube. It is acceptable to relieve the arm of the lower hinge in this area as shown in the revised Figure 132 below.



Page 242: A note will be added to the second paragraph stating: Drill the #10 holes perpendicular to the composite shell surface, not perpendicular to the hinge plate. This will ensure that the countersunk screws will be flush to the surface. The hardware used for this installation is also (4) AN509-10R8, (6) AN509-10R10 and (4) AN509-10R11 screws. If you mis-align a screw, it is permissible to slot the holes in the hinge plate slightly to get the screw head flush with the outer surface.

Page 268: An optional location for the GPS antenna will be given in Step 138. This location is right behind the Bulkhead A on the upper underside of the fuselage shell.



Page 287: A warning note will be added to the window installation regarding Silpruf silicone contamination on the exterior of the plane. You should be sure to tape and paper off any area where you might place your hands while installing the windows. Once silicone transfers from the hands to the exterior, it is very difficult to remove completely and will cause fish-eye problems during painting. We recommend PPG 330 Wax and Grease Remover. Wipe down the contaminated area with a Scotchbrite pad and clean rags two or three times.

In the Window Installation Section, a Baggage Door Window 101-14003-03 will replace the left quarter window 101-14003-01.

Section X: Final Assembly

Page 240: Figure 133.1 dimensions changed from 1.30 to 1.40, 1.25 to 1.30, 1.81 to 1.90. The text changed in Step 124 - Keep them connected to each other with the 24" rod. The important dimension is the ~~1.30/1.25~~ 1.40/1.35, but since you must drill from the inside you must measure from the edge of the 1/2" flange, resulting in a ~~1.8"~~ 1.90"

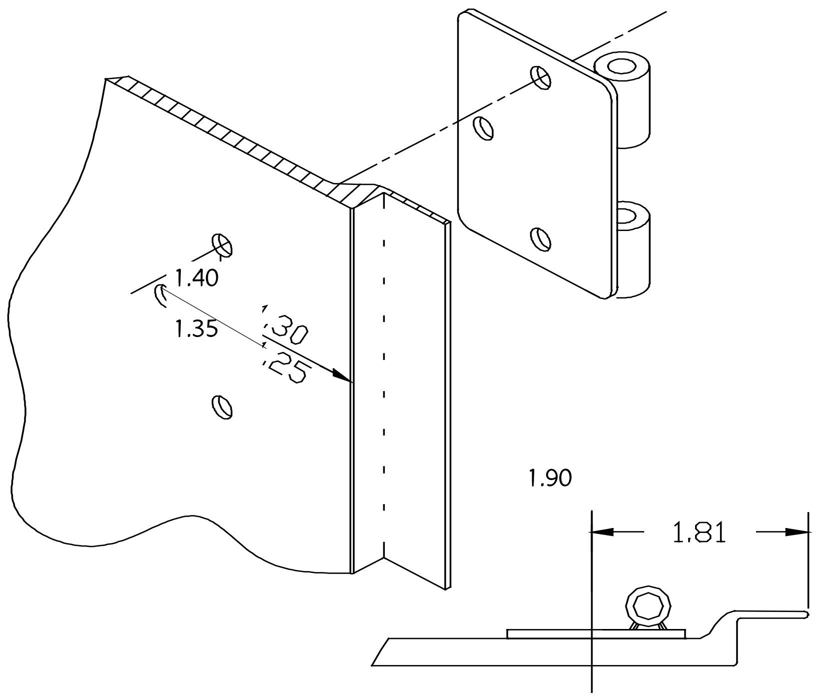


Figure 133.1: Location of the Forward Hinge Half on the Fuselage

Page 268: all text removed for Step 137.1

~~Step 137.1: Wing Fold Recess Covers~~

~~Before you go and fold your wings, be advised that the inboard flap tracks will contact the fuselage before the wings can be fully folded. For this reason there is a recessed flange on the outer fuselage surface just forward of the upper aft strut attach arm as referenced in Figure 119 in the Systems section of the manual.~~

~~In order to fold the wings, you must trim the inside of the recess until you have approximately 5/8" flange left. This will make room for the flap track to pass through the shell and allow the wings to be folded to their full extent. Then install the **flap track**~~

~~**recess cover** [233] over the flange. The covers come with a slight curvature to them, which approximates the curvature of the fuselage. The cover needs to be trimmed to shape and then it attaches to the recessed flange (forward side) using one AN507-8R8 screw and one K1000-8 nutplate. Refer also to the instructions included in the wing fold brace kit regarding the installation of the recess cups on the inside of the fuselage.~~

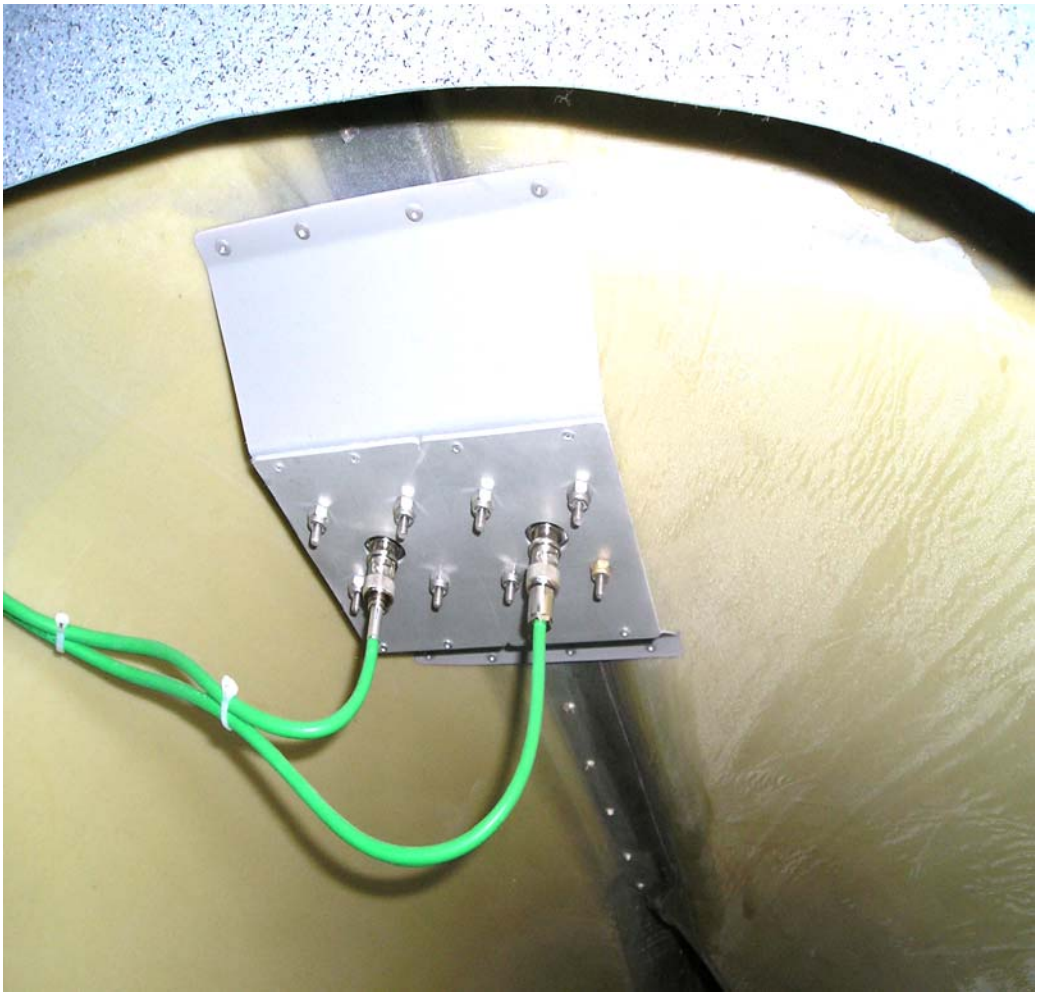
~~If you decide **not** to fold your wings, you can fill in the recess with a structural fill and then body finish over that. You may also chose to install the cover as described above.~~

~~**Completed: [ ]**~~

Page 9, Parts list-part removed.

194	~~Flap track recess cover~~ Part Removed	~~2~~	~~101-00040-01~~

Page 268: An optional location for the GPS antenna will be given in Step 138. This location is right behind the Bulkhead A on the upper underside of the fuselage shell.



Page 287: A warning note will be added to the window installation regarding Silpruf silicone contamination on the exterior of the plane. You should be sure to tape and paper off any area where you might place your hands while installing the windows. Once silicone transfers from the hands to the exterior, it is very difficult to remove completely and will cause fish-eye problems during painting. We recommend PPG 330 Wax and Grease Remover. Wipe down the contaminated area with a Scotchbrite pad and clean rags two or three times.

In the Window Installation Section, a Baggage Door Window 101-14003-03 will replace the left quarter window 101-14003-01.

Page 62: Figure 27 will show the addition of (1) NAS42DD8-43 clamp-up spacer, which is to be inserted between the two cage tabs where the forward end of the inboard seat track attaches. This will prevent the tabs from being bent and damaged in the event the AN4-32A bolt is over tightened.

Page 102-106: For those main wheel pants which are marked with a suggested trim line, care must be taken when trimming around the brake caliper depending whether or not you have rotated your brake mounting flange as shown in Figure 123 in the Systems Section of your manual. The trim marking templates were set up for a wheel pant where the brake flange had not been rotated the 7 degrees per Figure 123 in the Systems Section. If the trim lines are used for an installation where the brake flange is rotated, then the wheel pant will be mounted with a nose high attitude.

Page 113: The first paragraph in Step 51 will be revised to read as follows: Go back to the tail and sight from a position approximately 18" outboard from the centerline and 18" down from the stabilizer lower skin. We had the stabilizer in place and used rib positions as a reference. If the stab isn't installed, simply place a straight board in its place and make a couple of sight marks equally spaced to each side.

Page 133: The NAS43DD4-39 spacer identified should be a NAS43DD4-50 as specified in Section VIII, page 122.

Page 136-139: Step 65 will be revised to provide a simpler installation for the aft attach point on the nose wheel pant. It can be difficult to locate and install the nutplate on the nose fork. There have been cases where the tire valve stem will interfere with the nutplate at this location. For this reason we have designed a new attach bracket that attaches to the axle bolt and extends aft picking up the wheel pant aft of the axle.

The two brackets (401-00035-01) will be supplied in the later kits. Reference also the Systems Section, pages 244-246 of this ANOR. Use the same method of locating a blind hole shown in Figure 71.1 only locate the middle of the flat part of the bracket where it will be fixed to the nose wheel pant. When you have aligned the nose wheel pant as described in this step, then drill through the pant and the bracket with a #11 bit. Once drilled, install a MF5000-3 floating nutplate. Laminate a small 3 layer reinforcement patch for countersink depth over the inside of the pant at this location. Redrill and countersink for a #10 screw. The pant is secured to this bracket using AN507-10R8 screws.

The aft fairing spacers described in Step 65 may be omitted. If there exist too much space between the bracket and the wheel pant, a structural fill may be applied to the inside of the pant to obtain a better fit.