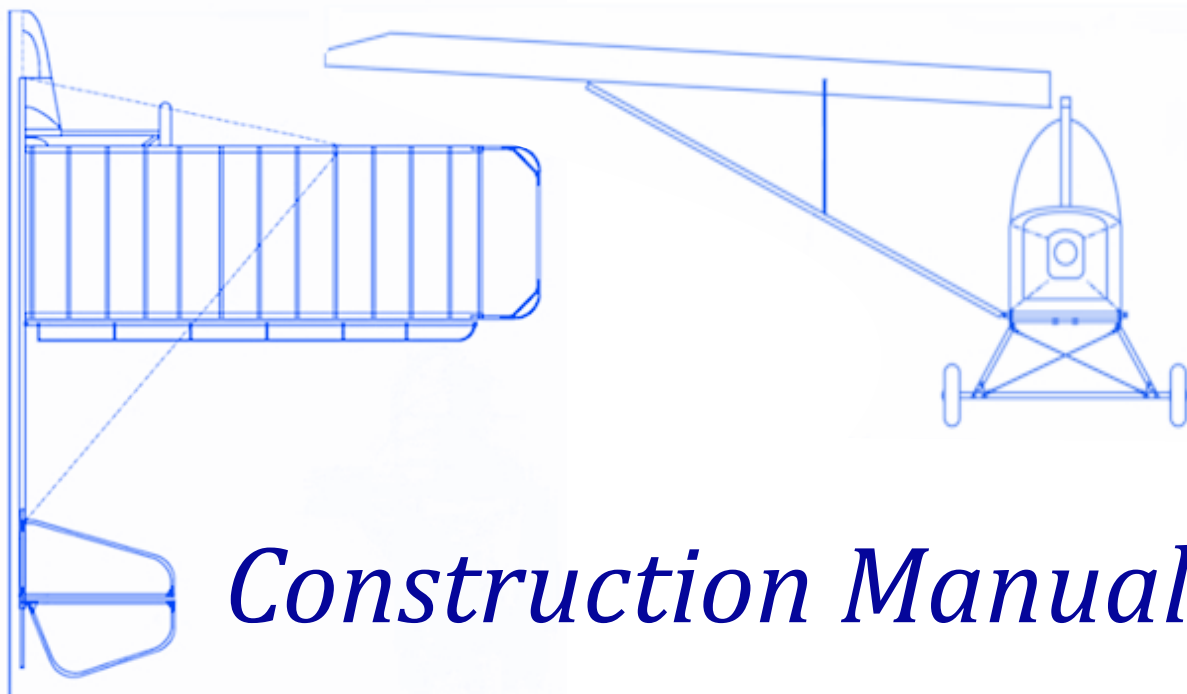


# *Affordaplane*

2013

*Complete Plans Set Inside*



# Affordaplane Ultralight Aircraft



## Construction Manual

By Dave Edwards  
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**Introduction**

Welcome! This manual contains a description of how to build an Affordaplane ultralight aircraft. It is to be used in conjunction with the plans provided. The Affordaplane concept was first born around December, 1998. The prototype was constructed over a 9 month period, and first flown on Dec 23, 1999. The plans sets were released in August of 2000, after a successful flight test program.

The Affordaplane has unique construction in that the structural fuselage members are made of square aluminum tubing. This kind of construction method has been used on gyrocopters since the 1950's. The wings, elevator and rudder are made using 'conventional' ultralight construction. The Affordaplane is a simple to build, fun flying aircraft. Since its introduction, now nearly a decade later, the Affordaplane is flying in almost every country, with many hundreds flying in all kinds of terrains and conditions. Our customers range from the first time beginner, to professional pilots and mechanics, and everyone in between.

We hope you have a great time building and flying the Affordaplane aircraft.

To start off with a solid foundation, we have included Ron Alexanders great article on aircraft hardware. This is very important information for anyone building an airplane.

## **AIRCRAFT HARDWARE**

### **What You Need To Know**

By Ron Alexander

The quality of our workmanship in building an airplane is very important. We all take the needed time and spend the necessary money to ensure we have a high quality airplane. We want it to not only look attractive, but also to be safe. But what about the materials that hold the airplane together the aircraft hardware? Do we try to cut expenses by using questionable bolts or used nuts? Is it really necessary to spend money on high quality aircraft hardware? Absolutely! The hardware used to assemble your airplane should be nothing but the best. Why take the time to build a perfect wing only to attach it to the fuselage with used hardware. It makes no sense. To quote the Airframe and Powerplant Mechanics General Handbook . . . "The importance of aircraft hardware is often overlooked because of its small size; however, the safe and efficient book also provides us with a very good definition of aircraft hardware. "Aircraft hardware is the term used to describe the various types of operation of any aircraft is greatly dependent upon the correct selection and use of aircraft hardware." Very well stated. The same fasteners and miscellaneous small items used in the manufacture and repair of aircraft."

The subject of aircraft hardware can certainly be confusing. Thousands upon thousands of small items are used on a typical airplane. What does the custom aircraft builder really need to know about hardware? Where do you find the information? What reference is really the end authority on proper installation? What do all of those AN numbers mean and do I have to know them? What types of hardware should I really learn more about in order to build my own airplane?

These questions will be answered in this series of articles on aircraft hardware. I hope to eliminate some confusion over what type of hardware to use and how to properly install

it.

To begin our discussion, it is absolutely imperative that you use nothing but aircraft grade hardware. Commercial grade hardware found in hardware or automotive stores is legal to use on an experimental airplane **but should not be considered for even a moment**. Why? Let's look at bolts as an example. Common steel bolts purchased from a hardware store are made of low carbon steel that has a low tensile strength usually in the neighborhood of 50,000 to 60,000 psi. They also bend easily and have little corrosion protection. In contrast, aircraft bolts are made from corrosion resistant steel and are heat treated to a strength in excess of 125,000 psi. The same comparison applies to most hardware items. So, **use only aircraft quality hardware on your airplane**. Save the other hardware for your tractor. If aircraft hardware is special, then there must be a standard against which it should be measured and manufactured. That standard was actually developed prior to World War 2, but became more definitive during that war. Each branch of the military originally had its own standard for hardware. As time went on these standards were consolidated and thus the term AN which means Air Force-Navy (some prefer the older term Army-Navy). Later the standards were termed MS which means Military Standard and NAS which means National Aerospace Standards. Thus, the common terms AN, MS and NAS. Together they present a universally accepted method of identification and standards for aircraft hardware. All fasteners are identified with a specification number and a series of letters and dashes identifying their size, type of material, etc. This system presents a relatively simple method of identifying and cataloging the 7 thousands and thousands of pieces of hardware. Several pieces of hardware will have both an AN number and an MS number that are used interchangeably to identify the exact same piece. A cross reference exists that compares these two numbers. So in the end, you are able to read your plans or assembly manual and identify, by number and letter, each piece of hardware on your airplane. You can then obtain that piece and properly install it in the right place. Imagine trying to do that without a system of numbers. The specifications for each piece of hardware also define the strength, tolerance, dimensions, and finish that is applied. If you would like further information on this numbering system, you can contact the National Standards Association in Washington, DC.

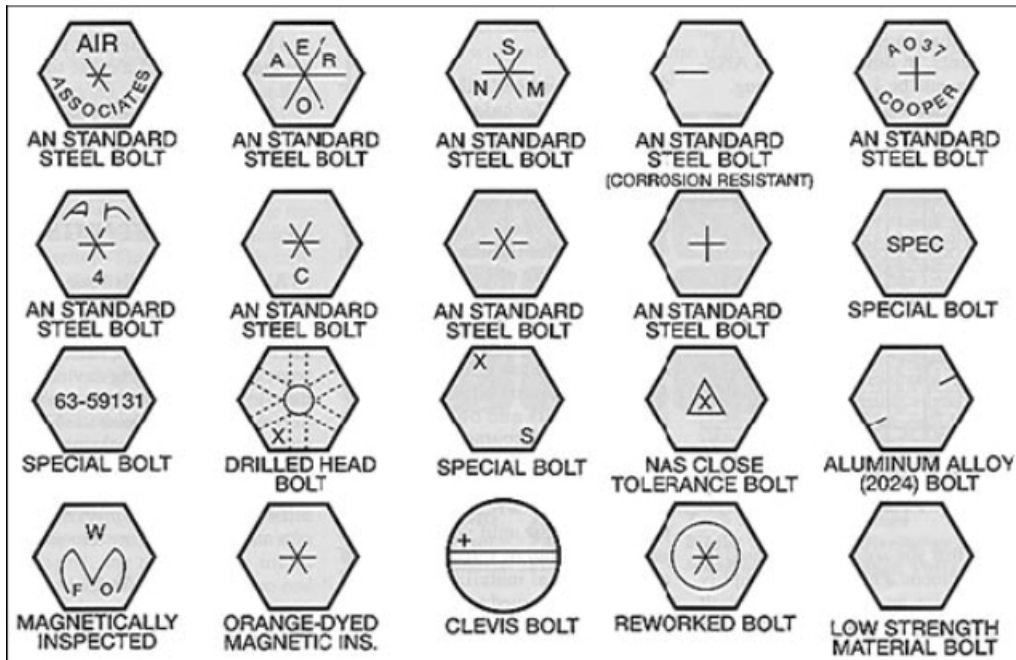


FIGURE 1

Out of all the thousands of hardware pieces manufactured, which ones are important to the custom aircraft builder? The following types and categories of hardware will be discussed:

- Bolts
- Nuts
- Washers
- Screws
- Cotter pins and safety wire
- Rivets
- Turnlock fasteners
- Miscellaneous items such as O-rings, crush washers, etc.
- Control cable hardware
- Fluid lines and fittings
- Electrical wiring and connectors

Where do you find information concerning aircraft hardware? Your aircraft plans or assembly manual should provide you with a general overview of hardware used on your project. Use the hardware the aircraft designer or kit manufacturer recommends. Do not substitute with your own ideas. This can be dangerous. The manufacturer has tested the design and its safety is dependent upon the proper pieces of hardware. FAA Advisory Circular 43-13-IA is an excellent reference source. The Airframe Mechanics General Handbook also has a very good section on the selection and use of hardware. These two books are considered the primary authority on the proper use of hardware. In addition, I would recommend two other small reference books: the Standard Aircraft Handbook and the Aviation Mechanic Handbook. Both of these provide a good reference source. The

Aircraft Spruce & Specialty catalog also contains good reference material on hardware. If you have any doubts about the quality of the aircraft hardware you are purchasing, request a copy of the manufacturer's specifications.

These specifications along with a specific manufacturer's lot number should be available.

## BOLTS

Bolts are used in aircraft construction in areas where high strength is needed. Where this strength is not necessary screws are substituted. Aircraft quality bolts are made from alloy steel, stainless or corrosion resistant steel, aluminum alloys and titanium. Within our industry the first two are the most common. Aircraft bolts will always have a marking on their head. If you see no markings at all on the head of a bolt, do not use it. It is probably a commercial grade bolt. The markings on bolts vary according to the manufacturer. You should see an "X" or an asterisk along with a name, etc. If you purchase a corrosion resistant (stainless steel) bolt, the head of that bolt should have one raised dash. An aluminum bolt will have two raised dashes on its head. Aluminum bolts have limited use. They should not be used in tension applications or where they will be continuously removed for maintenance or inspection. A chart of typical bolt heads is presented in Figure 1. NAS bolts have a higher tensile strength (usually about 160,000 psi) and can be identified by a cupped out head. Close tolerance bolts are machined more accurately than general purpose bolts and they are used in applications requiring a very tight fit. Close tolerance bolts can be either AN or NAS and typically have a head marking consisting of a raised or recessed triangle.

The standard bolts used in aircraft construction are AN3 through AN20. Each bolt typically has a hexagon shaped head and a shank that fits into the hole. The shank is threaded on the end and the unthreaded portion of the bolt is termed the grip. The diameter of a bolt is the width of the grip. The shank of a bolt will be either drilled to accept a cotter pin or undrilled. Another option is to purchase a bolt that has the head drilled for the purpose of accepting safety wire. Clevis bolts are manufactured with a slotted head and are used for control cable applications. The size, material, etc. of a bolt is identified by an AN number. A breakdown of a typical bolt AN number follows: AN4-8A AN means the bolt is manufactured according to Air Force-Navy specs. 4 identifies the diameter of the bolt shank in 1/16" increments. 8 identifies the length of the shank in 1/8" increments. A means the shank of the bolt is undrilled (no letter here means a drilled shank). So, this particular bolt is a 1/4 inch diameter AN bolt that is 1/2 inch long measured from just under the head to the tip of the shank. The bolt also has an undrilled shank which means it cannot accept a cotter pin. Also, bolt length may vary by +1/32" to -1/64". If the letter "C" follows the AN designation (ANC) that identifies a stainless steel bolt. The letter "H" after AN (ANH) identifies a drilled head bolt.

In constructing your airplane, you will not encounter many bolts larger than an AN8 (1/2 inch diameter). To add a bit more confusion, if the dash number defining the length of the bolt has two digits, the first digit is the length in whole inches and the second number the length in additional 1/8" increments. In other words, an AN514 bolt would be 5- 1/2 inches long. Now that you are totally confused let me recommend a hand tool to simplify bolt selection and sizing. An AN bolt gauge is available that will assist you in identifying a bolt. If you need to determine the proper

size of a bolt, the length must be sufficient to ensure no more than one thread will be inside the bolt hole. This is the grip length of the bolt and it is measured from the underneath portion of the head to the beginning of the threads (see Figure 3). The grip length should be equal to the material thickness that is being held by the bolt or slightly longer. A washer may be used if the bolt is slightly longer. A piece of welding rod or safety wire can be used to measure the length of the hole. In his book titled Sportplane Construction Techniques, Tony Bingelis shows a simple tool that can be made for this purpose.

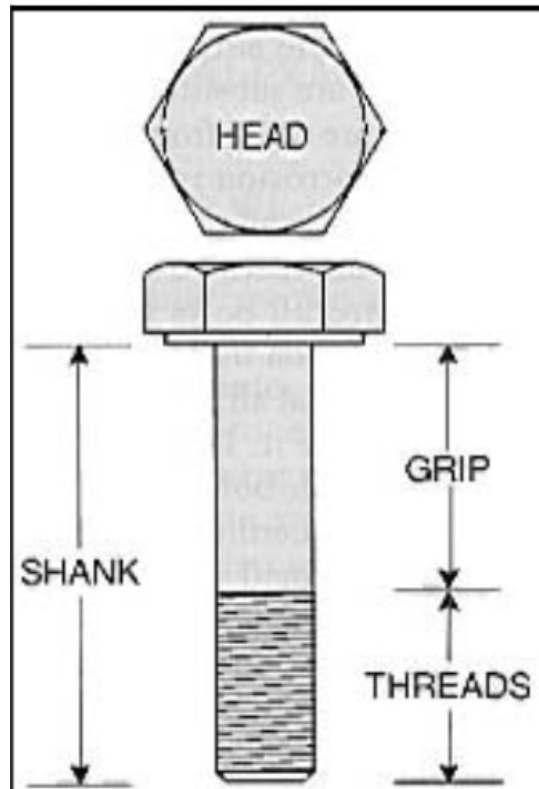


FIGURE 3

It is important that you do not "over tighten" or "under tighten" a bolt or the nut attached to a bolt. Under torque or under tightening results in excessive wear of the hardware as well as the parts being held. Over tightening may cause too much stress on the bolt or nut. The best way to avoid this is to use a torque wrench. AC43-13 presents a table of torque values for nuts and bolts. It shows fine thread and coarse thread series with a minimum and maximum torque limit in inch pounds. I recommend using a torque wrench whenever possible, at least until you get an idea as to the amount of force required. Of course, critical installations should definitely be torqued to proper values. A torque wrench is not that expensive and will be a worthwhile investment for a custom builder.

#### Basics of Bolt Installation

Certain accepted practices prevail concerning the installation of hardware. A few of these regarding bolt installation follow:

1. In determining proper bolt length - no more than one thread should be hidden inside the bolt hole.
2. Whenever possible, bolts should be installed pointing aft and to the center of an airplane.
3. Use a torque wrench whenever possible and determine torque values based on the size of bolt.
4. Be sure bolt and nut threads are clean and dry.
5. Use smooth, even pulls when tightening.
6. Tighten the nut first - whenever possible.
7. A typical installation includes a bolt, one washer and a nut.
8. If the bolt is too long, a maximum of three washers may be used.
9. If more than three threads are protruding from the nut, the bolt may be too long and could be bottoming out on the shank.
10. Use undrilled bolts with fiber lock nuts. If you use a drilled bolt and fiber nut combination, be sure no burrs exist on the drilled hole that will cut the fiber.
11. If the bolt does not fit snugly consider the use of a close tolerance bolt.
12. Don't make a practice of cutting off a bolt that is too long to fit a hole. That can often weaken the bolt and allow corrosion in the area that is cut.

## AIRCRAFT NUTS

Aircraft nuts usually have no identification on them but they are made from the same material as bolts. Due to the vibration of aircraft, nuts must have some form of a locking device to keep them in place. The most common ways of locking are cotter pins used in castle nuts, fiber inserts, lockwashers, and safety wire. The aircraft nuts you will most likely encounter are castle nuts, self-locking nuts, and plain nuts. Wing nuts and anchor nuts are also used.

## CASTLE NUTS

AN310 and AN320 castle nuts are the most commonly used (see Figure 4). Castle nuts are fabricated from steel and are cadmium plated. Corrosion resistant castle nuts are also manufactured (AN310C and AN320C - remember, when you encounter a "C" it will designate stainless). Castle nuts are used with drilled shank bolts, clevis bolts and eye bolts. The slots in the nut accommodate a cotter pin for safetying purposes. The thinner AN320 castellated shear nut has half the tensile strength of the AN310 and is used with clevis bolts which are subject to shear stress only. The dash number following the AN310 or AN320 indicates the size bolt that the nut fits. In other words, an AN310-4 would fit a 1/4 inch bolt.





FIGURE 4

## Self-Locking Nuts

Self-locking nuts, as the name implies, do not need a locking device. The most common method of locking is derived from a fiber insert. This insert has a smaller diameter than the nut itself so that when a bolt enters the nut it taps into the fiber insert producing a locking action. This fiber insert is temperature limited to 50-deg. F. The designation of these nuts is AN365 and AN364. This brings us to an example of a cross-reference MS number. An AN365 is also termed MS20365 with the AN364 being MS20364. Both of these nuts are available in stainless. The AN364 is a shear nut not to be used in tension. An all metal locking nut is used forward of the firewall and in other high temperature areas.

In place of a fiber insert, the threads of a metal locking nut narrow slightly at one end to provide more friction. An AN363 is an example of this type of nut. It is capable of withstanding temperatures to 550-deg. F. The dash number following self-locking nut defines the thread size. Self locking nuts are very popular and easy to use. They should be used on undrilled bolts. They may be used on drilled bolts if you check the hole for burrs that would damage the fiber. One disadvantage, self-locking nuts should not be used on a bolt that is connecting a moving part. An example might be a clevis bolt used in a control cable application.

### Plain Aircraft Nuts

Plain nuts require a locking device such as a check nut or lockwasher.

They are not widely used in most aircraft. AN315 is the designation used for a plain hex nut. These nuts are also manufactured with a right hand thread and a left hand thread. The check nut used to hold a plain nut in place is an AN316. If a lockwasher is used a plain washer must be under the lock washer to prevent damage to the surface.

### Other Aircraft Nuts

There are a number of other aircraft nuts available. Wing nuts (AN350) are commonly

used on battery connections or hose clamps where proper tightness can be obtained by hand.

Anchor nuts are widely used in areas where it is difficult to access a nut. Tinnerman nuts, instrument mounting nuts, pal nuts, cap nuts, etc. are all examples of other types that are used.

#### Basics of Aircraft Nut Installation

1. When using a castle nut, the cotter pin hole may not line up with the slots on the nut. The Mechanics General Handbook states "except in cases of highly stressed engine parts, the nut may be over tightened to permit lining up the next slot with the cotter pin hole." Common sense should prevail. Do not over tighten to an extreme, instead, remove the nut and use a different washer and then try to line the holes again.
2. A fiber nut may be reused if you are unable to tighten by hand.
3. At least one thread should be projecting past the fiber on a fiber nut installation.
4. No self-locking nuts on moving part installations.
5. Do not use AN364 or AN365 fiber nuts in areas of high temperature - above 250° F.
6. Shear nuts are to be used only in shear loads (not tension).
7. Plain nuts require a locking device such as a lockwasher or a check nut.
8. When using a lockwasher, place a plain washer between the surface of the airplane part and the lockwasher.
9. Shear nuts and standard nuts have different torque values.
10. Use wing nuts only where hand tightness is adequate.

#### WASHERS

Finally, a hardware item that is simple. You are likely to encounter only a couple of different types of washers AN960 and AN970. The main purposes of a washer in aircraft installation are to provide a shim when needed, act as a smooth load bearing surface, and to adjust the position of castle nuts in relation to the drilled hole in a bolt. Also, remember that plain washers are used under a lockwasher to prevent damage to a surface. AN960 washers are the most common. They are manufactured in a regular thickness and a thinner thickness (one half the thickness of regular). The dash number following the AN960 indicates the size bolt for which they are used. The system is different from others we have encountered. As an example, an AN960-616 is used with a 3/8" bolt. Yet another numbering system. If you see "L" after the dash number, that means it is a thin or "light" washer. An AN960C would be - yes, a stainless washer. I can tell you are getting more familiar with the system so I will throw another wrench into the equation - an AN970 washer has a totally different dash number system. I am not even going to tell you what it is. I will tell you that an AN970 is a larger area flat washer used mainly for wood applications. The wider surface area protects the wood. There are other types of washers. I mentioned lockwashers that are made several different ways. They are often split ring, they are sometimes internal tooth and even external tooth (see Figure 5). You will also find nylon washers and finishing washers that usually have a countersunk head. So, as you can see, washers are not quite as confusing as other hardware even though we can make it difficult if we wish.

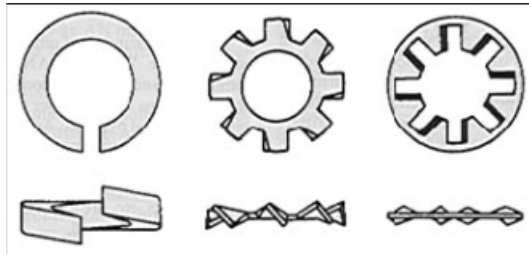


FIGURE 5

### COTTER PINS AND SAFETY WIRE

The cotter pins mostly used on custom aircraft are AN380 and AN381.

Cadmium plated cotter pins are AN380 and stainless are AN381. Cotter pins are used for safetying bolts, screws, nuts and other pins. You will normally use them with castle nuts. The MS number you may see is MS24665. The dash numbers indicate diameter and length of the pin. As an example, AN380-2-2 would be a cadmium plated pin 1/16" in diameter and 1/2" long.

All supply companies will have charts showing the various sizes versus the reference number.

Safety wire is also widely used. The most used sizes in diameter are .020, .032 and .041 or small variations thereof. The material is usually stainless steel or brass. The easiest method of installation is acquired by using safety wire pliers (see Figure 6). The pliers are used to twist the wire. The wire is installed so that if the nut or bolt begins to loosen it will increase the tension on the wire. Be sure you do not overtwist the wire - doing so will weaken the safety wire. Leave about 36 twists and then cut off the excess wire and bend its end so you do not snag it with your hand at a later time.



FIGURE 6

I want to emphasize the major point of this article. **USE ONLY AIRCRAFT QUALITY HARDWARE.** Do not assume the engineer role by using hardware types or sizes that are contrary to your plans or assembly manual.

By Ron Alexander, © 1998

### Pre-Planning Before You Build

It is recommended that you build your aircraft in sections. Most builders start with the fuselage first. Then wings, tail etc. Building a section at a time allows you to build in much smaller spaces than an airplane normally requires. The prototype was built inside a 9 foot by 19 foot screened in porch.

You should study the plans and manual until the assembly is clear. Then collect the materials for each section that you are working on. Please keep in mind the following: The Affordaplane is a very simple aircraft to build. Do not overcomplicate it, when simplicity almost always works better. Also, no matter how large an assembly may seem, it is still only made up of small parts. Completing small parts leads to having a finished aircraft! Its that simple. You can go at your own pace. Do not be rushed, this isn't a race. If you are frustrated, or upset, stay out of your shop. This is supposed to be fun! One of the greatest 'gifts' that you can give to yourself, is to enjoy every step. Take pictures, videos, anything that relates to your build. Go to your work space every day with a definite goal in mind. A definite outcome that you want. Even if you only work on one small part, for a fraction of an hour, if you do that every day, you will finish your airplane! It can be one of the most rewarding experiences you have ever had. Time spent in your shop working on your own airplane is something you will never forget, and it is worth recording for the future!

## **Fuselage**

The fuselage is a very simple affair. The first thing we need to think about however is a work space. The minimum space you can build in is 19 feet by 9 feet. This will be a tight space, if that is all you have, but you can build the entire airplane in this space. As stated earlier, the prototype was built in a space this small. A work table is required to build the fuselage on. Two 4 feet by 8 feet,  $\frac{3}{4}$ " thickness plywood sheets were placed end to end, to make a flat table 4 feet wide by 16 feet long. You can also use  $\frac{1}{2}$ " thick plywood.

This table will also be used to build the wings, elevator, and rudder. Make it strong, and be absolutely sure that it is level, and totally flat. Use shims where necessary. You will need to paint the surface of the table white, so that we can make layout lines that will be legible. One trick you can use to keep the table from moving is to cement the legs to the concrete floor with Bondo putty. These can be knocked free with a hammer when you are done.

We will draw the fuselage full size on the table using a Sharpie Magic Marker Pen (medium point), and a straight edge. **MAKE SURE** you check and recheck these lines, and insure that they are absolutely perfectly straight, and where they should be. Just take the measurements from the fuselage layout pages, and reproduce them on your flat table.

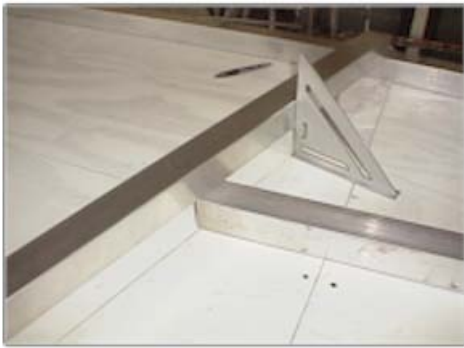
Once you are satisfied that the fuselage is accurately reproduced on the table, we can begin laying out the square tubing.

Now, we are going to lay out the first pieces of the 2" X 2" X 1/8th inch wall 6061 T-6 square aluminum tubes.

**Note On Cutting:** As most square tubing is shipped in twelve foot lengths, it is important to cut the tubing in a manner that allows you to get the most out of each piece, with the least waste. This is accomplished very simply by cutting the largest piece you can get from each length, and then following that with the next longest piece you can get from what is left.

Once you lay your first tube down, (many start with the seat rail tube) we turn our attention to marking the angles the tube ends need as shown in the plans.

**How                      To                      Mark                      Tubing                      Accurately**



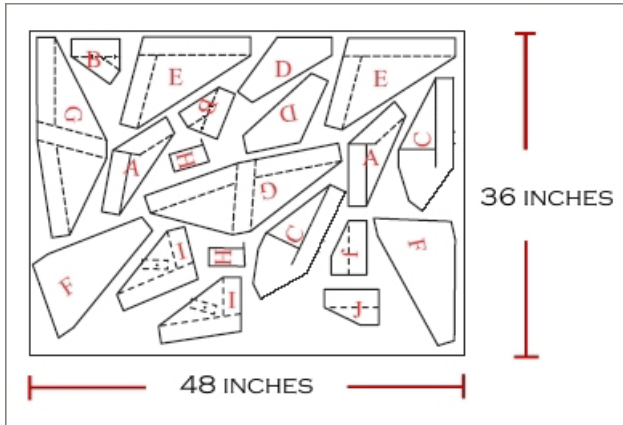
The tube on the bottom is the one being marked for cutting. Notice how by using a speed square and another scrap piece of tubing laid across, you can perfectly mark the tube below. This method is simple and very accurate. You want to mark all four sides of the tube.

### **Cutting Metal:**

Having the knowledge to do basic tasks such as cutting, drilling, bending metal and sanding are all that is needed to end up with a finished product that you can be proud of. As our airplane is mostly all aluminum, (with 4130 steel wing attach fittings we will discuss later) let's focus on aluminum to start. All of the aluminum used on the Affordaplane (and almost all other ultralights too) is made of 6061-T6 aluminum. This type of aluminum has all around good characteristics, is easy to cut and bend, and comes with an anodized coating to protect it. It is impervious to rust and corrosion, and this kind is used for all kinds of applications, from truck bodies to bridges, and other architectural structures. It is also available nearly everywhere. Compared to 4130 steel, aluminum cuts 'like butter'. Lucky for us! Thin aluminum sheet, up to about .016 inch thick, can be cut with regular scissors. But don't plan on using them for anything else after that, because they dull quickly. For thicker sheets, up to about .035 thick, you can use a paper cutter. This gives nice long, straight cuts. There are a lot of small parts that need to be made, and twenty years ago any airplane shop worth its salt had to have a band saw. If you are building a single airplane, then you really don't need one, but it does make things go faster. The A-Plane uses a lot of .125 inch (1/8 inch thick) aluminum plate. Cutting this material is made easy with a common jigsaw. You want to use a blade that is fine toothed so you make smooth cuts. There is only one thing you need to do to your jigsaw before cutting. You need to put tape on the shoe (the flat part that contacts the metal to keep it at 90 degrees to what you are cutting). This protects your metal from being scratched. Duct tape works well, and scotch type (wide strapping) tape works even better. Now its time to lay out the parts on the material you are cutting. Since most people build their fuselage first, lets use that as our example. First you will make paper templates from your plans, as our plans have full size templates, you can just make copies and use these. The heavier the paper, the easier it is to trace around it. The diagram below shows a typical layout for the fuselage gussets. ALL of the gussets for the fuselage can easily be cut from one single sheet of .125 inch

aluminum, 36 inches by 48 inches!

There are two goals when laying out your parts: 1) Using as much of the material as you can, without wasting a lot. 2) Leaving yourself enough space so that you can comfortably cut around the parts. Once you are satisfied with the placement of your parts, you attach them to the aluminum with double sided tape. Then, using a fine pointed Sharpie style marker, you draw the shapes onto your material. Now remove the paper templates.



Remember, the closer you cut to the lines you have made, the less sanding and filing you will have to do later, to finish the part. It is also important to have the material you are cutting securely clamped so that it doesn't move around. It's not good to let the jigsaw 'chatter' on the work, and you can minimize this by cutting as close as you can to where it is clamped.

What is the easiest way to cut square tube? With this: A chop saw with a metal cutoff blade. These saws have really come down in price in the past few years, and blades can be had for under \$5.00. Cutting only aluminum with them they last a long time. If you mount the saw on a long table, and provide support at the other end so that the tube being cut is at 90 degrees to the blade, your cuts will be perfect every time. Be sure to leave yourself a little room so that you can dress and finish the tube by sanding.

#### Finishing the Part:

To finish the part, we need to file and sand the excess material right down to the lines we drew. This step is very important, not just so the parts fit together correctly, but also because this step makes the difference between a very nice airplane, that everyone will complement you on, OR a train wreck where everyone will try and 'save you' from flying it! It does not take any extra time to do it right, to do it as perfectly as you can. In fact, you will make your job of finishing the aircraft much easier, and you will feel confident and safe when you fly it. Painting it will also be much easier.

Our goal is to finish the part by making it smooth, shiny, and with no nicks or scratches which can cause stress marks.

One easy way to remove most of the excess material quickly is to use a belt sander such as this Dremel belt sander, like the one shown here:



It is advisable to use one that has a wide belt, as the small one inch ones get eaten up pretty quickly. The parts being sanded can get pretty hot, so it is helpful to hold the part with vice grips or something similar.

Once you are comfortable with the dimensions of your part, now we can finish it. Using a hand file, and emery cloth, smooth all of the edges so that when you run your finger across it, you will not feel any nicks or dents, and the overall finish is smooth and even.

You also want to make sure that there are no burrs anywhere. It does not have to have a mirror finish, just smooth and nick free. The fittings need to be as perfect a fit as you can make them. You want a nice, tight joint.

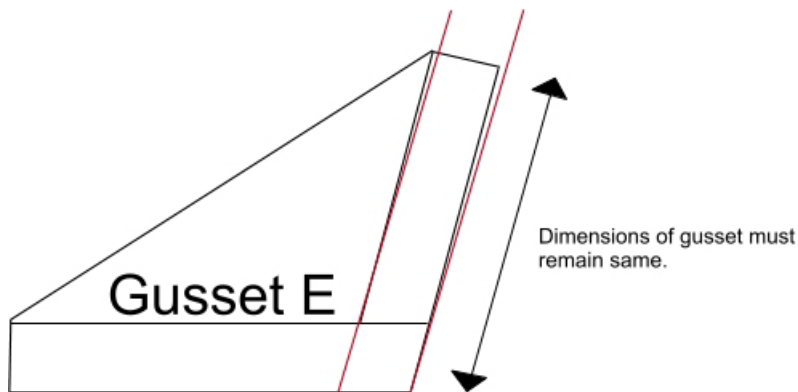
### **Wood or Phenolic Block Inserts**

Now add the 12" wood inserts that go into the motor mount, and the wing attach points. Use a skilsaw and block plane, until you get a nice, tight fit inside the tubes. Varnish or epoxy the wood to prevent moisture from getting inside before inserting the wood into the tubes. You may also use phenolic block, (similar to what cutting boards are made of) which is a much better option than wood, as it does not collect moisture and does not swell.

### **Gussets**

Once you get to the stage where the square tubing fits on your table, and you have checked and rechecked the measurements, you can start on your flat plate fittings. There are 20 flat plate fittings for the fuselage. These are all 1/8" thick and are made of 6061-T6 aluminum plate. These are all drawn full size on the plans. Make heavy paper templates of each of these gussets before you ever cut metal. Include the bolt hole locations also.

This next step is very important. The airframe that you have laying on the table may in fact have some slight variations than what the plans indicate. Therefore, some of the gussets may not fit perfectly on your particular airframe. So, in order to insure perfect accuracy and fit for each individual airframe, the following is suggested:



With the example above in mind, gusset E does not quite fit the square tubing, and your airframe is actually located where the red lines are drawn in the photo. You can adjust the

gusset to it. Simply make another template, but with the adjusted angles that match your airframe. Just keep the general dimensions as the original gusset. This way, your airframe will align perfectly, and the finished result will be a joy to paint and fly. Once you have all your paper fittings cut out, tape the paper to the 2' X 4' X .125 6061 T-6 flat plate stock. Arrange the fittings so you get the least waste from the sheet. Make sure that you allow enough room for cutting. Finish up the gussets as described in the section called metal cutting.

### **Bolt Hole Drilling**

Now we are going to transfer the bolt hole patterns from the paper fittings to the ones you made from aluminum. Tape the paper fittings to the corresponding metal gusset, and using a center punch, punch the bolt pattern onto the metal fittings through the paper onto your work piece. (a center punch is just a sharp steel pointed bit that puts a small dent in your material. This will insure your drill does not wander, and your holes will drill true). Remember, you only need to punch **one side of one set of fittings**. Now, one side of the gussets have little punch marks in them. Lets say it's the gussets for the left side of your airframe. Here you have two choices: You can drill the bolt hole locations right on the gussets first, then combine them with the square tube, or you can drill the entire assembly once it is clamped. For the first method: The goal is to have perfectly aligned holes in the gussets. You take the first gusset and match it to its corresponding partner, clamping them tightly together. Remember this when aligning holes: ALL holes for the fuselage gussets are centered on the 2" square tube it covers. If you drill through both gussets at the same time, then when you place them on the tubing, (clamped of course) you can use the holes in the gussets to drill the tubing, from either side. Its actually simpler to do than explain!

### **Match Hole Drilling**

Here is another variation of the process. Match hole drilling is a process whereby you drill all pieces at once. Your 'sandwich' will be two fittings, one on either side, and the square tube in the middle. We will clamp these together and use a table top drill press to drill the holes. You need a drill press that can cut through 2.5 inches of material. The one



I used was called a 'drill press stand' and attached to a hand held drill. Here is a picture of one:



At this stage you want to raise the entire assembly off of your work table, so you can clamp the pieces together, and so your drill does not go through the table. I used 2"X 2" scrap pieces of square tube. Make sure that the tubes are perfectly level. If you are using a drill press, make sure that the base of the press has enough room to get underneath the tubes easily.

Now we are going to assemble the fuselage. You will need a minimum of five C clamps for this. Wood ones are fine, as are the pipe kind with rubber clamps. Metal clamps are not a good idea unless you pad them with rubber or a soft wood. Now if you have a lot of clamps available, you can clamp the entire fuselage together to get an idea of what it will look like, and check fit. If you do not have a lot of clamps, you can do a small section at a time.

You need to make sure that the square tubing is directly above the lines you drew on the table. Use a speed square by laying the square on the line and making sure the tubing was directly above the line touching the square. A better method would be to add blocks to hold them in their respective places. Any method works as long as the tubes remain firmly in place while drilling. Here is what that looks like:



Clamp both fittings, (one underneath the piece, and one on top) to the square tubing. The fitting with the punch marks goes on top (unless you already drilled them, of course). Make absolutely sure that the fittings are exactly in line with each other, and the tube. To drill the holes, slide your drill press under the tubing, or clamp your drill stand to the

piece you are working on. Once your first hole is drilled, insert an AN-3-25 bolt with an AN-960 washer and AN365-1032 elastic stop nut. This will insure that the piece stays lined up. Continue in this fashion until all the fittings are bolted in place. Now we are ready to make the pieces for the diagonals attach. These are made from a scrap piece of square tubing, cut along the length to make C channel brackets. The dimensions are 2" wide by 1.5" by 1.5". You will make 4 of these. The diagonal attach brackets are attached to the longerons by using 4 3/16" X 1/4" long stainless steel pop rivets per piece. Once these are in place, you can start adding the diagonals. These are 1" O.D. by .035" wall 6061 T-6 round tubing. It is ok to slightly 'oval' the round tubes to make them fit inside the attach brackets.

You will need to drill a 3/16" hole through both F gusset fittings, as detailed in the plans. Using your ruler, measure the distance from this hole to the first bracket, on the bottom longeron, allowing 1/2" overlap on each end for edge margin of the tube.

Using a tubing cutter cut the tube to the desired length. Make sure you debur the tube on both ends. Now drill a 3/16" hole 3/4" from one end of the tube. As per the plans, you can use washers to center the tube between the fittings( heavy), or a better method is to cut half inch diameter tubing (any wall thickness) into two one half inch pieces and use those for spacers. Before you add these spacers we are going to cut the bottom of the tube to fit, so just slide a bolt through the pieces to hold it in place, then see how close a fit you have at the bottom. You want a *minimum* of 1/2" edge margin from the edge of the bolt hole to the end of the tube. You may need to trim away some material from the diagonal tube to make it fit. This is acceptable. What I did was to clamp the tube in place, 'eyeballing' the tubing, and making sure it was centered where I wanted the hole. Remember, another diagonal tube will be on the other side of the hole, so make sure when you drill that this tube is directly against the top of the fitting. You may need to gently compress the tubes to make them fit. Review the plans to see what I am talking about. Now go ahead and drill the hole through the tube. Place a bolt through the assembly to make sure it fits. Now go back to the hole at F Fitting. Remove the bolt, and then follow this procedure:

Slide the tube into place, and while putting the bolt in place, slide the first spacer on, then the diagonal, then the next spacer, and end with an elastic stop nut and washer. You should end up with one diagonal tube attached at both ends with bolts. Starting from the bottom of the tube you attached, repeat the above steps until you arrive at gusset fitting I. Here you will follow the same procedure as you did with fitting F. Remember, if you were looking straight down on the fuselage, and it was standing up, (like on the gear) the first

diagonal is centered between F gusset fitting, goes to the left space of the diagonal bracket, the following one fits in the right hole, and stays to the right when it meets the next bracket. The last tube starts out on the left side of the diagonal bracket, and ends up at I gusset fitting centered. It's actually very easy once you see it coming together.

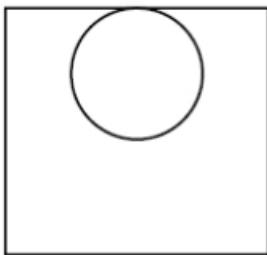
### **Landing Gear Cross Tube**

Now, on to the landing gear. Make two fittings out of .125 inch thick 6061-T6 angle, 2" X 3" X 2" wide. This is a critical area so make sure that your work is as exact as you can make it. Before clamping drill the two 3/16" holes through the angles, making sure that they match each other exactly. I clamped the angles together and drilled them together on

my drill press to ensure accuracy. Clamp these in place as per the plans on either side on the lower fuselage tube. Make absolutely sure they are square on then fuselage before drilling. Now, using the holes you drilled in the angles as a guide, drill through one side of the fuselage square tube at a time. This will insure the holes stay accurate. Here is a picture of the clamped angles:



Bolt the angles in place. Now we are going to add the cross tube seen in the picture above. This is called the landing gear support tube. It also doubles as the wing attach structure, so good workmanship really counts here. Actually this is probably the most complex part of the entire aircraft, and even so, it is very simple to construct. Start by drilling the holes that are shown in the plans. You can clamp the square tube to the angles, (make sure its centered) and drill the holes for the angles through the top of the square tube, then remove and finish drilling all the way through the tube with your drill press. A scrap piece of square tube may be clamped in between the angles to get the exact distance for where the lower fuselage tube lays between the angles. Cut a 26 1/2" long piece of round solid 6061-T6 aluminum rod. This will be the wing attach piece that rests inside the square landing gear tube. Make two marks on this tube with your marker pen, each 1 1/4" from each end. Make sure that you mark the square landing gear tube with 'top' on the top side first. Then take the square tube off of the fuselage, and slide the round solid stock inside it. Center the solid stock inside the square tube, making sure that the marks you made correspond with the ends of the square tube. What you want is to have the round solid stock resting on the underside of the top of the tube, like this:



Clamp the angles back into place on the tube, and very carefully drill through the holes you drilled previously, through the solid rod. There will be

4 holes drilled. Bolt the assembly in place before moving on to the next step. Now drill the two remaining holes that are located 1/2" from each edge of the square tube. Remove the round solid rod, and making sure that the wing attach holes are exactly at right angles to the previously drilled holes, (lay the rod on your drill press, with the bolt holes laying horizontally on the press) drill the 1/4" holes 1/2" from each end of the rod. Re-assemble the unit, this time using the spacer washers to insure the solid rod stays at the top of the square tube. Also insert the 1" stainless U brackets for the landing gear tubes.

## **Landing Gear**

On to the landing gear! The first thing you want to do is drill the 1/4" hole for the rear landing gear legs, on the fuselage. This is located 12" from where the seatback upright tube meets the lower fuselage tube. Add a stainless 1" U bracket on each side of the square tube. Before making the axle assembly, give some thought to what kind of wheels you are going to use. I used wheelbarrow wheels, which are much heavier than the ultralight "Azusa" brand wheels. If you are going to use anything other than wheelbarrow tires and hubs, make the appropriate changes to the widths of the axle tubes, and the sleeves. The plans show the axle arrangement needed for wheelbarrow tires and rims.

To make the axle assembly, start with the 1 1/8" 6061-T6 tube. Cut this tube to be 45 1/8" long. Mark the center of this tube for reference later. Now cut a 1" O.D. X .058 wall, 52 1/2" long. Slide this inside the 1 1/8" tube, centered. Now cut a 7/8" X .058 wall tube 52 1/2" long, and slide inside the 1" O.D. tube. Now make the landing gear plates out of .090 6061-T6 plate. You will need four of these. Go ahead and drill the plates for the axle holes only. Clamp the plates in position on the axle, and drill. You can back drill through each plate side also. Now make the forward landing gear tubes by cutting the 1" O.D. outside tubes to length as shown on the plans, and inserting the 7/8" sleeves. Drill the 1/4" holes on each end of the tubes. To drill the tubes for the gear plate holes, lay the whole assembly, cross tube, forward landing gear legs, and axle, flat onto the table. Make a mark that goes from the center of the cross tube, to the center of the axle. Use this for alignment reference. Bolt the top of the forward landing gear legs to the stainless U brackets. Clamp the lower part of the gear legs in place for drilling between the .090 gear plates. Remember, that there is a 1/8" difference between the axle width, and the gear legs. You will be adding washers to make up this difference, so add shims to keep everything straight for drilling through the plates. You will want to make sure that this assembly doesn't move, so you can add blocks or even nails to the table to keep everything in place. Drill the holes for the gear plates and tubes. Now is also a good time to add the cross wires for stiffness. It is much easier to do now than when the weight of the fuselage is on the gear, believe me! Also, you have a reference line that you wouldn't have if assembled once the fuselage is attached. Before tightening the bolts, add the 4 stainless steel cable tangs to each corner of the gear, as shown in the plans. Also add the two 1" stainless U brackets to the rear of the axle. Now make up 2 lengths of wire, making sure to leave enough extra so you can clamp the ends for swaging. Here's a trick I learned that makes this a lot easier. Slide a nicopress copper sleeve onto the cable you are going to swage, insert the thimble, slide through the cable tang, and loop it back through the nicopress sleeve. Make sure the loop is snug and tight as you can make it,

and then clamp both wires together right behind the nicopress sleeve using a pair of small vice grips. Swage the nicopress sleeve in place. Make **sure** you use your go / no gauge after swaging! These wires take the sway loads of the gear, and help stabilize the wing attach tube above. Now you have one end swaged in place, and the other end of the cable free. Make up the assembly for the other side, and snug up tight. It does not have to be super tight, just a snug fit. Follow the same process for the other wire, until you have one end of each wire swaged, and the other ends held snug with vice grips. Recheck your lines to make sure nothing has moved. Now swage the remaining ends. To add the gear to the fuselage, slide the forward part of the fuselage onto a sawhorse, and stabilize with boards temporarily tacked into place to hold upright. Bolt the gear to the fuselage with the 2 AN-4 bolts. Make up the rear tubes using the 1" X .058 6061-T6, and 7/8" X .058 round tubes. I laid these side by side on the table to make sure they were both the exact same length. You will have to assemble the unit in place to drill, as the brackets have to be turned slightly so they can accept the tubes. Drill the holes for the rear most attach brackets, and insert the bolts. Now recheck everything to be sure it is centered, and true. Now go ahead and drill the forward holes through the U brackets and assemble the unit. Here is what it looks like at this stage:



If you have chosen to use wheelbarrow tires, go ahead and make up the axle bearings out of 1 1/8" X .058 6061-T6 alum tubing. Slide your 1" I.D. washers on each side of the axle. Now slide the bearings in place. Use a liberal amount of white grease on the axle when you slide the bearings on. The wheelbarrow tires come with two rather badly built factory bearings. Knock these out with a punch, and then slide the wheels onto the axle. Secure with a 1" I.D. washer on each side, and drill and insert the steel cotter pins.

### **Tailwheel**

The tailwheel is made from a Capella Leaf spring, (or a 1/4" X 1 1/2" spring steel leaf) and a shopping cart wheel. The wheel is 5" in diameter. Depending on what kind of wheel you have, there will be a shaft that protrudes from the top of the wheel assembly. Drill the leaf spring to accept this shaft. Place the tailwheel on the leaf spring. Now, make a mark on the shaft, about 1/4" above the top of the spring, and drill a 1/4" hole in the shaft. Add washers to shim the wheel until it rests snugly against the spring, and secure with a bolt. Take the assembly apart and drill the holes for the tailwheel bellcrank. Bolt the bellcrank into place. Clamp the tailwheel spring assembly into place on the

fuselage, and mark bolt locations. Drill through the fuselage tube and the spring, and add the bolts and washers. Here is a picture of what the tailwheel looks like:



Here is a side view of the tailwheel:



This picture shows a piece scabbed on to test various configurations, lengths etc. Build yours as per plans. Congratulations! She's on the gear!

## **Cowling**

The cowling is an area where you can simply follow the plans, or design your own style. Keep in mind that the shape, length, etc of the cowling is dictated by your engine choice. The Affordaplane was designed to allow you great flexibility in the way your aircraft looks. If you are using the Rotax 447, you can simply follow the plans. If you are using another engine, it would be a good idea to draw out the outline of the cowling shape you want, and make the rest of the cockpit to follow that form. Lets get started!

The first thing you want to do is make the angles for the rudder pedals. These are made from 1 1/2" X 1 1/2" X 1/8" X 4" long 6061-T6 angles. These were clamped in place on the fuselage, one at a time, and back drilled through the existing gusset plate holes. Now clamp the 1 1/2" X 1 1/2" X 1/8" X 18" long angle to the rudder pedal angles. Make sure it is at 90 degrees to the fuselage using a speed square, then drill the two 3/16" holes and assemble with bolts. Measure and cut the cockpit floor runners using 3/4" X 3/4" X 1/8"

angles. Pop rivet these to the cross tube, and the forward angle.

### **Cockpit Floor:**

This is made of two pieces of .032" 6061-T6 sheet. The pieces go on either side of the lower fuselage tube. This sheet is placed between the cross tube, and the landing gear angles that attach the gear to the fuselage. It also lays on top of the forward rudder pedal angles, and rests inside the floor runners. See the plans for reference.



Pop rivet the cockpit floor in place, using 1/8" pop rivets. There is 1" spacing for rivets used on the floor runners. Add the angle that goes right behind the engine, and on the face of the vertical motor tube. Add the rest of the 3/4" X 3/4" angles to form the box structure, as per plans.



Now cut the instrument panel out of .032" sheet stock, and pop rivet to the horizontal angle that goes across the top of your knees while sitting in the cockpit. Now add the forward panel that is pop riveted to the front face of the vertical upright motor tube.

The cockpit is covered using .020 aluminum flashing, found at your local hardware store. Cut an oversize piece, and clamp to whatever side you start with. Just don't start with the top curved portion first. You want the top curved piece to go over the side pieces. Using your Sharpie marker, trace the outline of the cockpit side. Remove, cut and clamp back in place. Be sure to debur and clean up any rough edges, because they will show on the finished product. You will be using 1" spacing for your rivets. Start at one end, drill, then cleco each hole, until the assembly is completely drilled. Now remove the clecos one at a time, and pop rivet each hole.



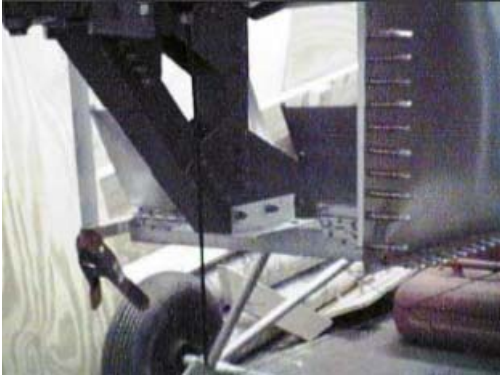
Using 1/2" tubing, make up the x brace as per plans, and pop rivet in place. Do not pop rivet the top of the cowling, as the top curved piece goes on top of this, and is pop riveted in place. If you rivet now, you will have to drill out all the rivets at this juncture. Once three sides are riveted, on each side of the cockpit, you can cut an oversize piece of flashing for the top, curved part. Lay the part in place, (drill a hole in each corner, and cleco in place) and trace the outline on the back side of the flashing. Remove, clean up and

debur, and place back on the aircraft. Now you can pop rivet in place. Now here is something I did that works really well to hold the shape of the curve. I rotated the fuselage upside down, and applied insulating foam from a spray can into the space behind the instrument panel. Make a cardboard baffle that will keep the foam away from the back of the instrument panel, to allow for instruments. Try to get an even thickness of foam, right around 2". Let this dry.



The rudder pedals are made from .125 6061-T6 plate. Attach these to the rudder angle using piano hinge, and 1/8" pop rivets.





Add the springs to the pedals. One end of the spring is wrapped around the end of the fuselage bolt, and the other end is secured to the small hole in the pedal. To make the rudder cables, make up two lengths of 3/32 aircraft cable, that extend beyond the fuselage tailpost about a foot. Nicopress each wire to the corresponding hole in the top of each pedal. leaving the ends free for now. Coil up and secure with electrical tape, and place inside the cockpit.

### **Nose Bowl**

We can't begin the nose bowl until you have chosen the motor you want. If you don't have your motor yet, skip this part until you do, and build something else until you get the motor. Make up the angles for the motor mount using 2" X 2" X 1/4" 6061-T6 angles. Also make the aluminum engine cross bars out of 2" X 2" X 3/8" 6061-T6 aluminum. Assemble the motor mount as per the plans, and attach the engine to the airframe. At this stage you want to make a template that shows a silhouette of the nose bowl profile, and get a good idea how long it is to be. You want to make absolutely sure that you build a bowl that reaches to the back side of the prop flange. Leave about a 1" space between the back of the flange, and the cowling exterior. The width is dictated by the cockpit already built. Remove the engine and set aside. Now we are going to build the nose bowl up out of 1" Dow Blue styrofoam. If you have the same kind of foam, only thicker, by all means use it. Attach the foam using T-88 epoxy, or whatever you have on hand. Just remember that some glues attack foam, epoxy doesn't, but it is hard to sand if you have a glue line you must sand through. What you want to do is fill the entire space for the bowl with foam. Make sure you leave enough all around so you can sand down to contour. Here is how this looks:





When shaping foam, make sure that you are wearing a respirator (dust mask), and have adequate ventilation. Foam dust gets everywhere! The shape of the nose bowl is entirely up to you. It is not structural, its only function being to keep the wind out of the cockpit. Just remember to keep the lines the same on each side, and match the rear cockpit shape. Once the rough shaping is finished, use finer and finer sandpaper, until the surface is as smooth as possible. Make sure that there are no dents, or knicks in the cowling, as this will show up later. Now coat the entire cowling with wax mold release, found at most nautical supply stores, and fiberglass stores. This will allow the lay ups of fiberglass to easily be pulled off the mold. To lay up the fiberglass, a medium weight boat cloth found at Wal Mart stores, or any hardware store was used. Also, “Bondo” brand polyester resin and hardener can be used. You want to lay up at least three layers of glass on the entire bowl. Also make sure that you extend the fiberglass onto the aluminum part of the cowling at least 1” so that you can attach it with pk screws later. Let cure for the time specified by the manufacturer of the resin. To separate the mold from the glass part, slide a butter knife between the foam and glass, and working your way around the part, apply pressure until it pops free. Clean up the surface of the cowling with sandpaper, until it is smooth and free of dents and knicks. Carefully measure the cutouts for the engine and prop, and draw them on the cowling. Carefully cut away larger and larger sections of the cowling, until your motor and prop flange clear the cowling, with enough room left for vibration, without the cowling touching any part of the engine. You can bolt the engine back into place, and test fit the cowling. Make any changes necessary, then attach the cowling to the airframe using PK screws.

### **Windscreen**

The windscreen is made from 1/8” acrylic plastic. Lay out the 1” square lines on a large piece of paper, and transfer the outline to the paper. Then transfer the paper cutout to the plastic. Cut with a jigsaw and clean up the edges with sandpaper. Make up the windscreen clips and pop rivet to the cockpit area shown on the plans. Bend the windscreen to follow the top cowling, and drill through the plastic using the clips as a guide.

Pop	rivet	in	place.
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### **Elevator**

The elevator is made on the same table we built the fuselage on, and is very easy to build. Paint the table white, covering the lines you drew for the fuselage. Lay out the elevator lines on the table. Use wood blocks to keep everything in place. Cut the 1” X .058 X 8’

6061-T6 aluminum tube and place on the table.



Make the inserts out of 7/8" O.D X .058 T6 tubing. Now, and this is very important, you have to make absolutely sure that the sleeves are in the right position inside the tubes. I applied wd-40 on the sleeve so it would slide easily, and using a metal tape ruler, slide the sleeve inside the tube, and stopped when I reached the spot called for on the plans. You cannot move this tube very much on the table, or you will end up moving the sleeve!



Make the 16 fittings called for on the plans out of .090 T6 sheet. The bends for the tubing are accomplished with an 8" radius tubing bender. Make small bends, checking each bend against the lines on the table, until it matches. Once all tubes are in place, and the inserts are in place, you can pop rivet the structure together. You can also add the stainless steel hinges at this time. Make the elevator bellcrank out of .090 6061-T6 aluminum plate.

Also fabricate the 1" X 1" X 1/8" angle that attaches the bellcrank to the elevator. Bolt this to the elevator for now.

## **Rudder**

The rudder is built exactly like the elevator. Lay out the rudder on your table, using 3" squares to match the grid pattern shown on the plans. This will be your outline. NOTE: Do NOT use the 1/2" tubing for the curved parts as shown in the plans. Use a 1" O.D. X .058 wall tube instead. Cut the fittings out of .090 aluminum sheet stock. The 1" X .058 aluminum tubes are bent with a 6" radius tubing bender, and secured with Pop rivets.

Fabricate the rudder bellcrank out of .090 6061- T6 plate. Bolt into place on the rudder.

### **Vertical Fin**

The vertical fin is built using the same methods as the rudder. Build flat on your work table.

### **Wings**

The wings are a very simple affair, made from aircraft grade 6061-T6 tubing. You will build these on two sawhorses with one modification. Nail two flat boards to the sawhorse, 13 feet long, 6" wide, to the top of the horse, to allow the spars to rest on. Make absolutely sure that the sawhorses are totally flat and level, in respect to each other.

Use Bondo putty to secure the horse legs to the floor.



A word about marking tubes. To find the centerline of a tube, use this method. Find a long, totally flat board, and secure the tube to it. Do not let the tube move. Spray a light coating of Zinc Chromate on each side of the tube. Lay a scrap piece of 2" X 2" square tube against the side of the tube, and lightly scrape the paint away where the square tube meets the round tube. It looks like this:



This is an easy method of finding the exact center of a tube. Now lay out the spar tubes on the table. Secure with wood blocks so they do not move around. The tubes need to be exactly 54" apart as measured from the leading edge to the trailing edge.

Cut and insert the spar sleeves as shown on the plans. Make all the C Channel brackets out of 1 1/4" X 1 1/4" X 1/8" wall C channel. Drill the holes in the brackets as per plans.

Drill the hole locations shown on the wing drawings. Carefully rotate the spar tubes until the lines are exactly vertical, and using a drill press, drill through the tubes. Be sure to debur the holes. Now bolt the C channel fittings to the spars. Also bolt the 1" stainless U brackets to the spars. The anti-drag diagonals and compression tubes are all made from 1" X .058 6061-T6 aluminum. Measure these and clamp to the C channel fittings and the stainless fittings. One way is to cut a little oversize, and making sure you have enough edge grain margin (1/2"), clamp the tube centered on the fitting. Then drill with a hand drill through the fitting holes, through the tube, in place.



Secure the tubes with the appropriate bolts.



Now we are going to focus on the wing tips. They are built exactly like the rudder. The photo to the right is one way you can do your wingtips. We recommend however, to just use a single piece of 1 inch by .058 wall 6061-T6 aluminum tubing. It is easier to do, and it looks better.

This completes the basic structure of the wings. You may choose to finish the other wing first, and then add the ribs, or you may choose to do the ribs now on the wing you just finished, it is up to you. Just remember that the plans show the right wing only, and you must reverse the wing layout for the left wing.

## Ribs

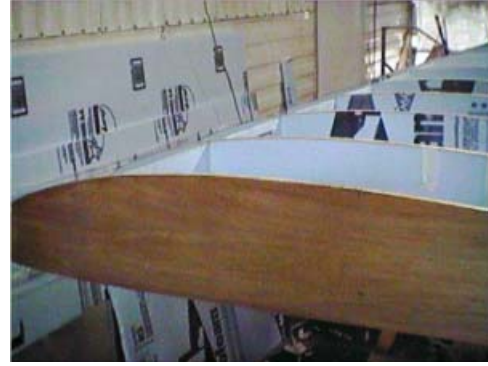
Now we move on to the ribs. You have a choice between aluminum tube ribs, or foam ribs. We strongly suggest the aluminum ribs, as they are easier to make, lighter, and last longer than the foam ribs. Both methods of constructing ribs are included in this manual.

## **Foam Ribs**

These are made from 1" Dow Blue Styrofoam. If you cannot find 1" foam locally, you may glue two 1/2" pieces together to get the dimensions needed. Use T-88 glue spread thin, but remember this method will add a little weight. Using the full size rib pattern given in the plans, make two templates made out of 1/8" thickness luan plywood (door skins). Door skins are available at your local lumber supply company. Test fit these patterns on the wings you built. Make sure they are a snug fit on the spars, but not so they warp or bend. We are going to stack cut the ribs out of 1" foam. We cut foam with a hot wire cutter. This is made from a length of nichrome or stainless steel wire, and a train transformer. You can also buy hand held 'foam cutters' at most model hobby shops. You can also buy a pre-made hot wire cutter from Aircraft Spruce and Specialty Company in California. You may also cut the ribs out on a bandsaw, by driving a nail through the luan ply door skin, into the foam, and cutting that way. There are 13 ribs in each wing. Simply place the ply ribs on each side of the blocks to be cut, again making sure they are exactly square, and true to each other. Draw lines on the foam blocks to make sure. Then simply hot wire the ribs from the templates. Once all the ribs are cut, mark the spar tubes to show where they go on the wing.

Now you want to lightly sand and scrape the surface of the spars where each rib is to meet the tubes. Don't go overboard on the sanding. You just want to remove enough material to make the aluminum stick to the epoxy we are going to apply. Now take the 8.7 oz. sq. yd. fiberglass tape, and apply epoxy over it to the spar, at each rib location. Overlap fiberglass tape by 1" on the end, forming a continuous band around the tube. There will be 26 such bands on the spars when you are finished. Clean up any epoxy runs, and re-mark rib locations on the fiberglass tape. Fit the foam ribs to the wing. If the ribs do not fit perfectly, use a rat tail file to remove material until it fits snugly on the spars. Just make sure that each rib matches all the rest, or your wing will not be true in flight. Also make sure there are no protrusions, or parts that do not line up, on the wing. Attach the ribs at this time using T-88 epoxy, and fiberglass tape. The foam spacer and support blocks can be added now. You can hold these in place with long T pins while drying. Use T-88 Epoxy to glue. The capstrips are made of 1" wide strips of 1/16" aircraft grade plywood. Be sure and plan ahead, not allowing the capstrips to meet (butt joint) near the front or rear spars. Apply them to the ribs, using tape to hold in place while drying. Wrap the capstrip all the way around the foam rib, and the two spars. Never allow a joint to be located on a spar! Where two capstrips meet, lay a layer of fiberglass tape 3" wide and 6" long over the wood joint, and glue to the side of the rib with T-88 epoxy.

Cover every part of foam and wood that is exposed with polyurethane varnish. Give it a light coat, so the Poly Tak glue used in covering the wings does not attack the foam. Making sure you have cut all the ribs for both wings, you can now use one of the luan ply rib templates for the end cap sandwich. Glue the ply to the innermost rib (at the wing attach location) using a light spread of T-88 glue. Here is what the finished wing looks like:




The photo on the right shows the end cap rib.

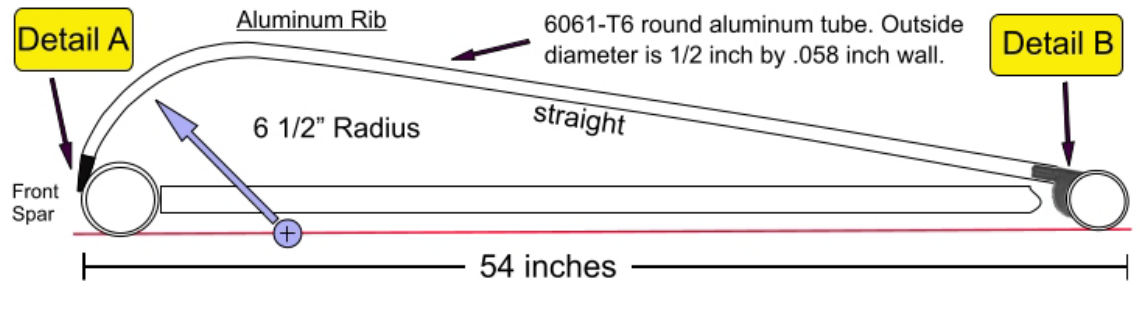
## Aluminum Ribs

**Ultra-Facts:**

The first airplane to use aluminum tubing for ribs was this one, the Gallaudet A2 Bullet. Built in 1912, the tube ribs were flattened at the ends so rivets could attach them to the caps and spars. That makes this type of rib over 90 years old!



Take a look at the rib to the left. It comes from a modern production ultralight. It is used on the majority of tube and fabric ultralights. They will work great on your A-Plane too. Plus: You can make all of them and install them on your wings in just a few hours. Ready? Let's get started.



The diagram above depicts the parts and shape used in the aluminum tube rib. Our metals supplier is Aircraft Spruce and Specialty, and we use this catalog to show you exactly what parts we are using. You may download the current catalog free from the Aircraft Spruce And Specialty web site.

How To...? 125%

### ROUND ALUMINUM TUBING 6061T6

O.D. (In.)	I.D. (In.)	Wall Thickness	Wt./Ft. (Lb.)	Part No.	Price Per Ft.
1/4	.180	.035	.0281	03-35300	\$0.96
	.201	.049	.036	03-00014	\$1.46
3/16	.180	.035	----	03-00012	\$2.65
5/16	.215	.049	.0423	03-35350	\$1.93
	.197	.058	.0561	03-35400	\$1.42
3/8	.305	.035	.0449	03-35500	\$1.66
	.259	.058	.0694	03-35600	\$1.50
	.245	.065	.0755	03-35700	\$1.46
7/16	.209	.083	.0895	03-35750	\$2.25
	.308	.065	.090	03-35775	\$1.89
1/2	.444	.028	.0496	03-35795	\$1.30
	.430	.035	.0612	03-35800	\$0.99
	.402	.049	.0816	03-35850	\$1.57
	.384	.058	.0962	03-35900	\$1.78
5/8	.376	.083	.1040	03-35950	\$1.99
	.260	.120	.168	03-35975	\$4.05
	.555	.035	.0775	03-36000	\$2.45
	.527	.049	.1060	03-36010	\$3.50
	.509	.058	.1227	03-36050	\$2.55
3/4	.495	.065	.1367	03-36100	\$3.00
	.680	.035	.093	03-36150	\$1.95
	.652	.049	.1288	03-36200	\$1.25
7/8	.643	.058	.1506	03-36300	\$2.15
	.620	.065	.164	03-36350	\$2.25
	.805	.035	.109	03-36375	\$1.76
1	.777	.049	.150	03-36380	\$1.93
	.759	.058	.1777	03-36400	\$2.70

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Also, you will need one poly tip rib end fitting, (detail A) and one rear spar contour fitting. Here are the corresponding parts in the catalog:





To complete the list of materials for the ribs, we will need two 1/8 inch diameter by 1/2 inch long stainless steel rivets per rib. These are used to attach the rib to the spars. The rivets are located on page 101 as shown below.

"POP" RIVETS – RIVNUTS											
For conversion of the most frequently used "Pop" rivets to the corresponding CHERRY numbers, see the following table:											
CHERRY Commercial Rivet Price Table											
Cherry Rivet Type	Cherry Rivet No.	USM "POP" Rivet Equiv.*	Rivet Dia.	Drill Size	Cherry Max Rivet Grip Length	Price**					
						Price Ea. 1-99	Price per 100 10% Discount	Price for 600 12% Discount	Price for 1000 15% Discount	Price for 3000 18% Discount	Price for 10,000 20% Discount
"N"	BSP-41	AD41BS	1/8"	30	.062	\$0.04	\$3.60	\$21.12	\$34.00	\$98.40	\$320.00
	BSPS-42				.125	\$0.04	\$3.60	\$21.12	\$34.00	\$98.40	\$320.00
	BSPS-43				.185	\$0.03	\$2.70	\$15.84	\$25.50	\$73.80	\$240.00
	BSPS-44				.250	\$0.03	\$2.70	\$15.84	\$25.50	\$73.80	\$240.00
	BSP-46				.375	\$0.06	\$5.40	\$31.68	\$51.00	\$147.60	\$480.00
"N"	BSP-48				.500	\$0.05	\$4.50	\$26.40	\$42.50	\$123.00	\$400.00
	BSC-43	AK43BS	1/8"	30	.187	\$0.04	\$3.60	\$21.12	\$34.00	\$98.40	\$320.00
	44	44BS			.250	\$0.03	\$2.70	\$15.84	\$25.50	\$73.80	\$240.00

## Bending Tubing

The ability to bend aluminum tubing into whatever shape you want will be a skill you will use often. If you are into light airplanes, this can also save you money. The good news is that once you know the basics, it's really easy to do. A tube by nature resists bending. The whole key to bending it is to have a form for it to go around which supports the tube fully, while you are applying force. This prevents a kink in the tube. There are two ways to accomplish this: You can make your own tubing bender out of wood, or you can buy a tubing bender at any home supply store. They cost around twenty dollars and luckily for us 1/2 inch and 1 inch (the size bender we need) are the same common sizes used in plumbing.

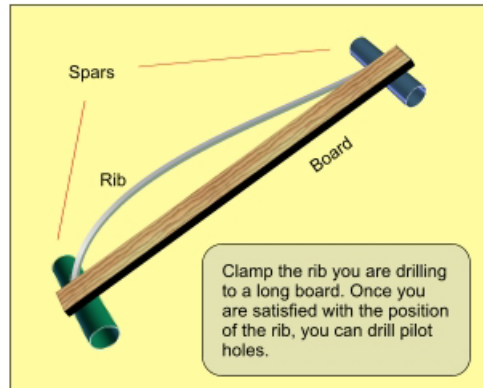
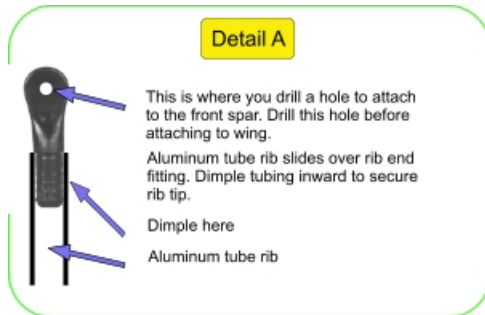
While you are at the home supply store, it's a good idea to consider getting some 1/2" electrical conduit pipe to practice bending with. Then you can bend your aircraft aluminum with confidence and save \$\$.



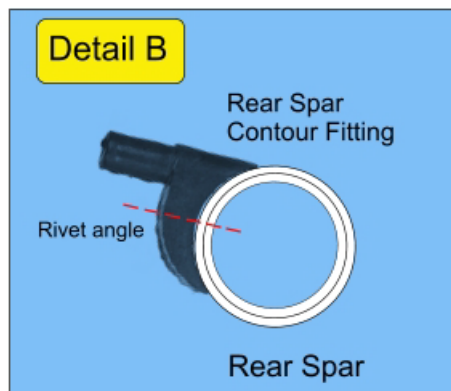
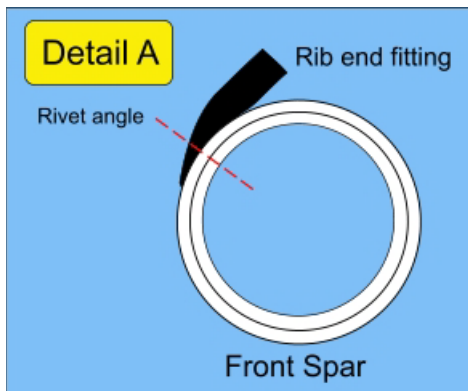
## Easy Wing Rib Jig

This jig doubles as a tubing bender, and rib assembly jig. The diagram above is to give you ideas, and not necessarily the only way to do it. Find a board that is at least 60 inches long, 8 inches wide, and at least half an inch of thickness. You want one that is perfectly flat. The first thing you want to draw on the board is the two round white circles you see, which represent the spars on the wing. These are labelled S. These are exactly 54 inches apart, as measured from the leading edge of the front spar, to the trailing edge of the rear

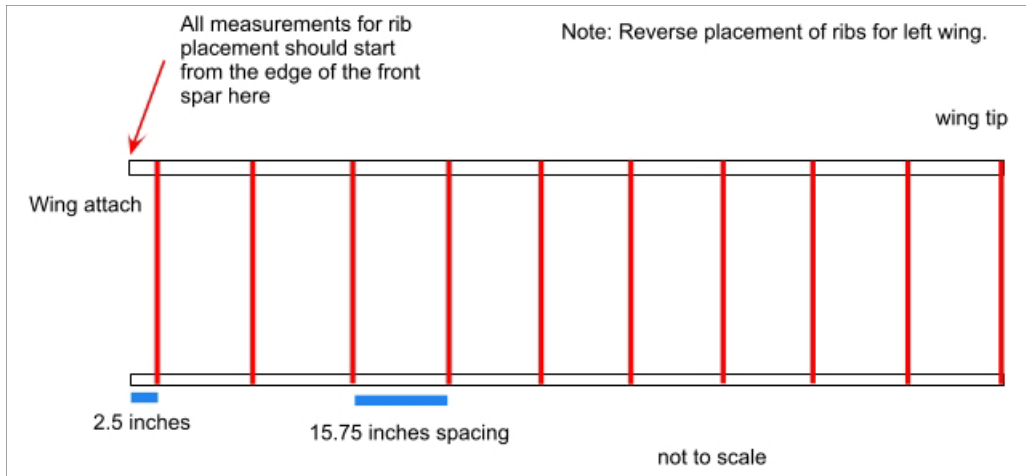
spar. The white lines are our rib, and we want to lay all of our formed ribs on this template to insure that they are the same. The piece labelled C is only used if you are bending the rib on the board. It must be at least half an inch thick. Next we will attach the plastic fittings and then to the wings.



Now we attach our poly tip rib end fitting, and the rear spar fitting. On your rib jig, assemble the rib with these three parts. Make sure you have deburred the tubing before using it. You secure the plastic fittings to the aluminum tube using a center punch. This slightly dimples the tubing inward in one spot, to pinch and hold the plastic fitting. Please remember, we are only trying to keep the fittings from falling off the rib, as once they are put on the wings, the fabric will keep them in position.



To determine where to place the aluminum ribs on each wing: First, the wing you are working with should be supported evenly on two sawhorses. All of our measurements are taken from the wing attach part of the front spar.



There are ten ribs per wing, for a total of twenty. At each location, place a mark on the tube where the rib will go. Mark both the front and the rear spar. Make all of your marks first, before attaching any ribs. The very first rib is placed 2.5 inches away from the edge of the tube, towards the wing attach part. The rest are all spaced about 15.75 inches on center from each other. If there are any protrusions from the spar, such as a strut attach, etc, simply joggle the rib slightly left or right. The idea is to space each rib evenly with each other in the space allowed. Once you are satisfied with the look, go ahead and attach.

This completes the tutorial on aluminum ribs.

## Ailerons

The ailerons are very simple to assemble. The plans show the right aileron. You will make one right and one left aileron. Start by marking the centerline of the 1 1/8" O.D. tube, as described in the wing assembly. Insert the aileron sleeve and secure with two 3/16" pop rivets. You will drill a series of 1/2" holes through the tube. You can use a wood block clamped to the tube to keep the holes vertical when drilling. Make absolutely sure that they all line up! Drill the half inch holes. Take a 12 foot length of 1/2" X .058 wall tubing and bend a 6" radius in one end. Insert the end with the bend into the main tube. You will have some material sticking out of the large tube. That's ok, we will sand this off later. Secure this by drilling a 1/8" hole through the assembly, and pop riveting in place. Make sure that the leading edge of the large tube, and the trailing edge of the small tube are exactly six inches apart. Now add the aileron ribs. Secure the aileron ribs to the main aileron tube by drilling and inserting a 1/8" pop rivet. Make the rib clips out of .032 T6 aluminum sheet. Secure the ribs to the trailing edge material with the clips bent around the trailing edge, and secured with one pop rivet on top, one underneath, and one on the trailing edge of the aileron. Here is a picture of what the finished aileron looks like:



Make the aileron bellcranks out of 1 1/4" X 1 1/4" X 1/8" wall C channel. Make one for each aileron.

### **Elevator Attach**

The elevator is attached to the airframe with two 3" X 2" X 1" X 1/4" 6061-T6 aluminum angles. Level the fuselage by placing a 4 foot level on the wing attach tube above the pilots head. Block the tail until this tube is dead level. Now place a 3/8" shim between the fuselage tube, and the rear horizontal stabilizer. Clamp this in place. Lay your level on top of the horizontal stabilizer, pointing towards the cockpit. Add scraps of wood, (shims) to the front of the stabilizer until it is perfectly level. The elevator is at 0 degrees incidence to the fuselage reference line. Clamp the 3" elevator brackets to the fuselage, making sure they are directly beneath the most forward tube on the elevator. The only thing to watch for is that you must have at least 1/2" edge grain margin on the fuselage tube, and the angle. Drill through the angles and attach them to the fuselage. Now, (very carefully) drill from the top of the stabilizer, to the attach fittings. Drill a 3/16" hole on each side. Attach the elevator to the fuselage using the bolts and the 1" washers.

### **Rudder and fin Attach**

Attaching the rudder and fin to the fuselage is simple. Drill two holes for the 1" stainless U brackets for the vertical fin. Bolt the brackets in place. Now drill the aft tube with a 1/4" hole. Bolt the rear part of the fin to the fuselage using the rear U bracket. Clamp the front part of the vertical fin to the forward stainless U bracket, and drill through the bracket and the tube in place.

If you have not attached the rudder hinges yet, go ahead and do this now. Simply mark the locations shown on the plans, and do one side of the hinges, and then match up and drill the other side. You can tape the hinges in place temporarily, and drill them. Then use 3/16" pop rivets to secure.

### **Stick / Torque Tube Assembly**

To begin, drill a 1/4" hole on the cross tube, to accept the 1" U channel stainless bracket. Secure this bracket with a AN-4 bolt, and a castle nut and cotter pin. Make the control stick out of 1" O.D. 6061-T6 aluminum tubing, 19 1/2" long. Insert the 7/8" sleeve. Now drill the three 1/4" holes through the stick, making sure the bottom hole is at 90 degrees from the top two. Make two fittings from 2" X 2" X 1/4" 6061-T6 angle. Drill a 1" hole Through each angle, as shown on the plans.

Here is a shot of the stick and torque tube assembly:



Now drill the holes in the angles (2 each) for attachment to the fuselage. Clamp these in their respective places on the lower fuselage tube, and drill through the existing holes in the angles as a guide. Bolt these in place. The torque tube is made of 1" O.D. X .058 wall 6061-T6 aluminum tubing. The sleeve is made of 7/8" O.D. tubing. Secure with two 3/16" pop rivets. Make the torque tube bellcrank out of 1 1/4" X 1 1/4" X 1 1/4" X 1/8" wall C channel. Drill this piece with the torque tube in place. Bolt together.

Make a bracket out of 1/4" X 1 1/4" X 1 1/4" X 1/8" wall C channel, 2 1/2" long. This piece holds the down tube that connect the stick. Drill this on your table, with the torque tube bellcrank assembled. Make sure that you drill the hole 90 degrees to the bellcrank, and in the proper position. Now make the down tube, which is 4 1/2" long. There is a sleeve in this one also. Take the C channel down tube connector off of the torque tube.

Make the torque tube end play bearings out of PVC pipe, 1" I.D. These are 1" wide. Slide the torque tube through both angles, inserting the PVC bearings as you go. Position the torque tube so that there is 1/2" clearance between it and the cross tube. Making sure that the PVC bearing is on the forward side of the forward angle, drill a 3/16" hole through the pvc and one side of the torque tube. Now do the same for the rear PVC bearing, making

sure that it rest behind the rear face of the rear most angle. You want a tight fit, with no play forward to back, but not to where it will bind. Bolt the down tube assembly into place. The rod end connector connects the torque tube to the control stick. Cut a piece of threaded rod, fine thread, 1/4" diameter, 9" long. Assemble the rod ends, and stop nuts. Be sure to slide the 1/2" tubing over the threaded rod before securing the rod ends. Adjust the rod ends on the threaded rod until the torque tube down tube is vertical, and the control stick is vertical. Then tighten the stop nuts against the rod ends. The aileron bellcrank assembly is fabricated next. Make a fitting out of 2" X 2" X 1/4" X 6" long 6061-T6 angle. Clamp the angle in place on the fuselage and drill the two holes shown on the plans. Drill the holes for the pulley assemblies. Now add the pulley assemblies and

bolt the unit to the fuselage. The rear aileron bellcrank assembly is started by cutting a scrap piece of 2" X 2" square tubing to the shape shown on the plans. Drill and bolt this in place on the fuselage.

The aileron bellcrank is made from .090 6061-T6 plate. Make a hole in the center of this piece to accept the machined bellcrank. Pop rivet this in place. Now bolt the bellcrank to the square tube. The aileron control rods can be fabricated now. Bolt these in place on the bellcrank.

### **Wing Attach**

Clamp the wing attach U brackets into place on the top fuselage tube, as per the plans. Make sure that when you drill, the main spar attach point is 1/2" above the centerline of the square tube, and the rear attach is 1/2" below the centerline. This is critical. To make sure that the holes were exactly even with each other, I drilled through each fitting, one side at a time, until the holes met in the middle.

### **Wing Struts**

The wing struts are made from 1 1/8" X .058 wall 6061-T6 aluminum tube. The plugs are made from 1" T6 round solid rod. Make up the struts as per the lengths on the plans. Insert the plugs, but only drill the lower strut attach fittings. Clamp the fittings to the tube, with plug in place, and drill the assembly through the attach fittings, and the tube. Attach the wings to the airframe. Make sure if you use spacers inside the wing attach bracket, that they are the same on both sides. Level the aircraft. Block the axle so the wheels are off the ground. The top wing attach tube should be zero degrees to the horizon. Bolt the struts to the lower strut attach tube only, on either side. String a line that is 0 degrees (level) starting from the wing root, out past the tips. The line should be directly on the wing attach bolt. Now, at the strut attach (101" outboard from the wing root) you want to raise the wing until the upper strut attach bolt is 5.2" above the line. This sets your incidence to 3 degrees. Now use wood boards or a ladder to hold the wing exactly at that level. Now run a line from the rear wing attach bolt and repeat the same procedure as above. Clamp the strut to the rear fitting on the main spar only, center the tube on the fitting, and making sure you have enough edge grain margin as shown on the plans, drill through the fitting and the strut and plug. Now you can center the front strut fitting on the strut, and back drill through the rear fitting and tube, through the front fitting. Remove the front fitting and clean up the extra length, and then bolt the assembly back into place. Do the same procedure for the rear struts, and the other wing.

### **Jury struts**

These are made from 1/2" X .058 wall 6061-T6 aluminum tubing. They are attached to the lift strut with an Adel clamp. The upper strut is attached with a 'duck bill' plastic rib attach piece and a 1/8" pop rivet. You also want to run a length of 1/2" tubing between the lift struts to where each jury strut attaches. Secure with an Adel clamp.

### **Control Hook Up**

NOTE: You will want to have the aircraft covered with fabric before you attach any cables. Let's start with the rudder pedals. The first thing you want to do is pop rivet two RG1 cable guides on either side of the lower fuselage tube so the cables clear the struts,

and other obstructions. Run the cables through the guides, slide two copper sleeves onto the cables, behind the guides, (one on each side) and hook up to the rudder bellcrank. Don't swage these cables yet, just hold in place with cable clamps. Make sure you have a nice, snug fit, with no slop. Also make sure that the rudder is centered, and held in place. Now add the springs to the tailwheel bellcrank, and swage two cables to the springs, one on each side. We are going to make a Y attachment from the rudder cables to the tailwheel. Take the ends of the cables from the tail wheel bellcrank, and slide through the nicopress sleeves on the rudder wires. Slide the sleeves toward the front of the aircraft until you have a good angle to the tailwheel. Clamp in place but do not swage yet. Now, making sure that the rudder springs are in place on the pedals, go ahead and swage the rudder to the rudder pedals. You want to make sure they are not very tight, but a good, snug fit, with no slop. Now you can swage the tailwheel cables to the rudder cables. On to the aileron cables. Run a length of cable from the aileron torque tube bellcrank, through the pulley, and to the aileron bellcrank. Making sure the stick is centered, and the aileron bellcrank is centered, swage the cables to the aileron torque tube bellcrank. Run them through the pulleys, and swage to the aileron bellcrank shackles. Now we are going to add the wires to the tail. These wires stiffen the elevator and rudder assembly. They are attached to the frame using 3/16" stainless cable tangs. Here's a tip to getting a nice tight fit. Place washers underneath the tangs to be swaged, and once you are done swaging the

cables, remove the washers to get the desired tightness. The interstrut bracing is made the same way. The wires describe a big X between the struts. These are made with 3/32 aircraft cable, and attach to the upper strut bolt on the lower strut attach points, and on the lower most bolt on the upper strut attach. The wires that run from the nose of the aircraft to the wing struts, and then from the wing struts to the elevator attach can be made now. These wires keep the tail from swaying, and generally tightens up the entire structure.

### **Elevator Attach Tube**

Clamp the elevator and the stick in a neutral position. The elevator tube is made from 7/8" X .065 wall 6061-T6 aluminum tube. Clamp the elevator tube to the U channel bracket on the stick. Drill through the fitting, (two locations) and bolt together. Now clamp the elevator tube to the elevator bellcrank, and drill through the tube using the bellcrank hole as a guide. Cut the tube 1/2" behind the hole you drilled. Bolt together as per plans. The elevator tube support bellcrank is made from .090 6061-T6 aluminum plate. Make the assembly as per plans and bolt to the aircraft.

### **Fuel Tank**

The gas tank is held in place by two long bungee cords wrapped in an X shape. Pop rivet the gas tank support to the vertical attach tube as per plans. The gas tank is a 5 gallon plastic kind found at any Wal Mart or hardware supply store. The fuel line is a 1/4" I.D. fuel line, and is inserted through a hole drilled into the top of the fuel tank. Route the line to the engine, and secure to the fuselage using plastic zip cords. You will want to insure the line does not get crushed from the zip cords by using a piece of pvc pipe 1" long at each connection point. Also make sure you have a fuel bulb attached to the line where you can reach it from the seat, so you can prime the engine.

## **Seat**

Before attaching the seat, make sure it is in the right place for your size. You can move the seat a few inches forward and aft if needed. The seat is attached using 4 pieces of 1 1/2" X 1 1/2" X 3" long 6061-T6 angle. Drill the holes for the angles, and clamp the angles to the lower fuselage tube as per plans. Make sure the seat angles are inclined on the fuselage tube slightly for comfort. Put the seat in place, and drill through the seat using the holes you drilled in the angles as a guide. Bolt together.

## **Covering**

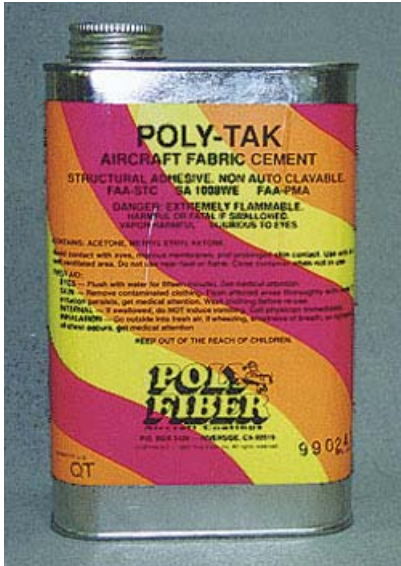
Now it is time to cover your creation and paint it. We will cover the Affordaplane with "Dacron Fabric For Homebuilt Aircraft". This is 1.8 ounce fabric, and you can get it from Aircraft Spruce. The key to any good covering job is knowledge and preparation. Read everything available to you about covering, not just this manual. Talk to your local EAA chapter. Ask people at the field who have covered their own aircraft. Weigh the pros and cons, and decide what finish you want, and how much you want to spend.

Covering your aircraft is usually the last big job you do to your airplane before you go fly. Remember that your covering job is going to be the first thing people see on your aircraft, and even if every part is perfect inside, they are going to judge your workmanship by your covering job! So take the extra time to insure that you do the best you can.

## **Materials Needed**

Dacron Fabric  
Poly-Tak Adhesive  
Acetone  
1" to 2" Throw away paint brushes  
Razor knife, razor blades  
clamps  
mixing cans (coffee cans)  
Sharp scissors  
Mixing sticks  
iron  
Fabric thermometer





## About Poly Tak

A high-strength, fast-drying, one-part cement manufactured from a proprietary formula especially to attach polyester fabric to airframes. It is FAA approved with the Poly-Fiber STC for use in making a 2" overlap cement seam on the wing leading edge and a 1" overlap cement seam on the balance of the aircraft, regardless of the wing loading or maximum speed ( $V_{ne}$ ). No other aircraft fabric cement has this approval. Poly-Tak is also an excellent cement for cotton, linen, and glass fiber, and will adhere to most surfaces for shear load bonding. Add methyl Ethyl Ketone (MEK) when necessary to reduce viscosity due to solvent evaporation from an open container. Refer to the Poly-Fiber Manual for details on approved methods for cement seams. SHELF LIFE: Guaranteed 2 years unopened in protected storage under 100 degrees F. Not affected by freezing. Do not use if appears dark or whiskey colored. Poly-Tak should be clear. Discolored cement has been heat damaged. Test adhesion of fabric to bare aluminum if storage temperature exceeds 100 degrees F for several months or guaranteed shelf life has expired.

## Preparation

Be aware that the chemicals used in covering are extremely flammable, and you should take precaution to make sure the area you work in is well ventilated. Also try to keep the chemicals such as acetone from getting on your hands too much. This can be dangerous to your health.

A quick word about using acetone instead of MEK. Mek is the solvent that has been used on the Affordaplane Ultralight, and many people have used this in the past for thinning the Poly Tak. Nowadays many people use acetone, so we switched to acetone after finding that it works just as well, is more inexpensive, and more readily available.

Also try to keep the dust down if you have an open place you are covering in. This isn't as critical now as it will be once you start painting.

## Ready, Set, Cover!

Let's get started! First, prepare the surface for covering by removing any dirt, oil, and grime that may be on your airframe. Take a rag soaked in acetone and wipe down the entire surface. Here is a picture of what a typical ultralight airframe looks like before covering:



The following shots will show a wing being covered, but the process is exactly the same for elevator and rudder. After preparing the surface, we need to apply a layer of Poly-Tak to the bare airframe. What I did was to make a 50/50 mix of Poly-Tak and acetone in a coffee can, and apply that with a brush to the frame. What this does is it gives the area underneath the fabric more 'wetter area' to work. I have seen people skip this step, but it seems easier to me to achieve a good coat underneath the fabric. You can activate it by applying fresh Poly-Tak to the surface and the dry layer underneath activates and wicks up through the fabric.

Now we are ready to apply fabric. You want to cut a piece that is about 2" oversize on all dimensions you want to cover. Make sure you only use a pencil for marking, as other pens and markers will contaminate the fabric. Here is what it will look like:



You want to make sure that the fabric is laying evenly around the entire surface. No big wrinkles, warps, etc. Use clamps that wont damage the fabric to hold it in it's general position. Clothes pins work great on tubes under 1/2". The fabric should wrap at least halfway (180 degrees) around the tube.

You want to start attaching the fabric near the middle of one side, and work your way to the edge, making sure the fabric doesn't creep. On the wing in this picture, myself and a helper got on opposite sides and worked towards the wing tip. Where there are hinges, or protrusions such as an elevator bellcrank, you simply slit the fabric, and tack it down around the object. The goal is to get the fabric attached securely all around the frame you are covering. Apply the Poly-Tak from the outside and let it soak through the fabric. Small wrinkles are no problem, however, try to insure that you get the fabric to lay down without wrinkles on the tubes. If you shrink the fabric, and then find a big wrinkle that is laying over a tube, for instance, it is possible that when you try to take the wrinkle out with acetone, it will pop off the frame, and that can mess up a few hours of your time!

I liked to thin the Poly-Tak with a little acetone, so that it flows better into the fabric, and gets a good bond. It also allows the Poly-Tak that you applied underneath the fabric to activate, and seals the fabric better.



When attaching corners, take your time, and make sure there are no wrinkles on the tube. I like to use clothes pins to hold it in place while drying.



Here are some shots of what your frame should look like after you have it covered.



**Shrinking The Fabric**

This part of the process is fun and rewarding. It is almost magical to see a wrinkled, loose covering turn into a taught, smooth surface, just with the application of a little heat. You will shrink the fabric in three steps. Using a household iron, (1100 watts) you want to first shrink the fabric on a low setting (around 250 degrees average). Please refer to the instructions given with your fabric for the correct temperatures. You will want to calibrate your iron. I used a little thermometer from "Black Baron" (model aircraft supply and Aircraft Spruce). Lay the iron upside down and make marks around the temperature control with a marker. Now your iron is calibrated. Here is a shot of the shrinking process:



Keep your iron moving, and just work out any wrinkles that may appear. This shot shows how the fabric tightens up.



You will want to shrink the fabric on one side first, on the low setting, and then cover the other side. Shrink the other side on the low setting, and then finish shrinking both sides in this fashion. This will insure that the frame doesn't warp or twist.

NOTE: I used reinforcing tapes sparingly on my airplane, and I did not use Poly-Brush. Always follow your designer's recommendations first!  
Here is a picture of the finished product:



Congratulations! Now your airplane is covered. Let's move on to the painting section then, shall we?

## **Painting**

Here is the method I used to cover the aircraft. It is written and tested by Mr. Jerry Bunner, with his permission.

May 15, 1999

### **Experimental Paint For Your Homebuilt**

This describes a painting method, which is highly experimental in nature, and if you choose to use this please be advised you do so at your own risk. The ONLY way to paint and finish any airplane is with certified and proven methods.

I have experimented for 10 years using different painting methods to finish fabric on light experimentals. The alternate finishing methods can and will hold up well given proper application and protection from the elements. My first attempt at painting was using Mike Fisher's latex method. It was my conclusion that this would not provide the level of finish that I wanted to see on my airplane. In 1994 I built and finished a Nieuport 11, (Graham Lee Design) and covered it in 1.6oz Stitts. I used a combination of black latex primer to fill the weave of the fabric and industrial polyurethane oil base paint for the finish. This experience started my search for a better method. My goal was a serviceable finish that would look good and avoid the need to spend the large amount of money for the certified stuff! Here is what I have come up with and I might say it works well, looks good with a nice gloss and is very easy on the pocket book. This finish goes on easy, and the need for elaborate spray painting facilities is eliminated.

### **STEP 1**

Seal aircraft with wood sealer if it is a wooden airplane. There is no need to finish an aluminum tube structure if it is not flown near salt water. For the Special I am building I am using 2 brush coats of MINWAX OUTDOOR CLEAR SHIELD POLYURETHANE WOOD SEALER. This material is applied unthinned but brushed on in thin coats. I use satin finish so that I may see better where I have brushed.

## STEP 2

If you are using the STITTS FABRIC (1.7oz) you can brush a thinned coat of POLY TAC cement over the fabric gluing points. Use your Stitts manual for further information on this. The cement can be thinned with MEK SOLVENT and I used about 50/50 cement/thinner. Let this dry and then the fabric can be applied and the cement underneath the fabric can be reactivated by brushing 50/50 cement through the fabric at these areas. After the fabric has been applied and shrunk then the tapes that you're using for reinforcement and or rib stitching/attachment can be applied using this same glue combination. A little iron run along the rough spots will smooth them and make sure that they are attached well. I use a Modelers Heat Shrink Cover Iron for this process.

## STEP 3

Clean the fabric with a clean cotton cloth and solution of MEK. Just dampen the cloth and wipe the fabric with it. Remember that this stuff is a strong solvent and is capable of melting the glue joints and dissolving your Polyurethane wood sealer. If you just dampen the cleaning cloth and wipe the surface of your covering job this will remove the sizing and other contaminants on the fabric. If you do not do this the paint will not adhere very well.

## STEP 4

Using a Good Quality Tac Cloth wipe down the area to be painted BEFORE EVERY STEP!

## STEP 5

Using EMPIRE POLYURETHANE LATEX PRIMER thinned with 30% FLOETROL LATEX PAINT CONDITIONER and a 3"FOAM PAINT BRUSH, brush the primer into the fabric using span wise strokes. This is the first coat so do not try to fill the weave completely with this first coat. If you do you will have runs inside the fabric and just in general make a big mess. Repeat this process using cross coats until the fabric weave is filled. This will take 3 to 4 coats. Be sure to let the paint dry well before each application. If you use nice even brush strokes there will be no need to sand before final paint application. The FLOETROL will help the paint flow out into the fabric and be self-leveling. It also adds flexibility to the paint. Minor brush stokes are acceptable to me but you make you own decision about sanding. Preparation is the key to a great final finish. No short cuts here.

## STEP 6

Using ENTERPRISE GLOSS POLYURETHANE OIL BASE ENAMEL and a 4" WIDE 1" DIAMETER WHITE FOAM PAINT ROLLER roll the first coat of finish color onto the fabric. The finish will be much smoother if you put the paint on a smooth surface to apply it to the roller. I used wax paper taped to a smooth surface. Remember that you are

not trying to apply the complete finish coat in one step. Roll the paint out to a nice even coat and when the paint begins to tack stop rolling. The urethane paint will self level as it begins to cure. All you are doing here is to apply the paint evenly and get most of the air bubbles out of the finish color. Time between coats will be about 24 hours depending on humidity. The finish color will take 2 to 3 coats depending upon the color you choose. You should have a very glossy finish.

## STEP 7

After the paint has cured for at least a week, clean the painted surface and wipe on a coat of SON OF A GUN PROTECTANT or similar to protect the paint and give the surface some UV protection. I clean my paint job often and keep a coat of this protectant on at all times. The paint samples that I have done over the years have spent their entire time out door in all kinds of weather in the state of Indiana. This system seems to hold up well and still look good after all of this abuse. Please do your own samples and satisfy your self as to your technique and results. Best of luck and happy aviating.

## LIST OF SUPPLIERS AND MATERIALS

### LOWE'S HARDWARE STORE

WOOD SEALER MINWAX CLEAR SHIELD POLYURETHANE WOOD SEALER

LATEX PRIMER ENTERPRISE BRAND LATEX PRIMER IN WHITE

LATEX CONDITIONER FLOETROL BRAND LATEX PAINT CONDITIONER

FINAL COLOR ENTERPRISE BRAND POLYURETHANE OIL BASED ENAMEL

SOLVENT MEK

ROLLER 4X1" WHITE FOAM PAINT ROLLERS

## Center Section Covering

This detail is very important! **This aircraft will not fly without the center section covered.** Using some hardware store flashing, measure and cut a piece to cover the holes between the wings, above and below the wing attach tube. Leave enough material to wrap around the leading edge, and overlap the wings by one inch on either side. and attach with pop rivets to the lower piece. Make cutouts for the aileron controls on the top piece. Once the top piece is covered, secure to the wings by drilling 1/8" holes through the flashing, into the cap strips on the innermost ribs. Space the holes 2" apart. Then use #30 PK screws dipped in epoxy to secure the flashing. Now take the leading edge of the flashing and wrap around the leading edge of the wings, and pop rivet to the piece you made for the bottom (1" spacing for rivets). Secure the bottom piece the same way you did the top piece.

## Engine Choices

The Affordaplane was originally designed with a Rotax 277. With the weight of the test pilot being 240 pounds, and carrying a ballistic, it was not enough power. I recommend an engine with at least 35 horsepower, and weighing not over 80 pounds. You can choose from a rotax 377, 447, 1/2 vw (watch the weight and hp on these) a 2SI 35 hp, or a Kawasaki 440. The plans show an engine mount for the Rotax 447.



## **Weight and balance**

If there is one thing that is extremely important to building and flying an airplane, it is weight and balance. The basic process involves leveling and weighing the aircraft and doing some simple math to find the Center of Gravity. The weight positions which must be taken are the most forward CG, and the most rearward CG.

### **Useful Terms and Definitions**

**Center of Gravity (CG):** the point about which an aircraft would balance if it were possible to suspend it at that point. It is the mass center of the aircraft or the theoretical point at which the entire weight of the aircraft is assumed to be concentrated.

**Center of Gravity Range:** the distance between the forward and aft c.g. limits

**Maximum Gross Weight:** Maximum allowable weight of the aircraft and its contents authorized for takeoff as determined by design limits.

**Datum line:** an imaginary vertical plane or line from which all measurements of arm are taken. The datum on this aircraft is located at the forward most face of the vertical upright motor mount tube. After the datum is selected all moment arms and the c.g. range must be computed with reference to that point.

**Empty Weight:** The empty weight of an aircraft includes all operating equipment that has a fixed location and is normally carried in the aircraft and any other parts or equipment which are required for flight and are installed in the aircraft. Full oil and residual fuel (that remains in the lines and tanks but is not available to the engine) are included in the empty weight.

**Arm (or Moment Arm):** The horizontal distance, in inches, from the datum to the center of gravity of an item. A plus (+) arm indicates the item is located aft of the datum. A minus (-) arm indicates the item is located forward of the datum.

**Moment:** Moment is the product of a weight (in pounds) multiplied by its arm (in inches).

**Mean Aerodynamic Chord (MAC):** The mean chord of the wing. For weight and balance purposes, it is used to determine the CG range of the aircraft. The mean aerodynamic chord of the Affordaplane is 60" (includes ailerons)

**Station:** a location in the aircraft which is identified by a number designating its distance in inches from the datum. The datum is therefore identified as zero and the station and arm are usually identical.

## **Weight and Balance Procedures**

1) Make sure that the aircraft has everything on board that should be in place for finding the most forward CG, and most rearward CG. All of these measurements should be taken with pilot onboard. For the most forward CG, fill the fuel tank to full capacity. For the most rearward CG, place one half gallon in the tank. Move the aircraft inside a closed building to conduct the weight and balance measurements. Place the aircraft on three scales (one under each wheel). The scales under the mains must be capable of accurately weighing up to 250 pounds each. The main wheel scales should be level with one another so that the aircraft will be level laterally. If the aircraft is not level laterally, place shims under the main wheel on the low side until it is level. Position a sturdy stand under the tailwheel with a scale between the stand and the wheel. Adjust the height of the stand

until the airplane is level. Use an accurate bubble level on the fuselage floor tubing to verify that the aircraft is level.

2). With the aircraft level and all fixed equipment installed, record the scale readings. Make sure to deduct any shims used to level the aircraft.

3). With the aircraft still level, drop a plumb line from the leading edge of the wing at the root just outboard of the wing root fairing and mark the floor at this point. A piece of masking tape and a fine-point marker work well for making the marks on the floor. Repeat this on the other side. Similarly, mark the floor at the points directly below the center of the axles of the three wheels. Roll the aircraft out of the way. Using a chalk line, make a line on the floor between the two datum points. With a carpenter's square, make a perpendicular chalk line from the nose/tailwheel axle mark to the datum line and perpendicular lines from the main gear axle marks to the datum line. Measure as accurately as possible along the perpendicular lines between the axle marks and the datum line and record the dimensions below (in decimals, not fractions).

4). Compute the aircraft MOMENT by multiplying each scale reading by its ARM.

5). Now that you know the most forward CG, and most rearward CG, and the moment of the aircraft, divide the moment by the weight to obtain the moment-inches from the datum.

#### **Weight and balance worksheet**

(these figures are representative only! Record your own numbers to get accurate results).

Item	weight	X	arm	=	moment
main gear	219		26		5694
pilot	170		38		6460
Tail	35		170		5950
fuel	30		60		1800
<b>totals:</b>	454		296		19904

#### **Results:**

Center of Gravity: total moment/ total weight = 43.84"

The wing leading edge is 26" from the datum. The allowable CG range is:

25% MAC + 26" = 41"

30% MAC + 26" = 44"

#### **Flying**

The Affordaplane is a taildragger. You will at least need to get checked out in a two seat ultralight taildragger, (which is best) or are signed off for solo in a certified aircraft like an Aeronca Champ or similar. It is best, if you have no flight time at all, to let your instructor know what you intend to do, and FOLLOW what he or she says. There are no shortcuts to getting proficient in any aircraft. A taildragger requires more attention on landing and taking off than a tricycle gear aircraft, but is fairly easy to master. The Affordaplane flies at slow speeds, and has generous surfaces for positive control. She was designed to be stable in all flight regimes, with no 'bad habits'. **Absolutely no aerobatics should be attempted with this aircraft!**

### **And Finally...**

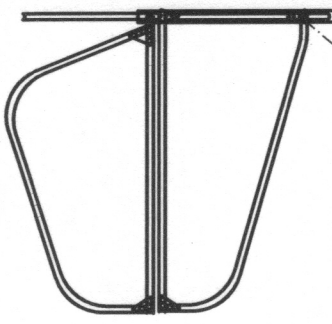
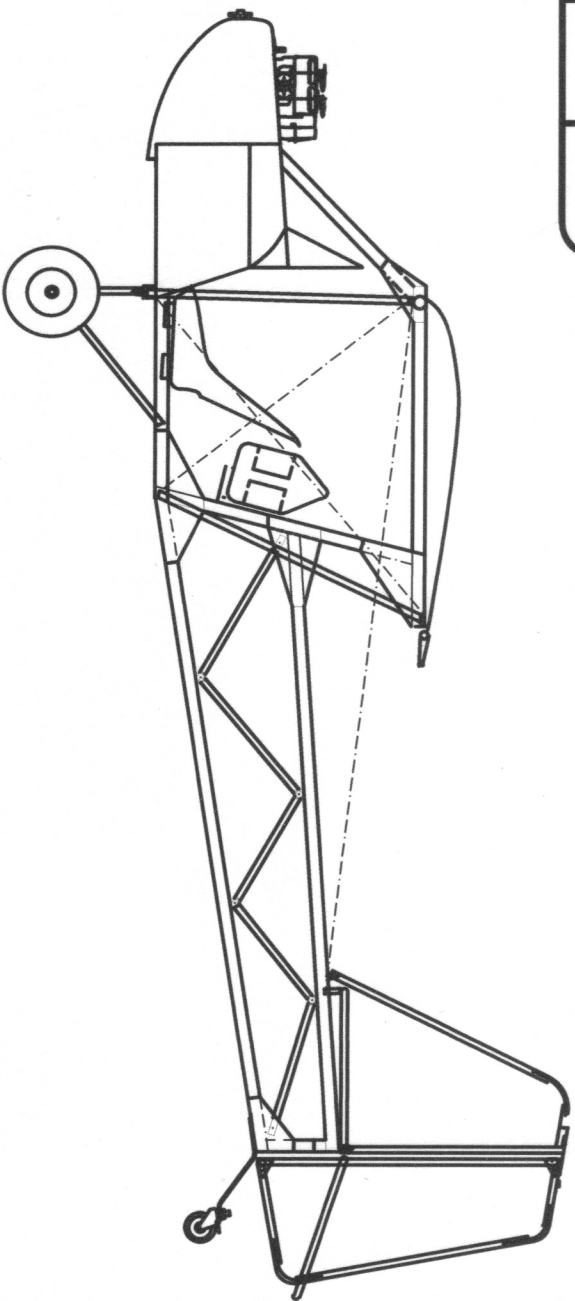
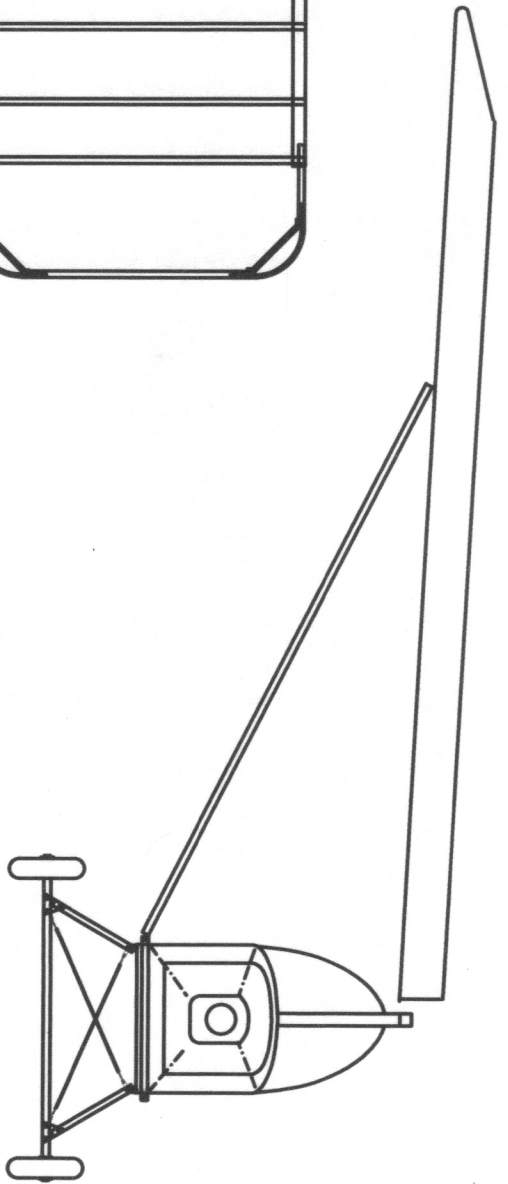
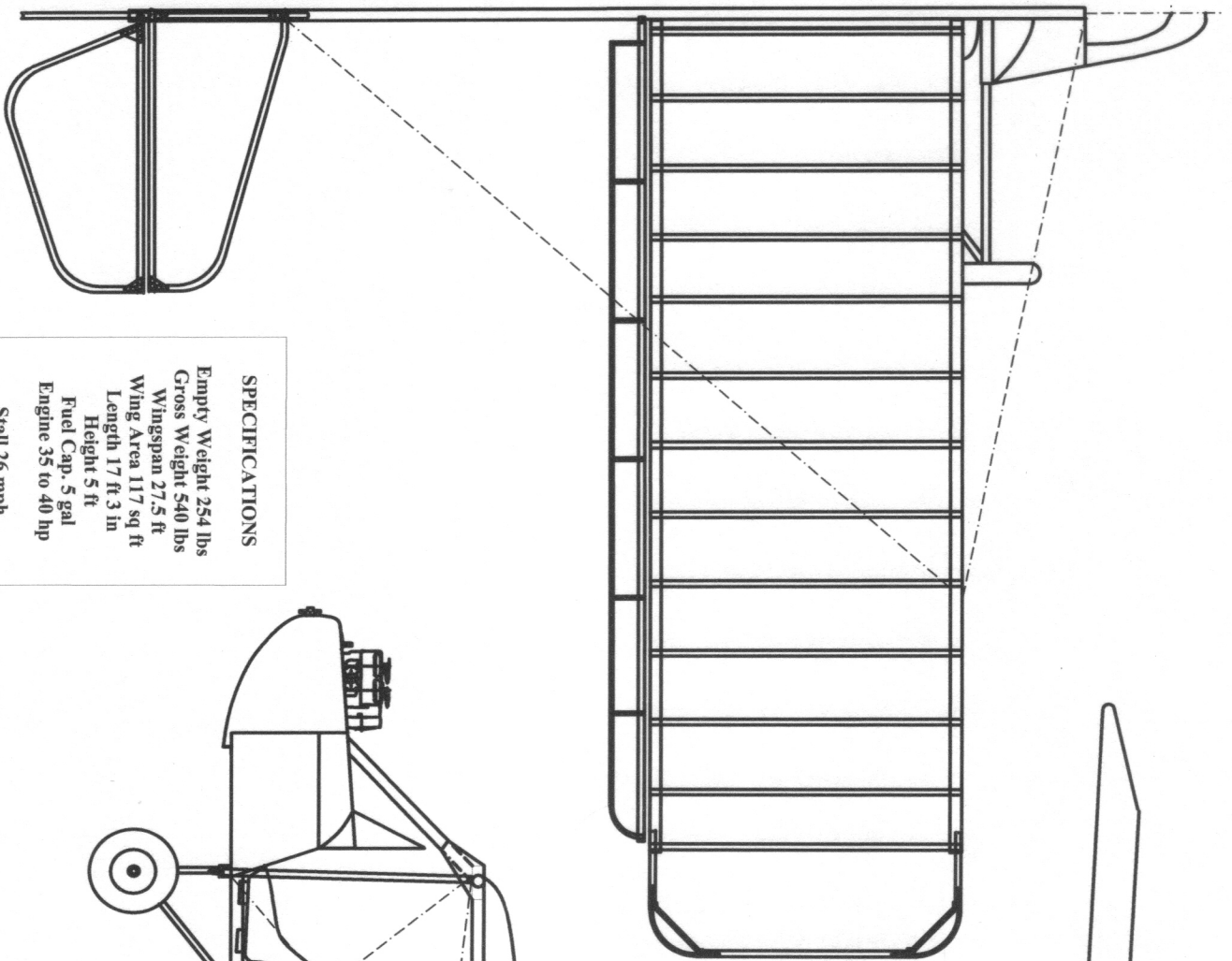
Building an airplane is one of the most fun and rewarding experiences a person can have. The build has its high points and low points, but rest assured when the day comes that it is actually finished, and your Affordaplane is sitting at the airport, waiting on you, it will be all worth it. Then you can join the small rank of people who can proudly proclaim, “yes, I did build my own airplane!”

So let me be the first to have the honor of congratulating you, on this wonderful achievement.

Congratulations!!! You did it!!!!

Best Regards,

Dave Edwards



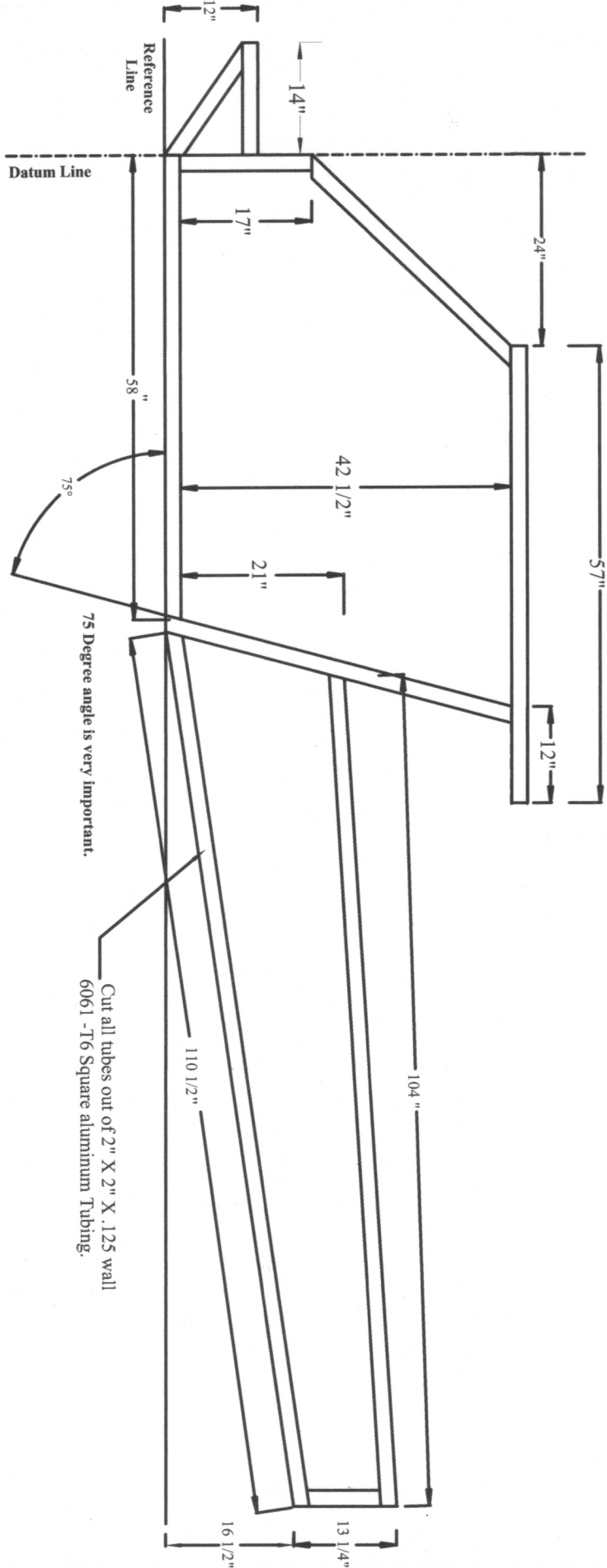
**SPECIFICATIONS**

Empty Weight 254 lbs  
 Gross Weight 540 lbs  
 Wingspan 27.5 ft  
 Wing Area 117 sq ft  
 Length 17 ft 3 in  
 Height 5 ft  
 Fuel Cap. 5 gal  
 Engine 35 to 40 hp

Stall 26 mph  
 Cruise 55 mph  
 Max power 63 mph  
 V/ne 70 mph

Build time... approx. 250 hrs

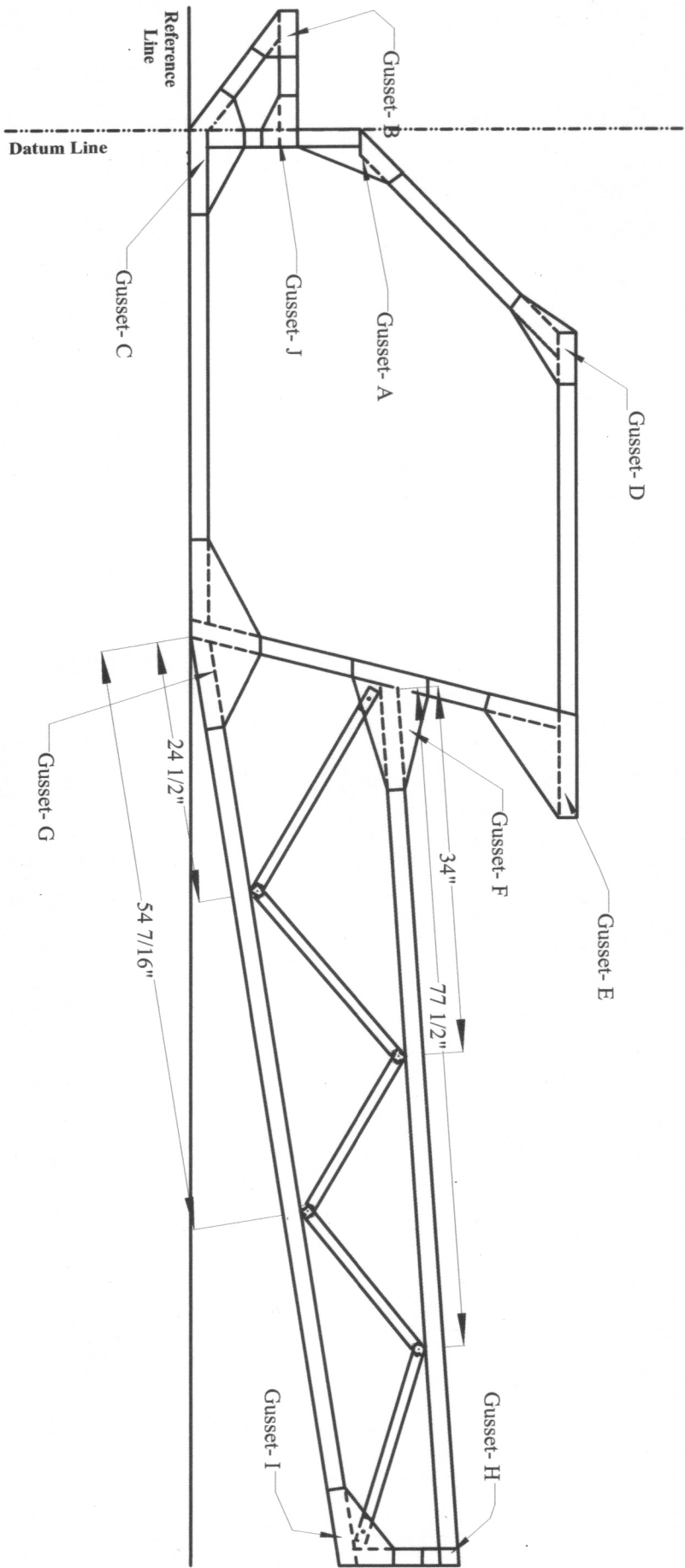
<b>Affordaplane</b>	
<b>Description:</b>	<b>3 View</b>
Copyright 2010 by Dave Edwards	
<b>Drawings#</b>	<b>1</b>



75 Degree angle is very important.

Cut all tubes out of 2" X 2" X .125 wall  
6061 -T6 Square aluminum Tubing.

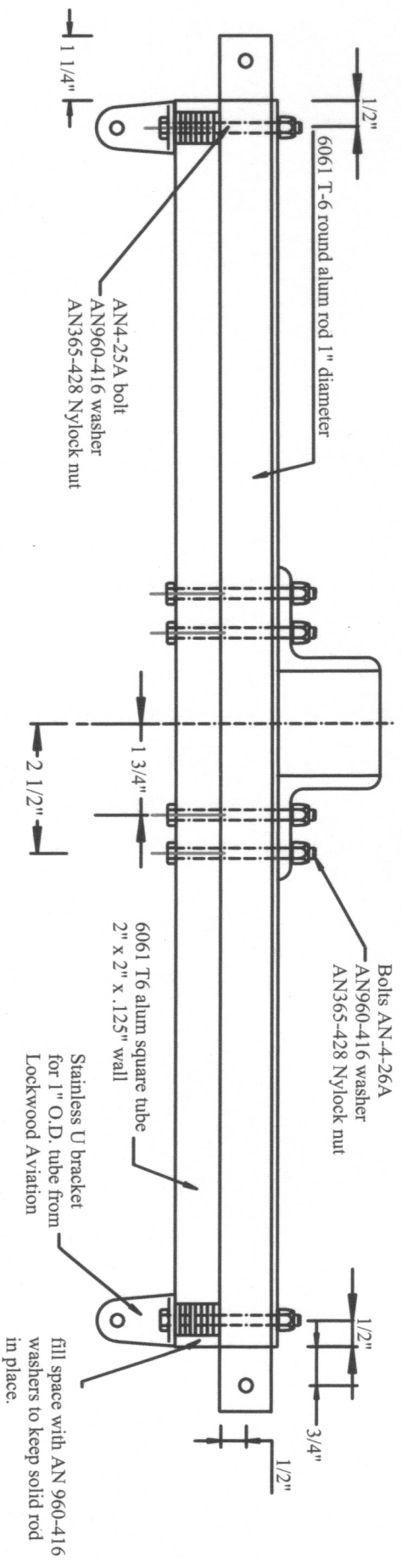
<b>AFFORDAPLANE</b>	
Description	
Fuselage Tube Layout	
Drawing#	2



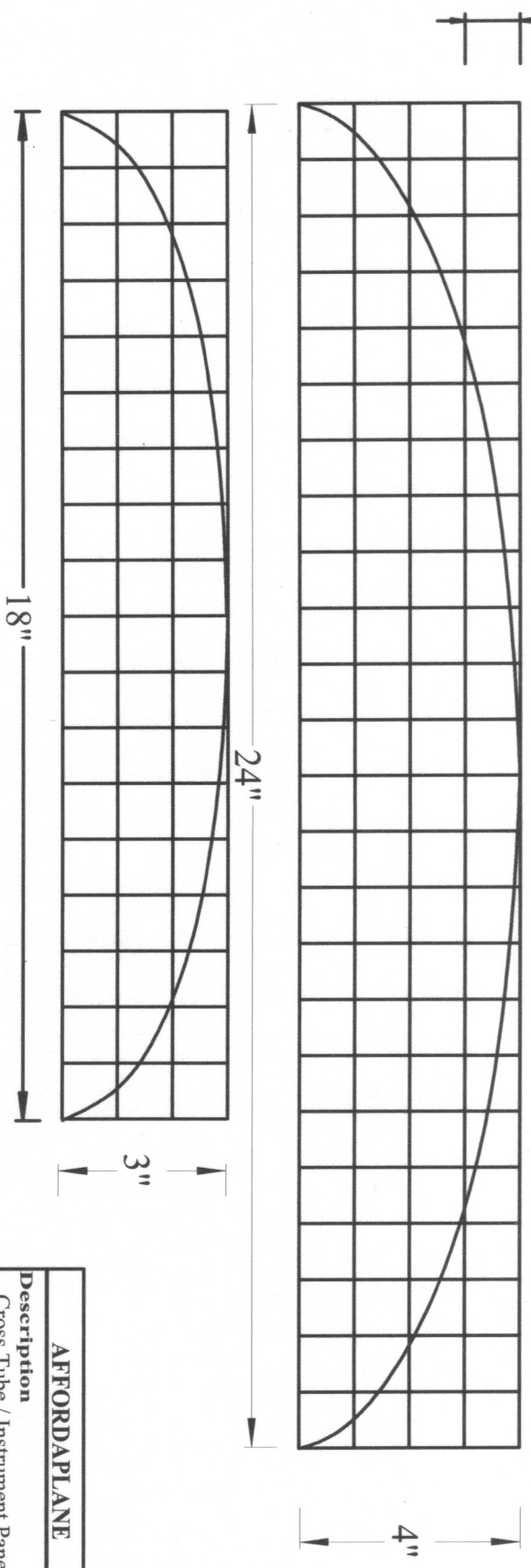
NOTE: Assemble fuselage with  
 AN3-25 bolt  
 AN960-10 washer  
 AN364-1032 nylock nut

NOTE: All diagonal tubing is  
 1" X .035 wall 6061-T6 alum  
 Tube.

<b>AFFORDAPLANE</b>	
Description	Gusset Locations / diagonal placement
Drawing#	3



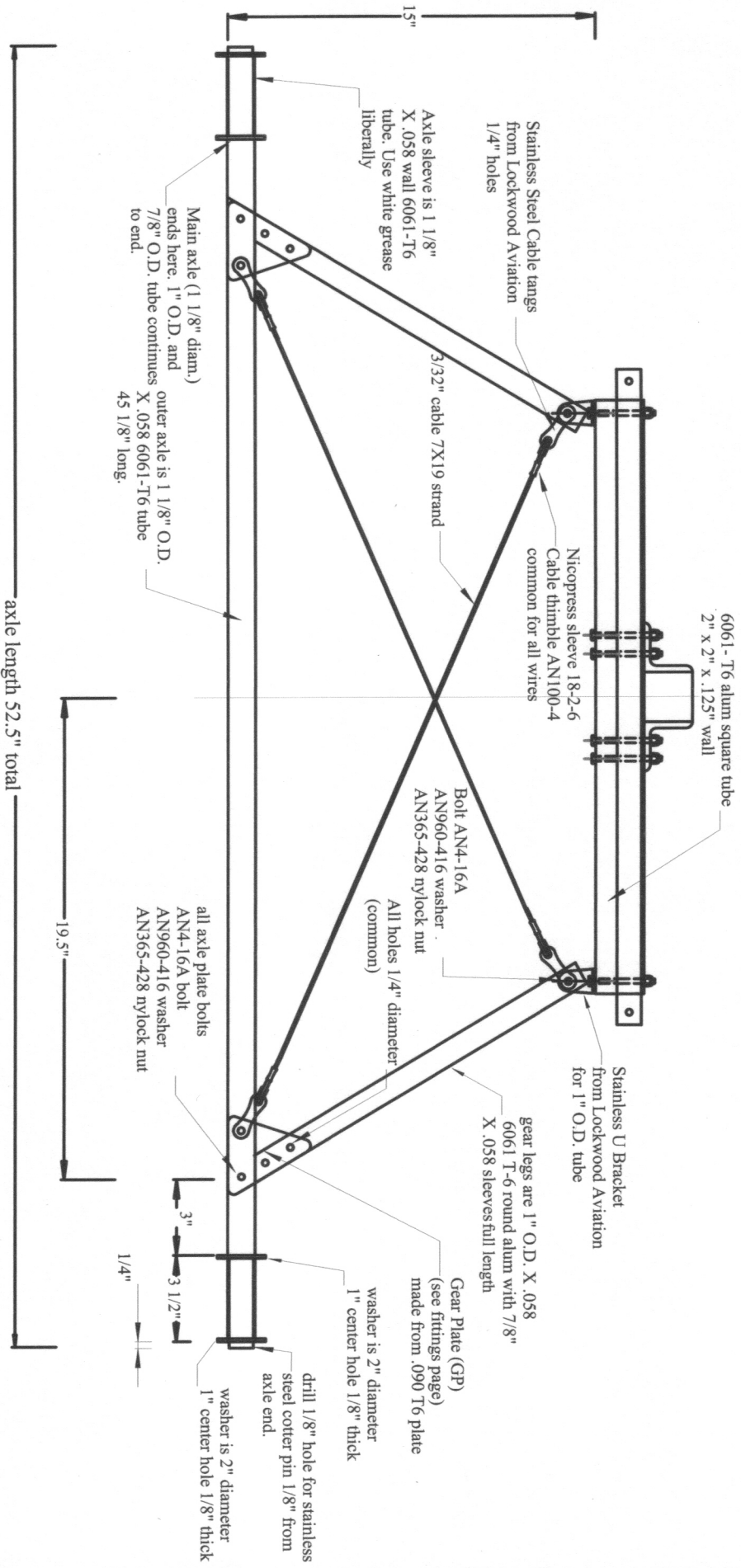
### CROSS TUBE DETAIL / WING ATTACH



Panel made from  
.032 alum sheet

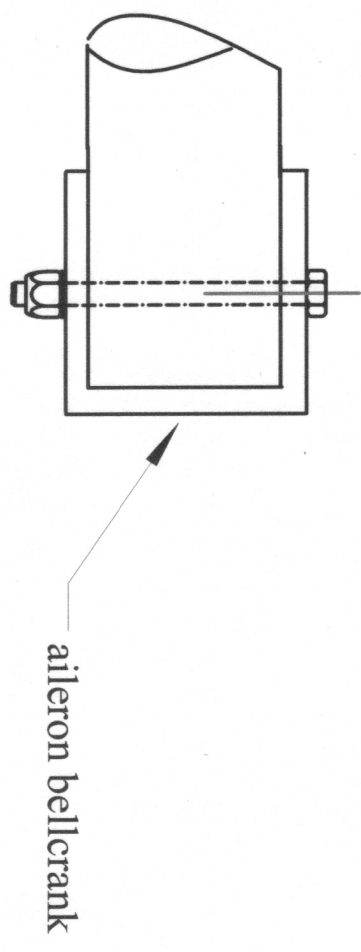
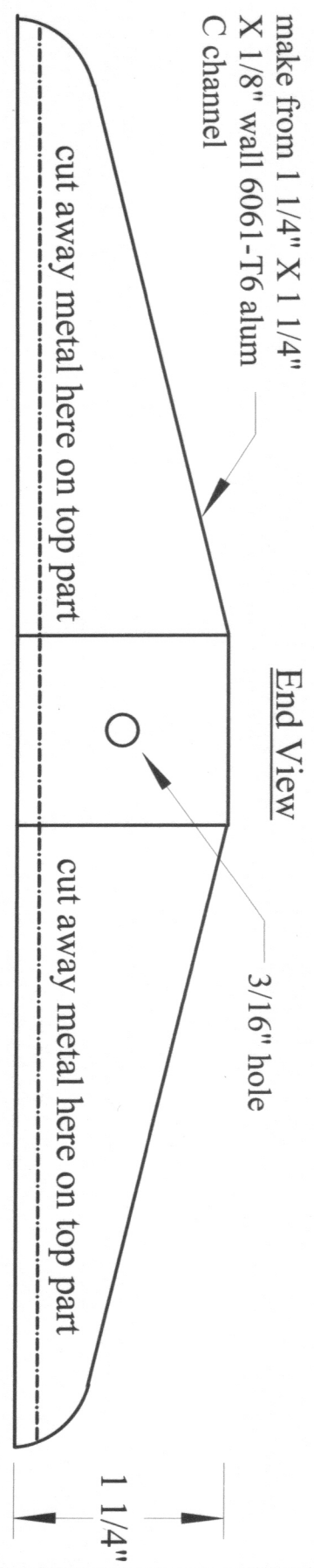
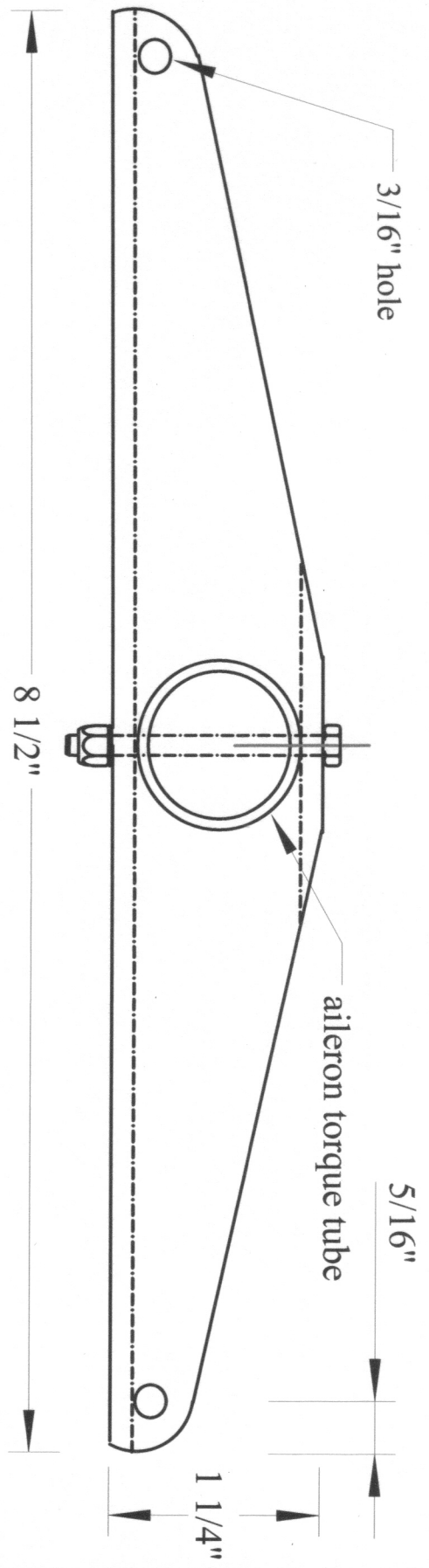
Instrument panel /  
Forward top cowling curve

<b>AFFORDAPLANE</b>	
<b>Description</b>	
Cross Tube / Instrument Panel	
<b>Drawing#</b>	4



<b>AFFORDAPLANE</b>	
<b>Description:</b>	Landing Gear
<b>Drawing#</b>	5





Side View

# AFFORDAPLANE

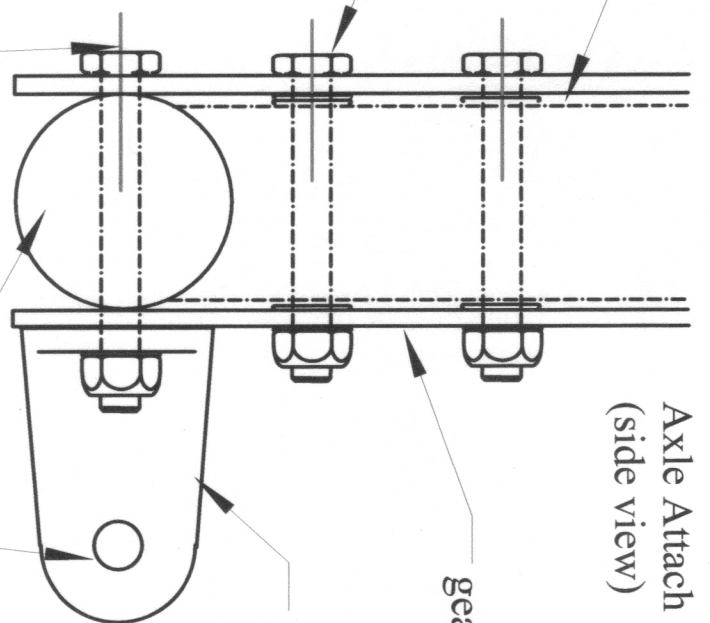
<b>Description</b>	Full size fittings Gear Detail
--------------------	-----------------------------------

<b>Description</b>	Full size fittings Gear Detail	<b>Drawing#</b>	6
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Axle width wider than  
down tubes. Fill space  
with AN960-416 washers

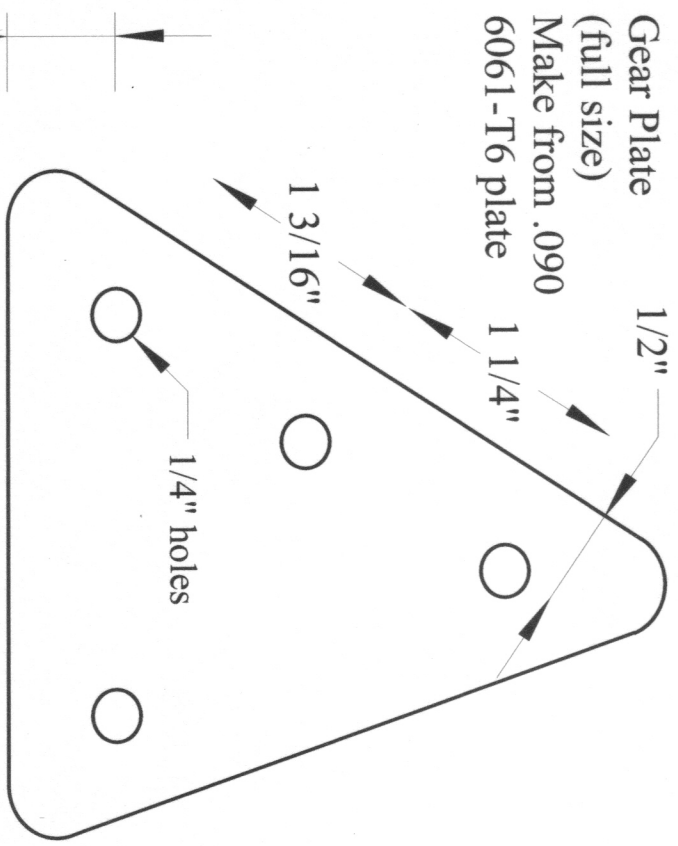
AN4-16A bolt  
AN960-416 washer  
AN365-428 nylock nut

Axle Attach  
(side view)



AN4-17A bolt  
AN960-416 washer  
AN365-428 nylock nut  
Bolt AN4-16A  
AN960-416 washer  
AN365-428 nylock nut

Gear Plate  
(full size)  
Make from .090  
6061-T6 plate

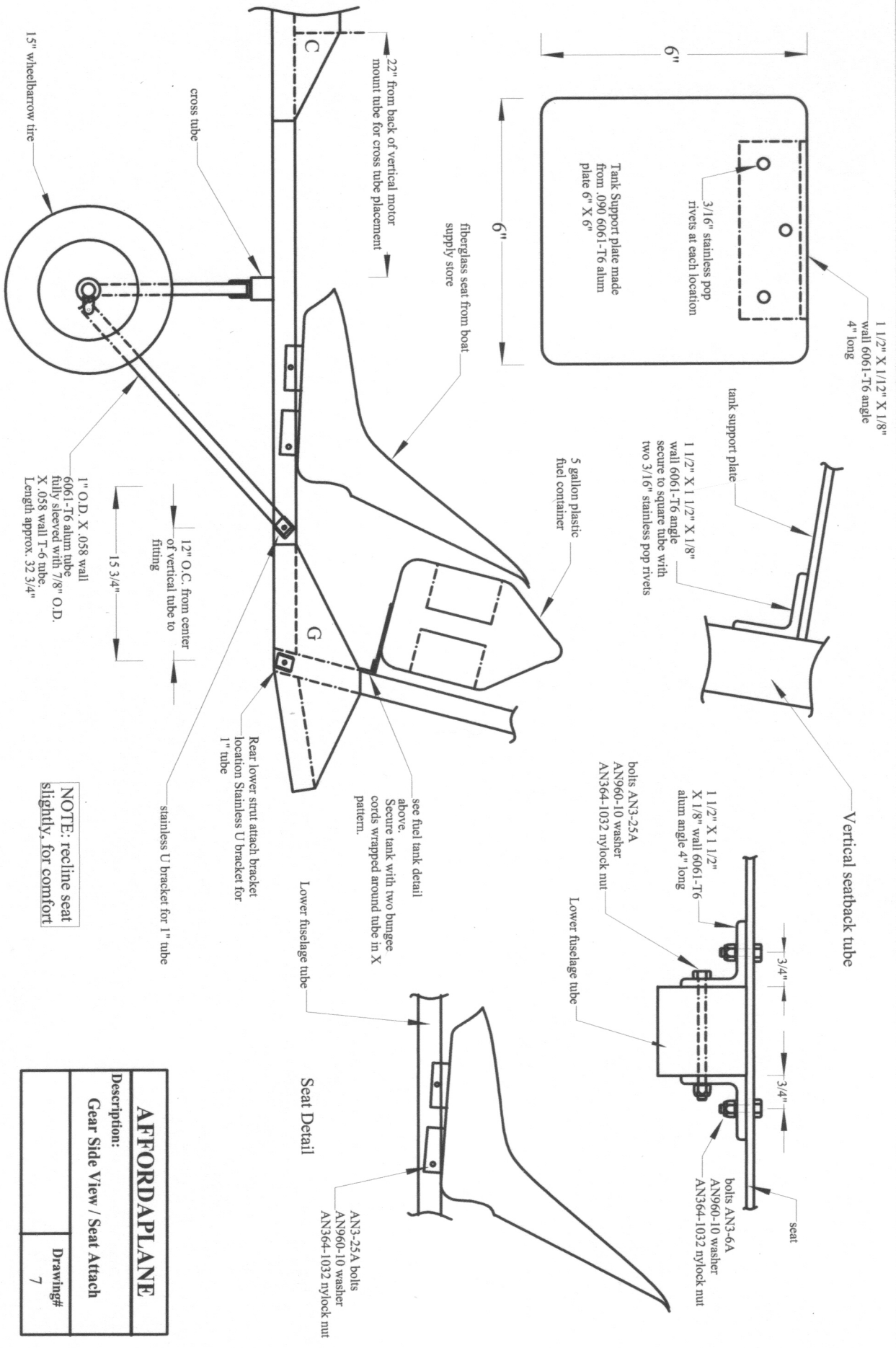


9/16"  
2 1/16"  
3 1/2"  
5/8"

**AFFORDAPLANE**

Description Full size fittings  
Gear Detail

Drawing# 6A



**AFFORDAPLANE**

Description:  
Gear Side View / Seat Attach

Drawing#  
7

6061 T-6 alum angle  
1.5" x 1.5" x 1/8" x 18" long

6061 T-6 alum  
1.5" x 1.5" x 1/8"  
x 4" long both sides.

AN3-5A bolt  
AN960-10 washer  
AN364-1032 nylock nut

fuselage gussets  
(bolts not shown for clarity)

6061-T6 alum angle  
3/4" x 3/4" x 1/8"

AN4-30A bolts  
AN960-416 washer  
AN365-428 Nylock Nut

alum angle 2" x 2" x .125" 6061 T-6

landing gear support tube is  
made from 2" x 2" x .125"  
wall 6061-T6 aluminum

cut angle on top side  
only and bend to fit

alum angle 2" x 2" x .125" 6061 T-6

DATUM

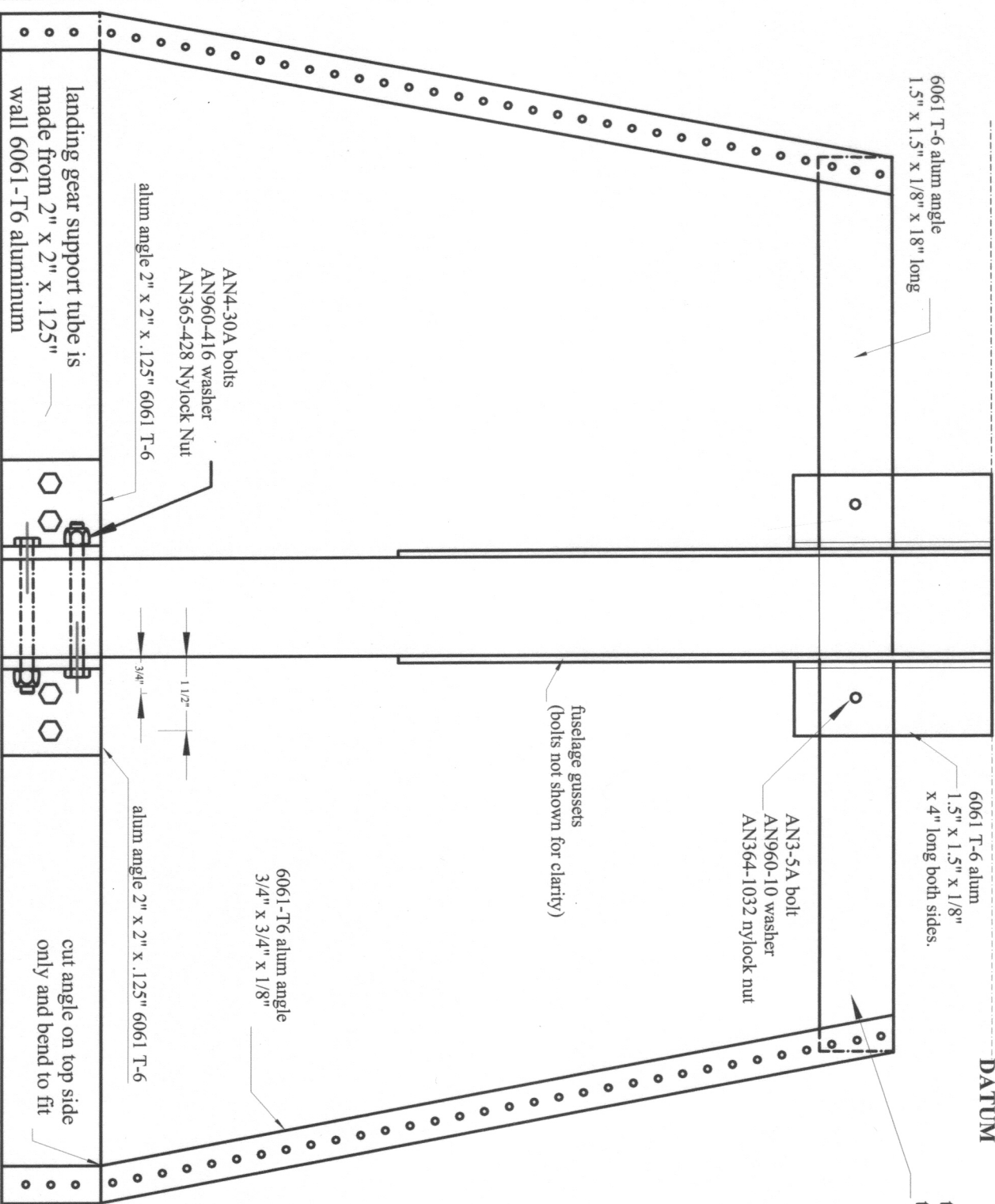
this angle may be widened  
to accommodate larger motor.

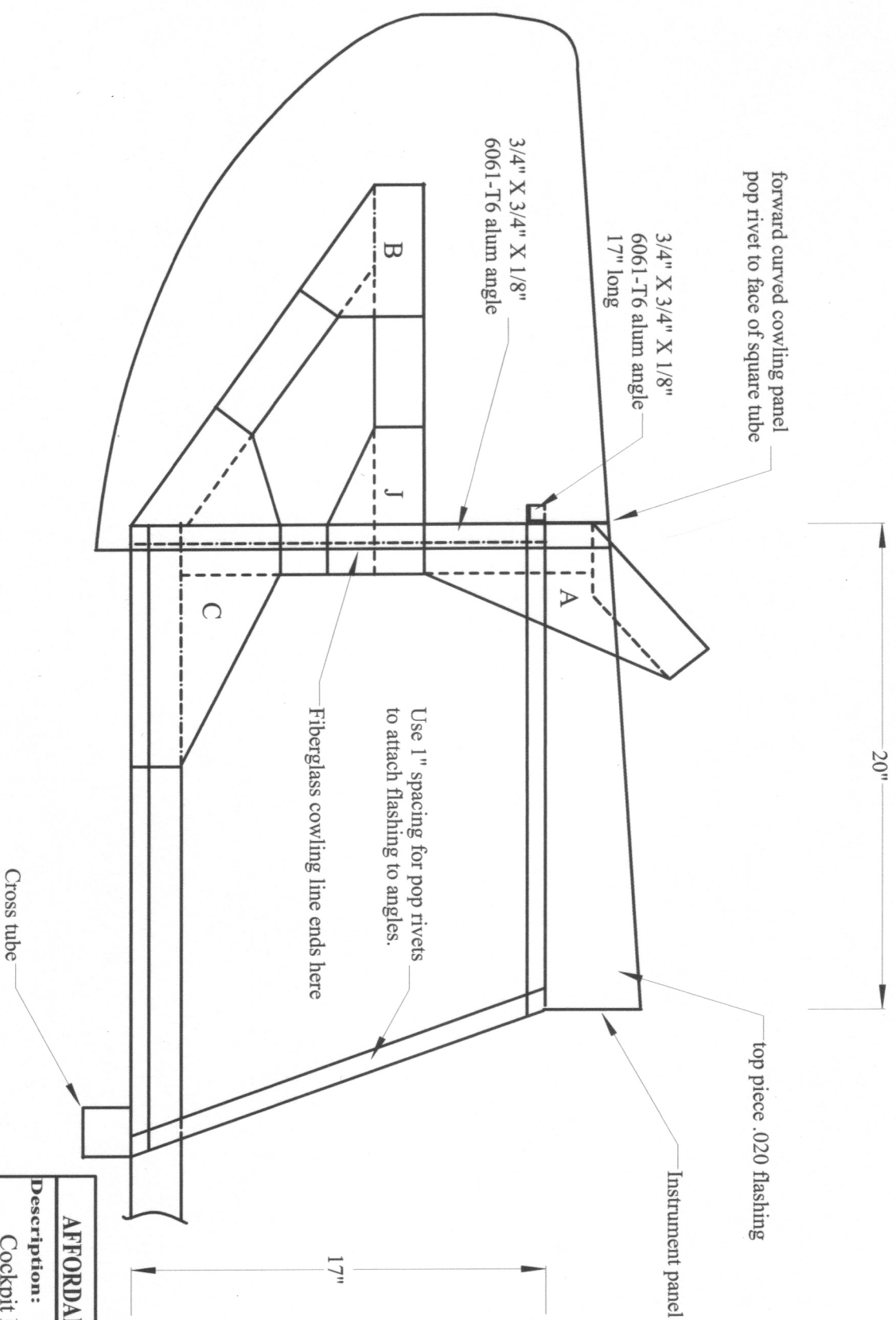
26"

**AFFORDAPLANE**

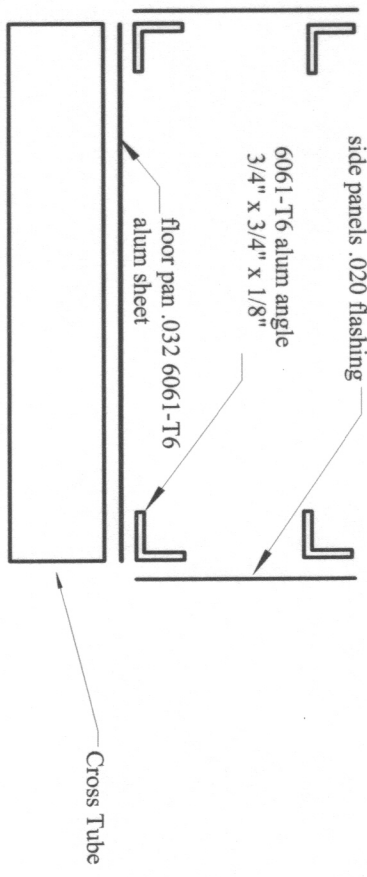
Description  
cockpit floor details

Drawing#  
8





<b>AFFORDAPLANE</b>	
<b>Description:</b>	
Cockpit Details 1	
Drawing#	9



Exploded View Cockpit Details

bend here and cut to fit  
cross tube. Secure with  
three 1/8" x 3/8"  
pop rivets.

forward cowling piece  
.032 alum pop riveted to  
vertical motor tube

vertical motor mount tube

3/4" X 3/4" X 1/8"  
6061-T6 alum angle  
X brace made from 1/2"  
X .058 alum tube. Pop rivet  
to angles with 1/8" pop r

gussets made from  
.032 alum sheet  
Use 4 1/8" pop rivets  
4" X 4"

Instrument panel  
Secure to angle with 4  
1/8" pop rivets

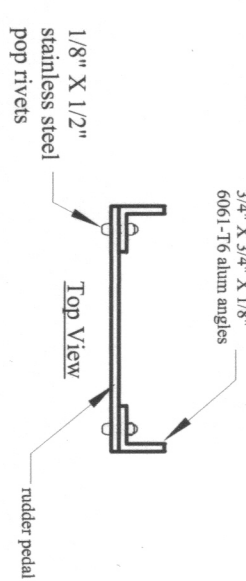
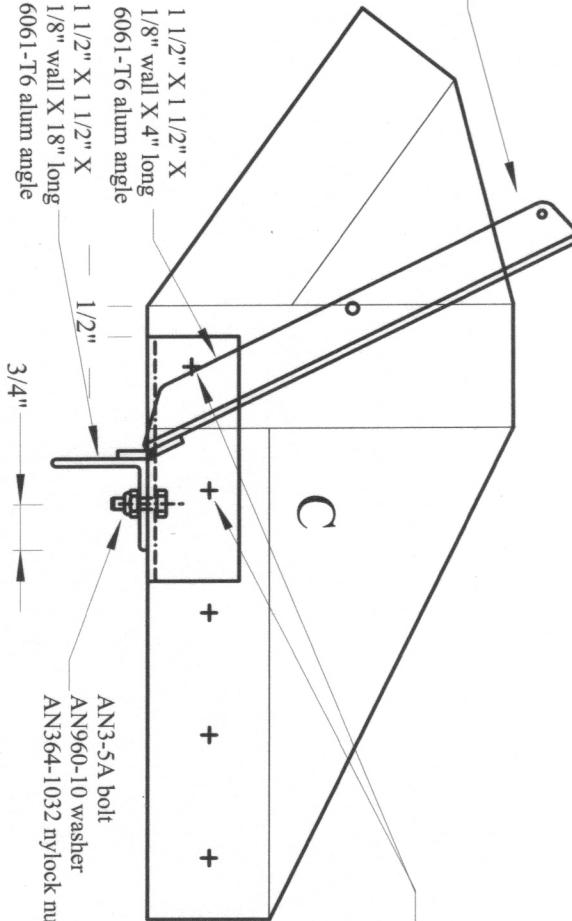
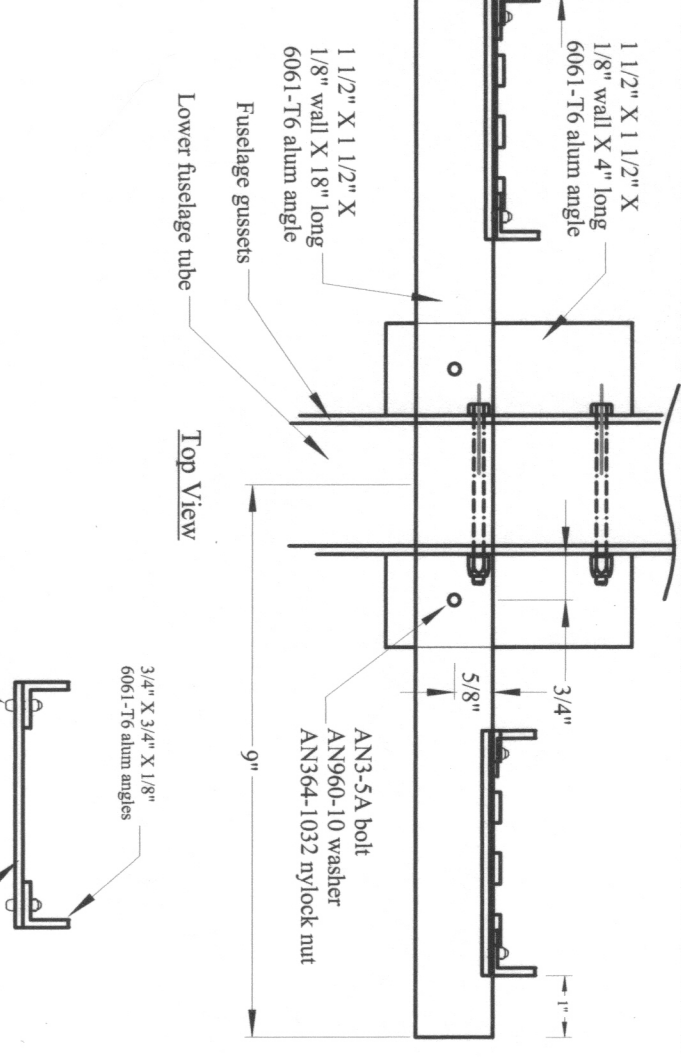
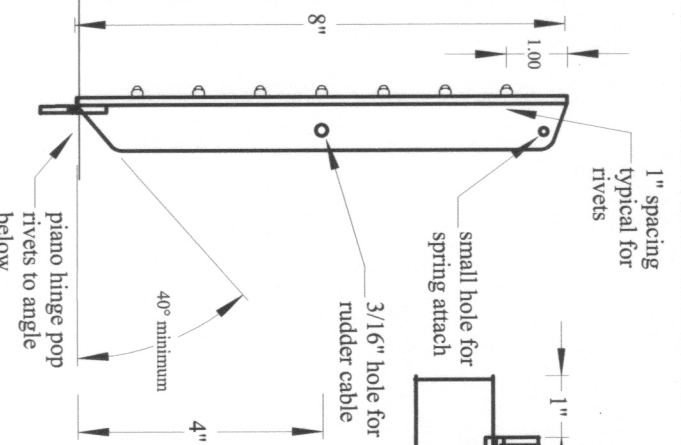
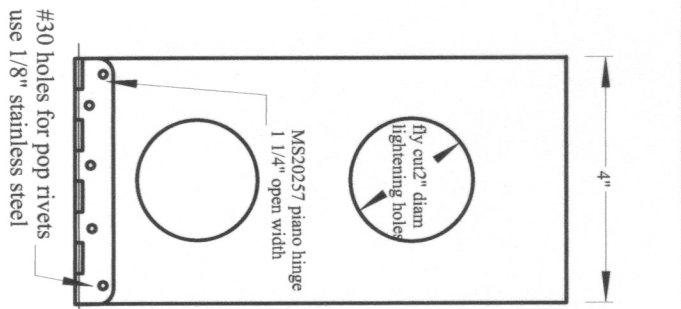
Make two gussets  
one top one bottom.

3/4" X 3/4" X 1/8"  
6061-T6 alum angle

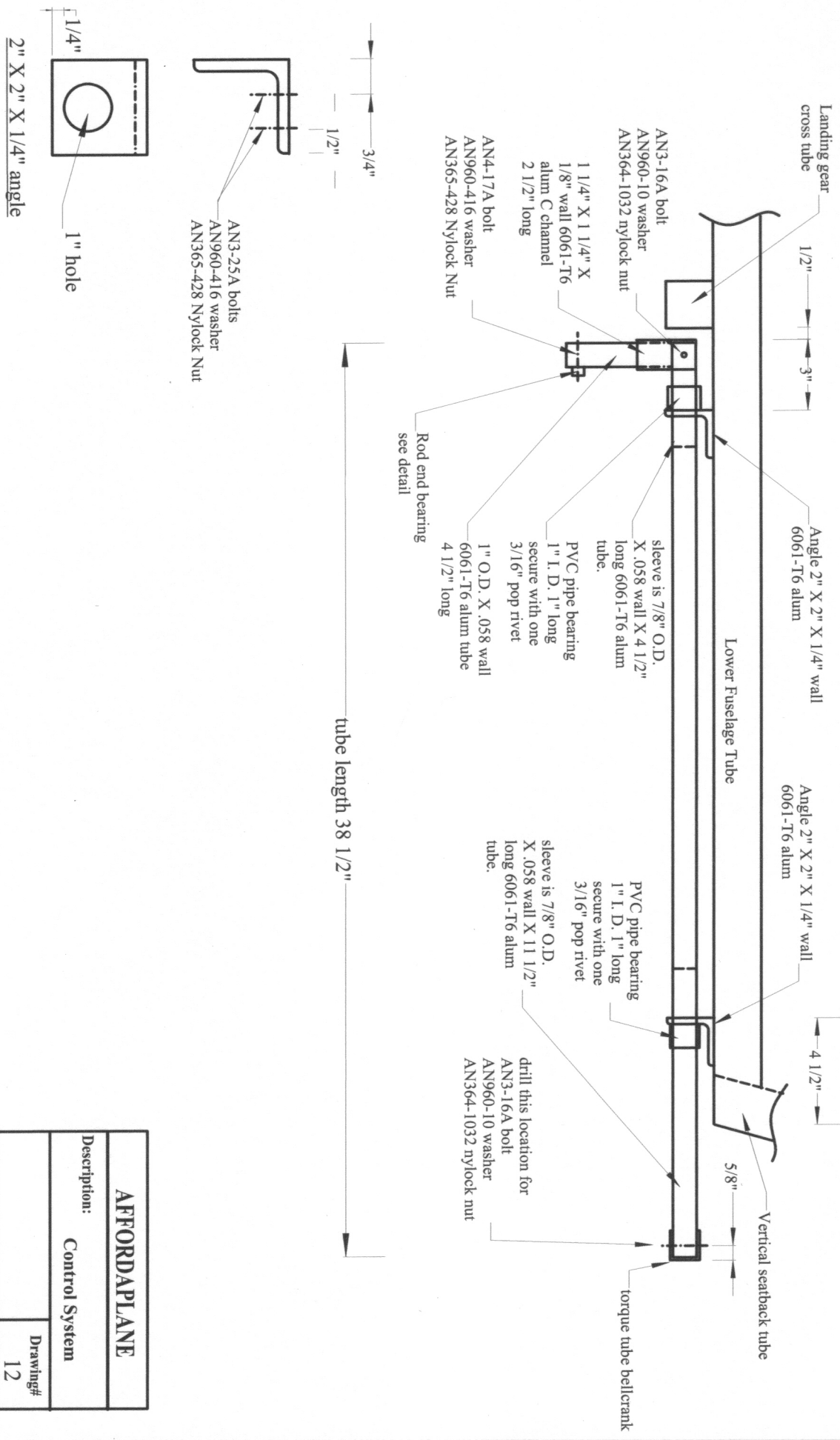
pop rivet faces of angles

<b>AFFORDAPLANE</b>	
Description: Cockpit Details	
Drawing#	10

Top View Cockpit

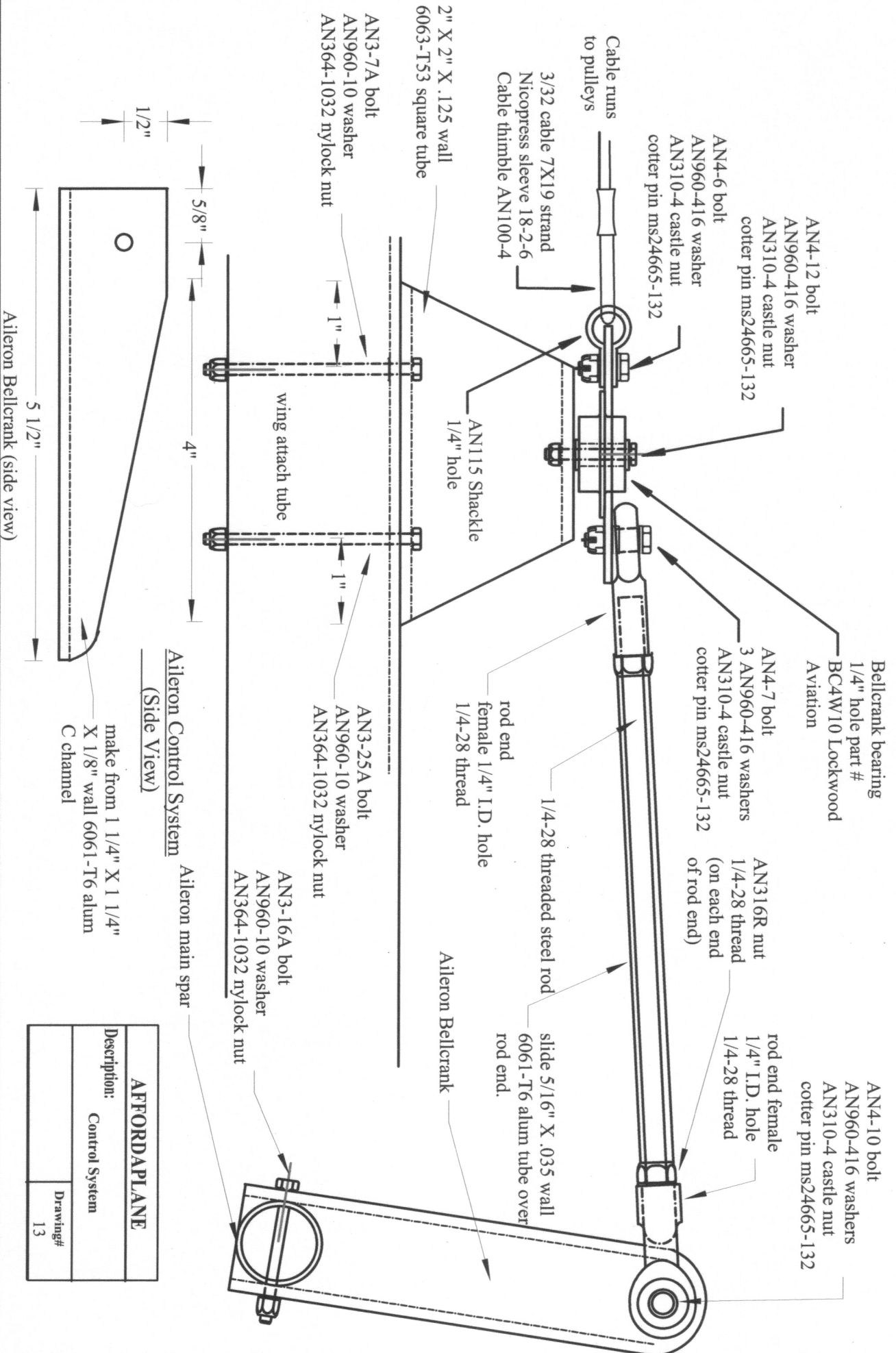


<b>AFFORDAPLANE</b>	
Description	
Rudder Pedal Detail	
Drawing#	11

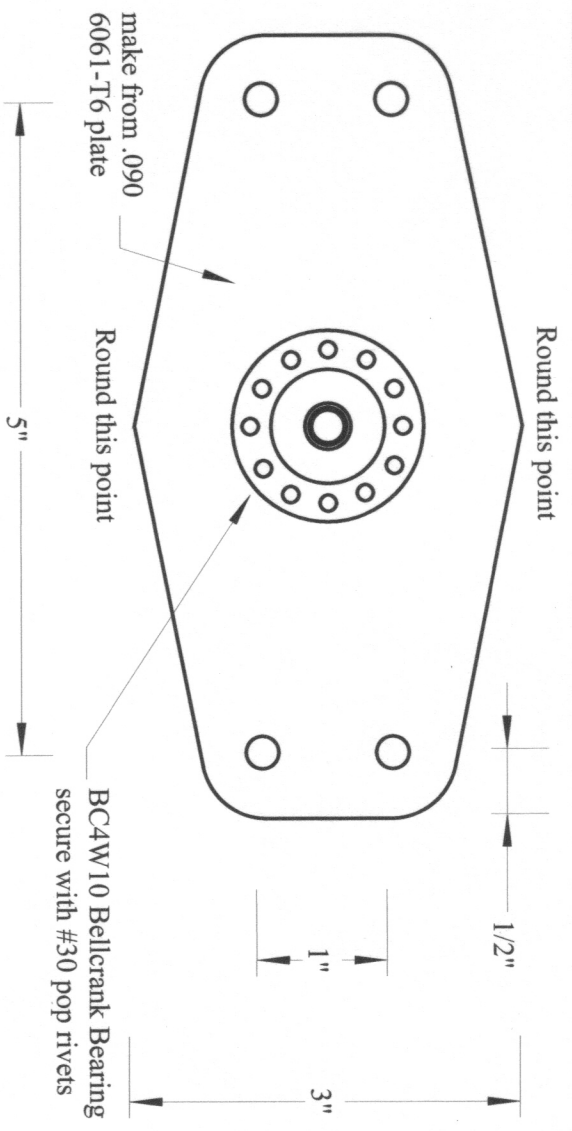


<b>AFFORDAPLANE</b>	
Description:	Control System
	Drawing# 12

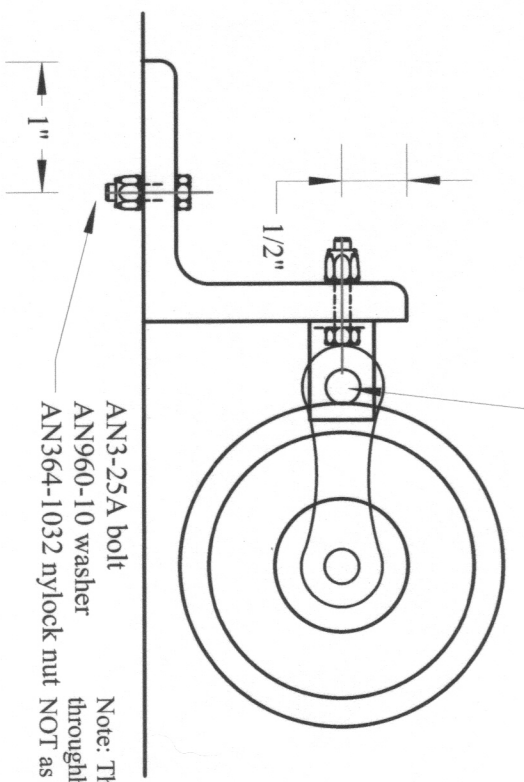




<b>AFFORDAPLANE</b>	
Description: Control System	
Drawing# 13	



Control System Bellcrank

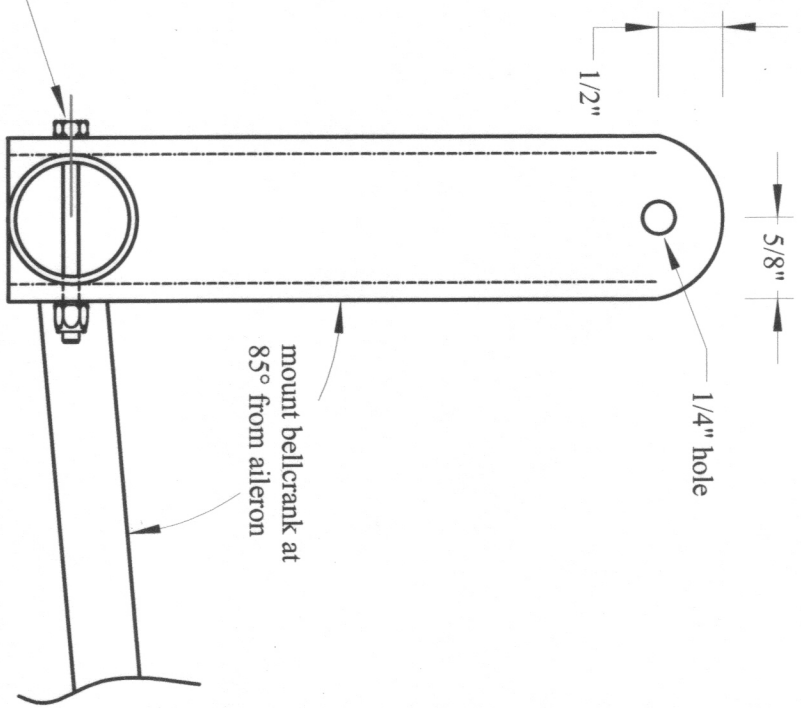


Side View

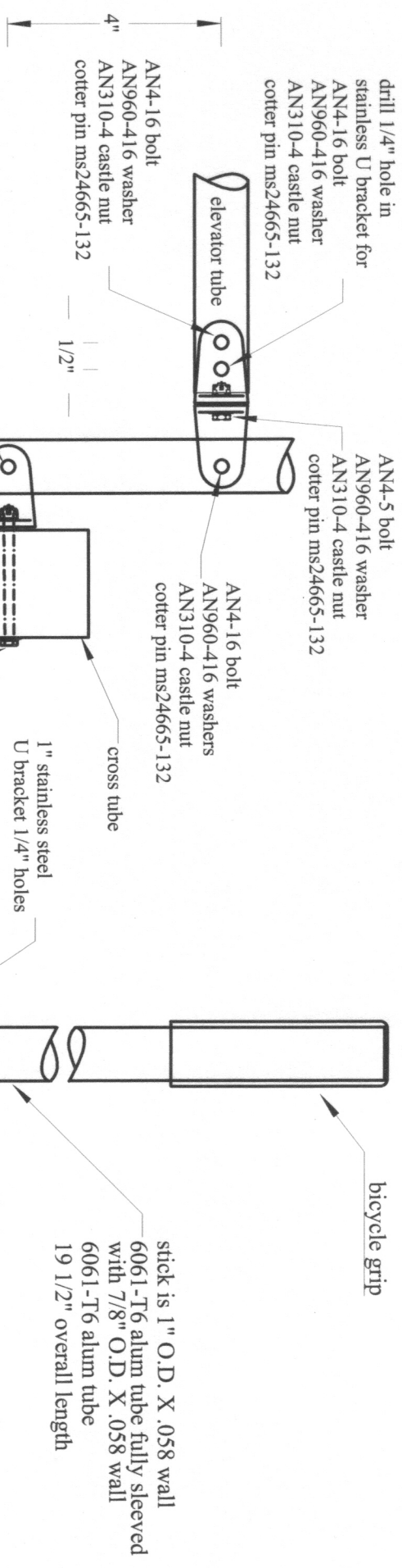
Note: This bolt goes all the way through the wing attach tube, NOT as shown here.

- MSS20392-2C19 clevis pin
- AN960-10 washer
- cotter pin ms24665-132
- AN3-16A bolt
- AN960-10 washer
- AN364-1032 nylock nut

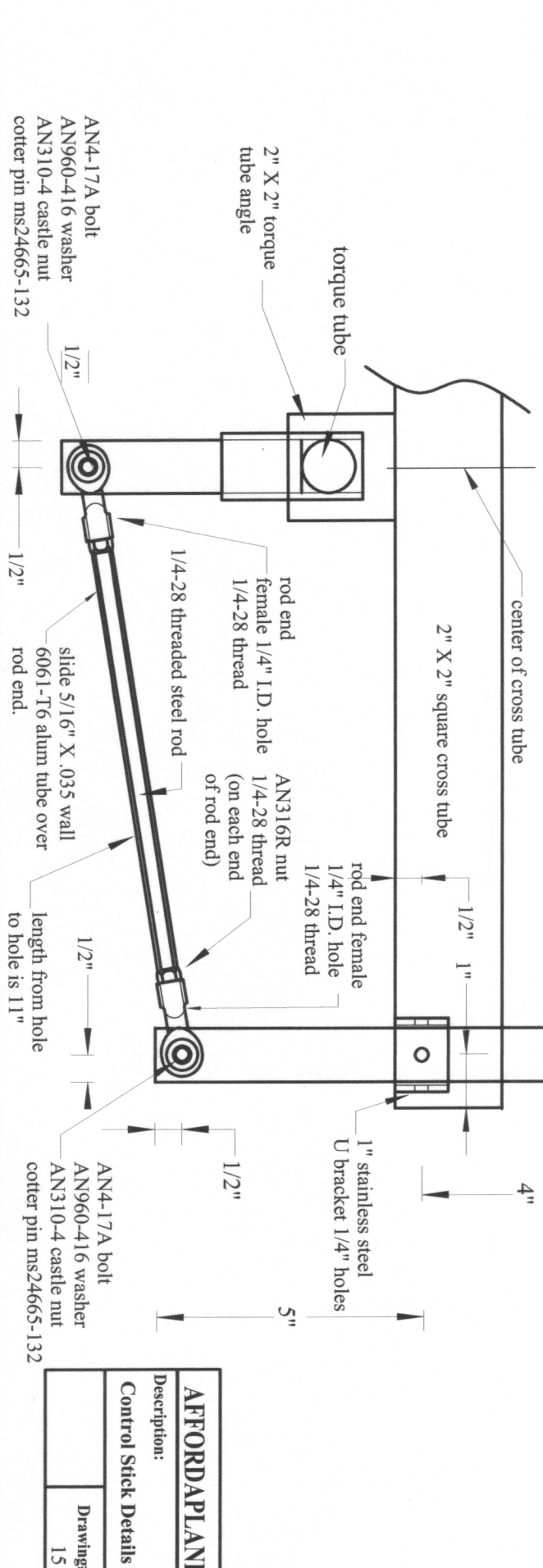
Aileron Bellcrank  
(end view)



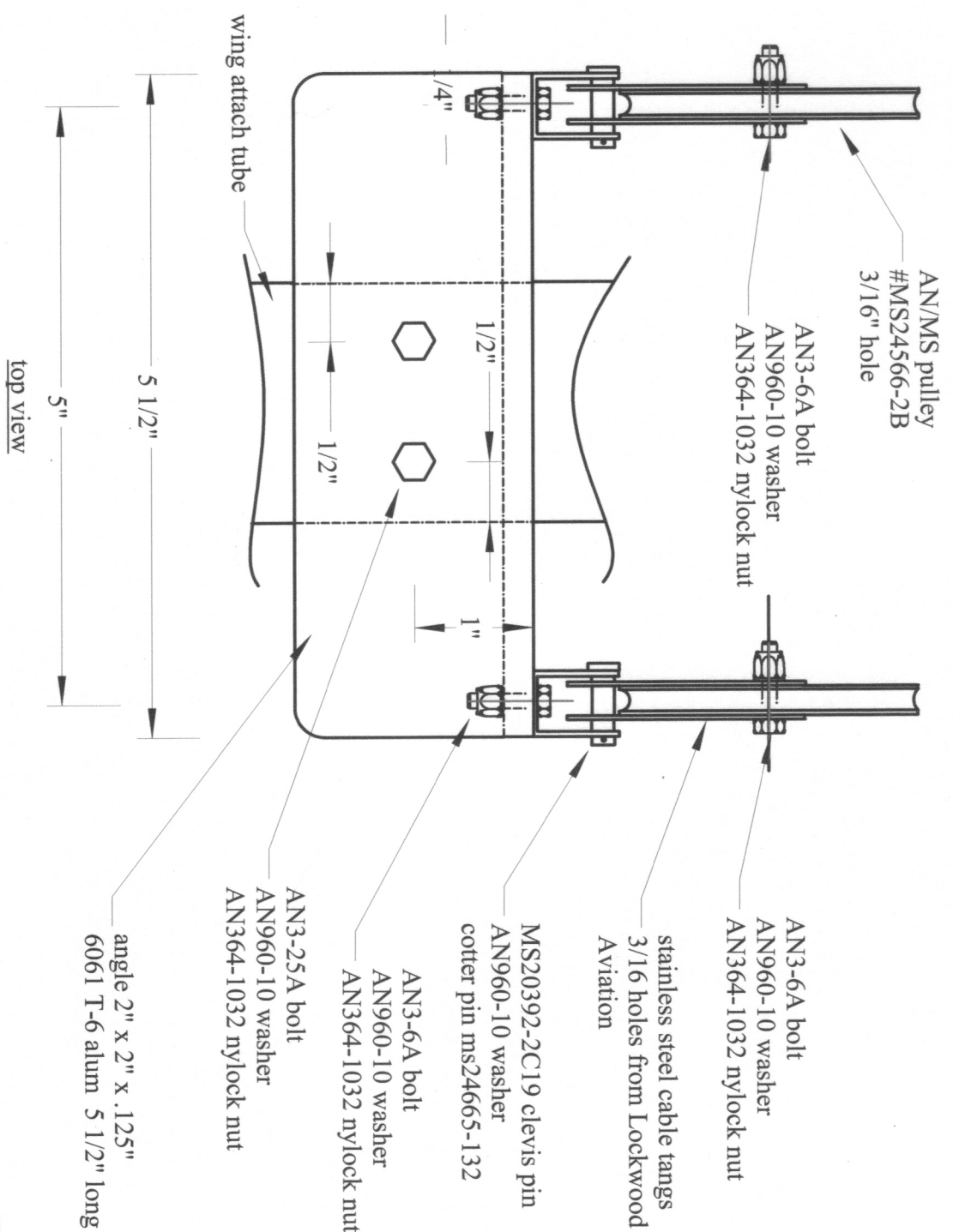
<b>AFFORDAPLANE</b>	
Description:	
Aileron Control Bellcrank	
Drawing#	14



**Elevator Tube Attach Detail**



<b>AFFORDAPLANE</b>	
Description:	
<b>Control Stick Details</b>	
Drawing#	15



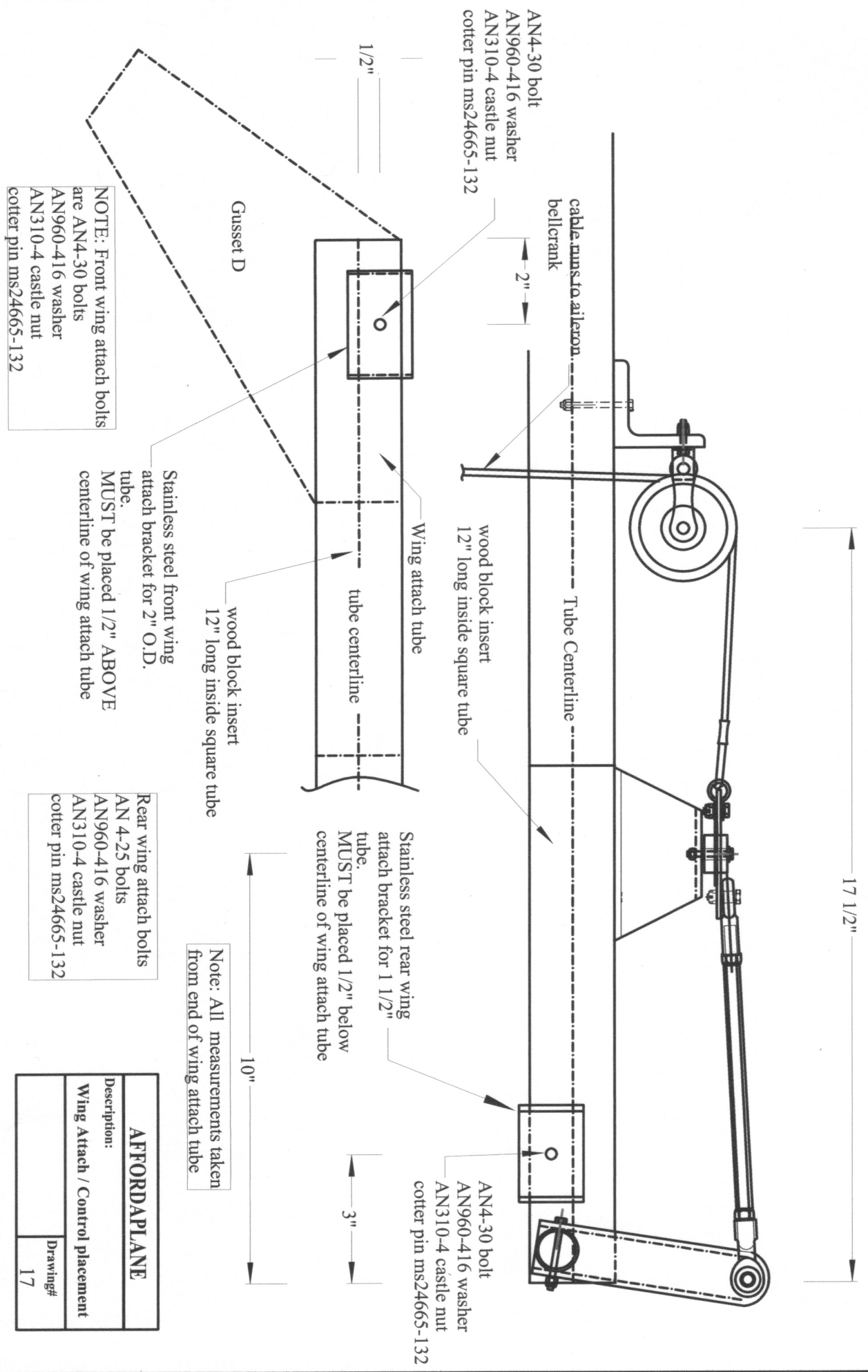
**AFFORDAPLANE**

Description:

Control Pulleys

Drawing#

16



NOTE: Front wing attach bolts are AN4-30 bolts AN960-416 washer AN310-4 castle nut cotter pin ms24665-132

Stainless steel front wing attach bracket for 2" O.D. tube. MUST be placed 1/2" ABOVE centerline of wing attach tube

Rear wing attach bolts AN 4-25 bolts AN960-416 washer AN310-4 castle nut cotter pin ms24665-132

Note: All measurements taken from end of wing attach tube

<b>AFFORDAPLANE</b>	
Description:	Wing Attach / Control placement
	Drawing# 17

AN4-30 bolt  
AN960-416 washer  
AN310-4 castle nut  
cotter pin ms24665-132

cable runs to aileron bellcrank

Tube Centerline

wood block insert  
12" long inside square tube

Wing attach tube

tube centerline

Stainless steel rear wing attach bracket for 1 1/2" tube. MUST be placed 1/2" below centerline of wing attach tube

AN4-30 bolt  
AN960-416 washer  
AN310-4 castle nut  
cotter pin ms24665-132

17 1/2"

10"

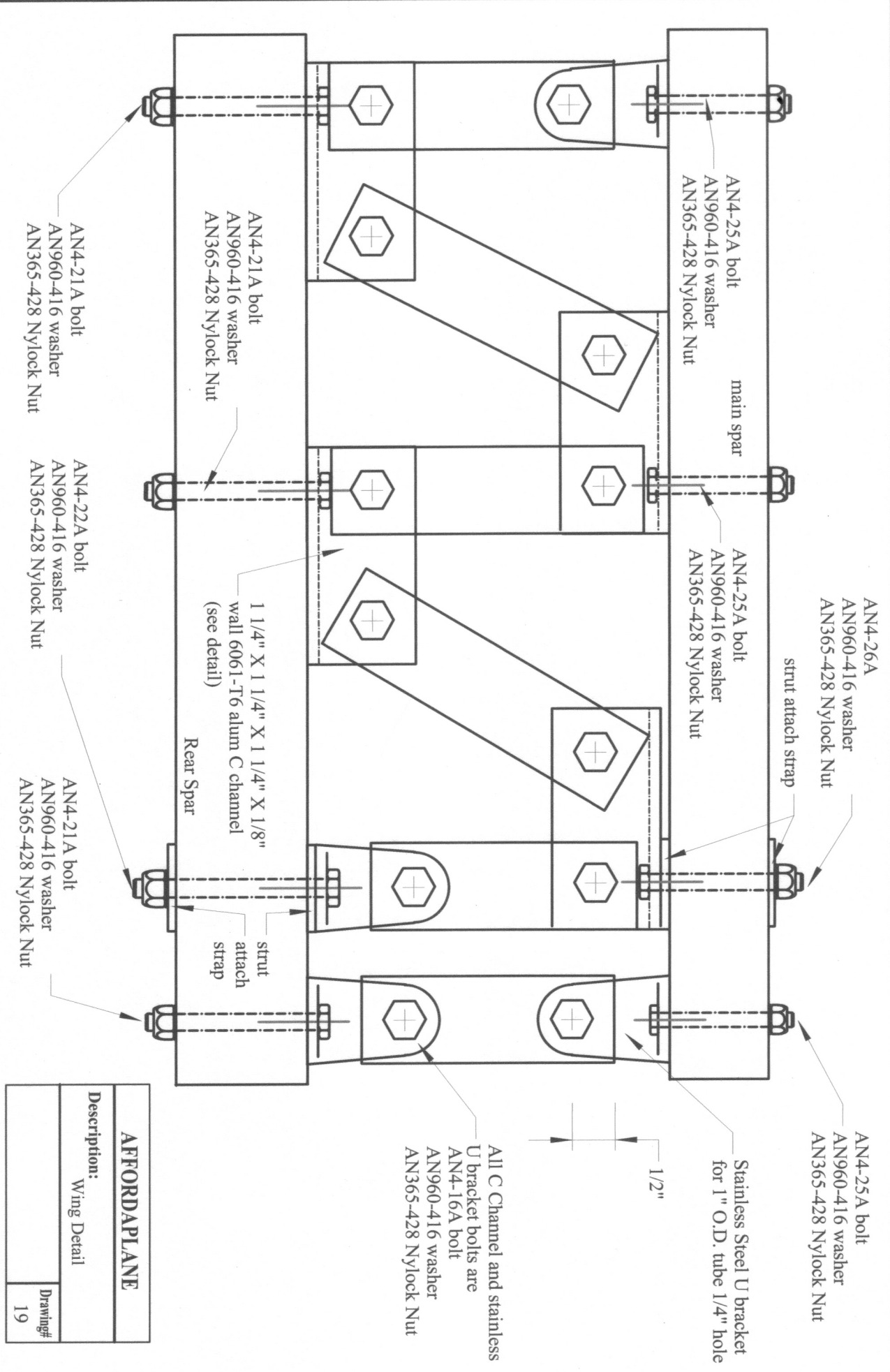
3"

2"

1/2"

Gusset D





AN4-26A  
AN960-416 washer  
AN365-428 Nylock Nut

AN4-25A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

strut attach strap

Stainless Steel U bracket  
for 1" O.D. tube 1/4" hole

AN4-25A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

AN4-25A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

1/2"

All C Channel and stainless  
U bracket bolts are  
AN4-16A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

AN4-21A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

1 1/4" X 1 1/4" X 1 1/4" X 1/8"  
wall 6061-T6 alum C channel  
(see detail)

Rear Spar

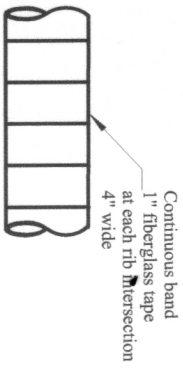
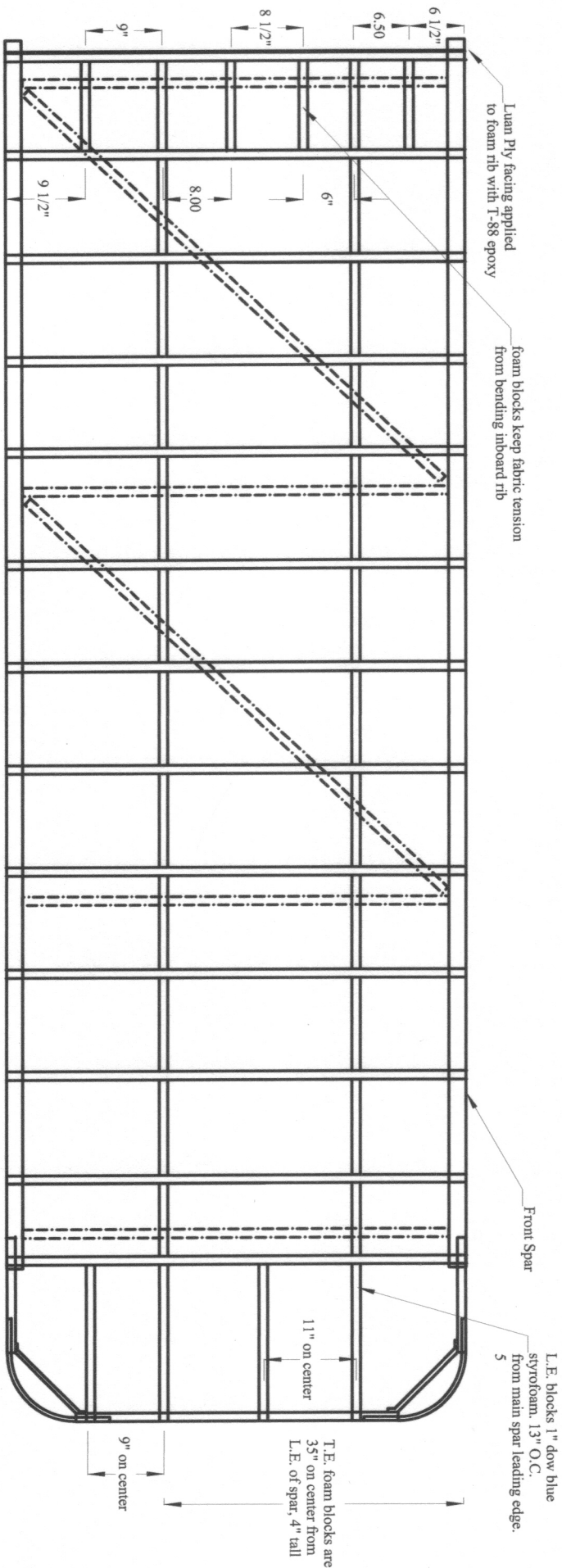
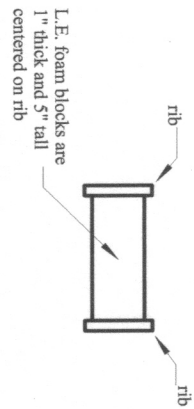
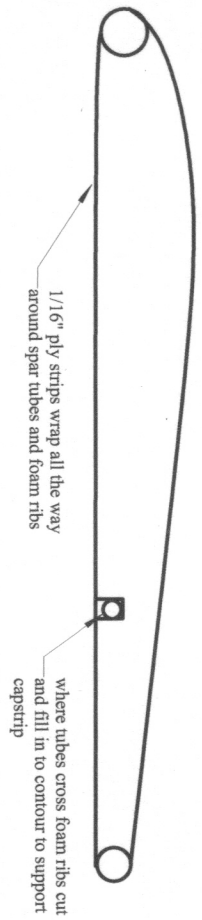
strut  
attach  
strap

AN4-21A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

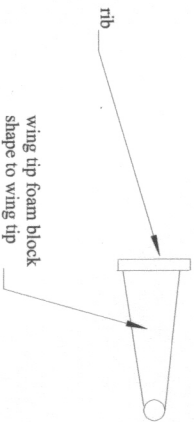
AN4-22A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

AN4-21A bolt  
AN960-416 washer  
AN365-428 Nylock Nut

<b>AFFORDAPLANE</b>	
<b>Description:</b>	Wing Detail
<b>Drawing#</b>	19



Top View  
Right Wing Shown

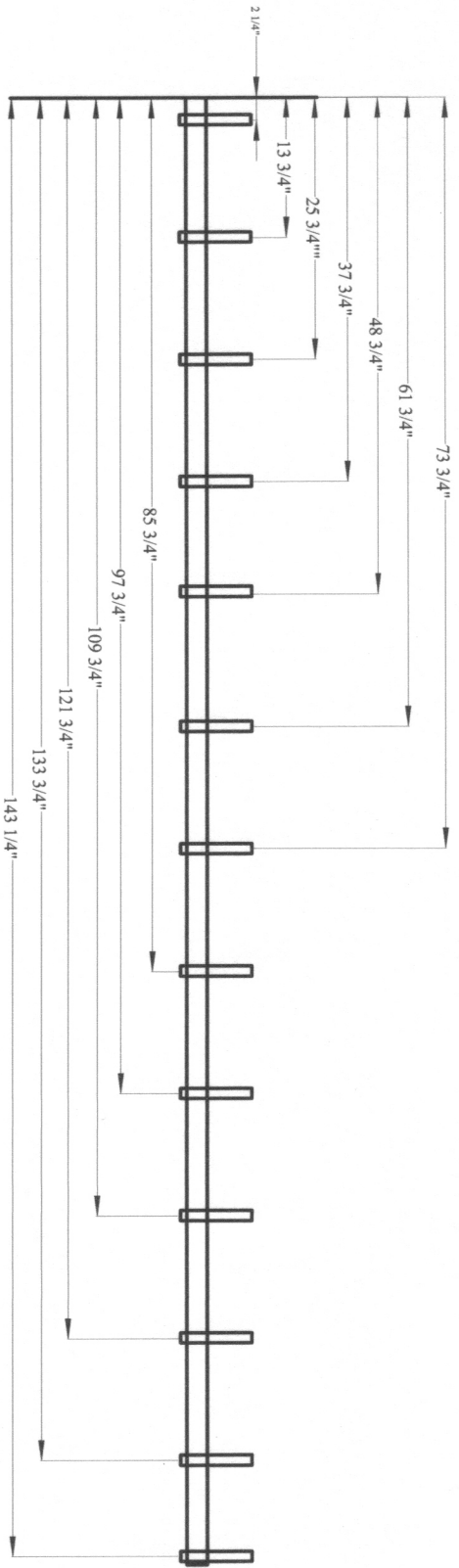


### AFFORDAPLANE

Description: Foam rib and block placement

Drawing# 20





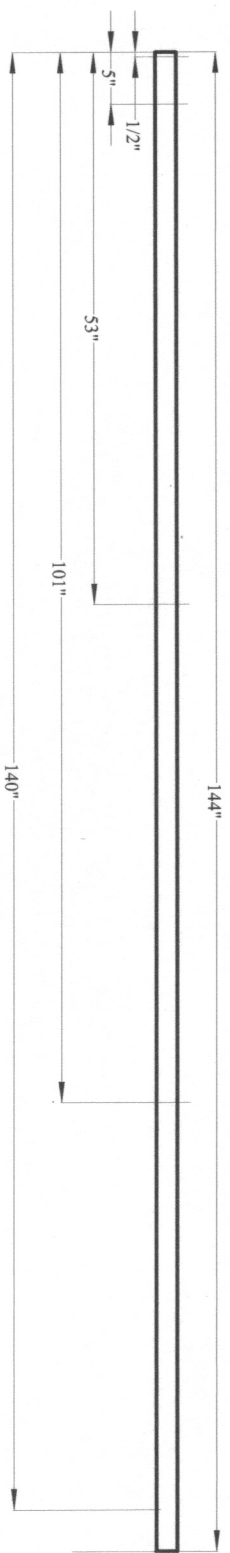
Foam Rib Locations



Rear Strut

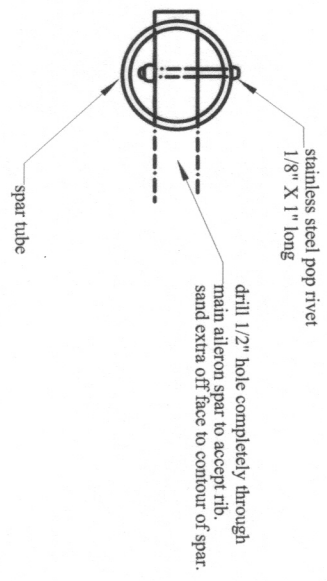
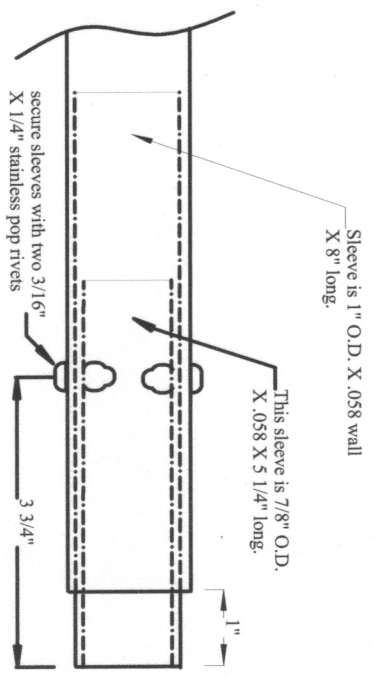
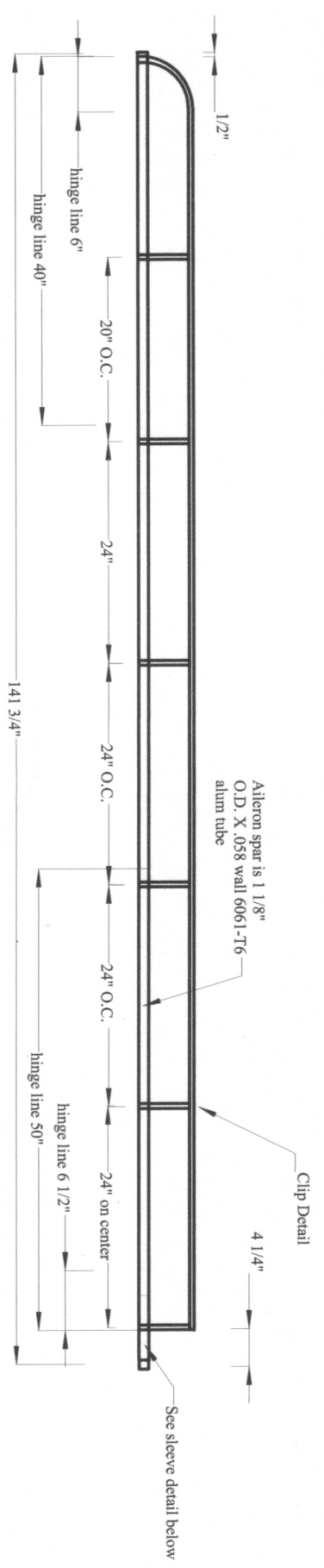
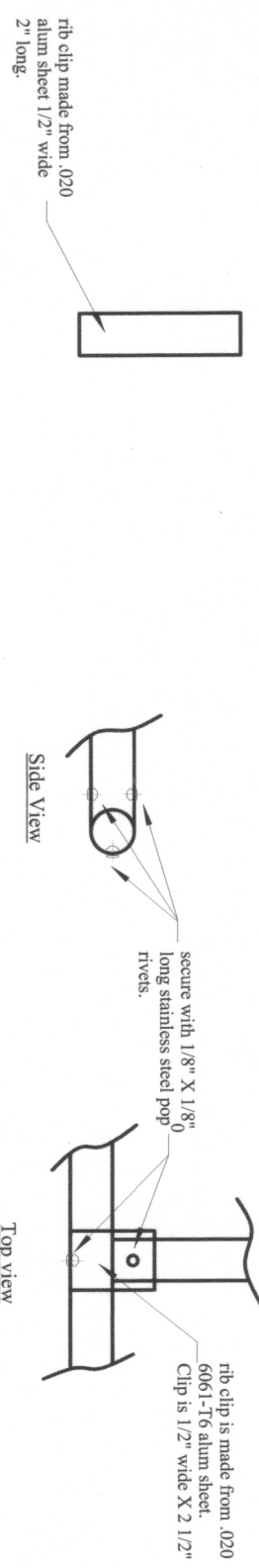


Front Strut



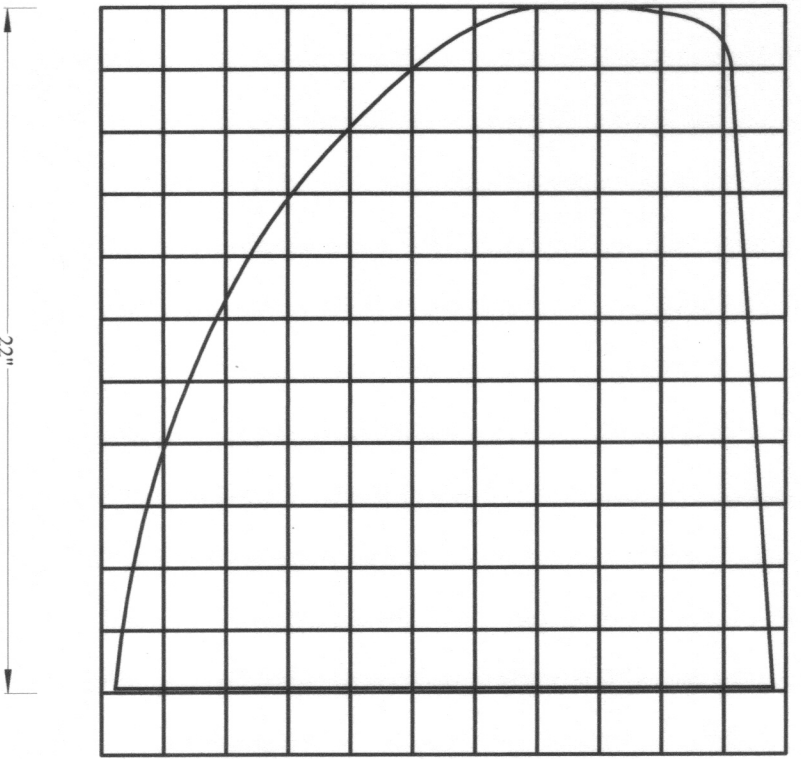
Main spar and rear spar bolt hole locations

<b>AFFORDAPLANE</b>	
Description: Foam Rib Placement / Spar Hole Locations	
	Drawing#
	21

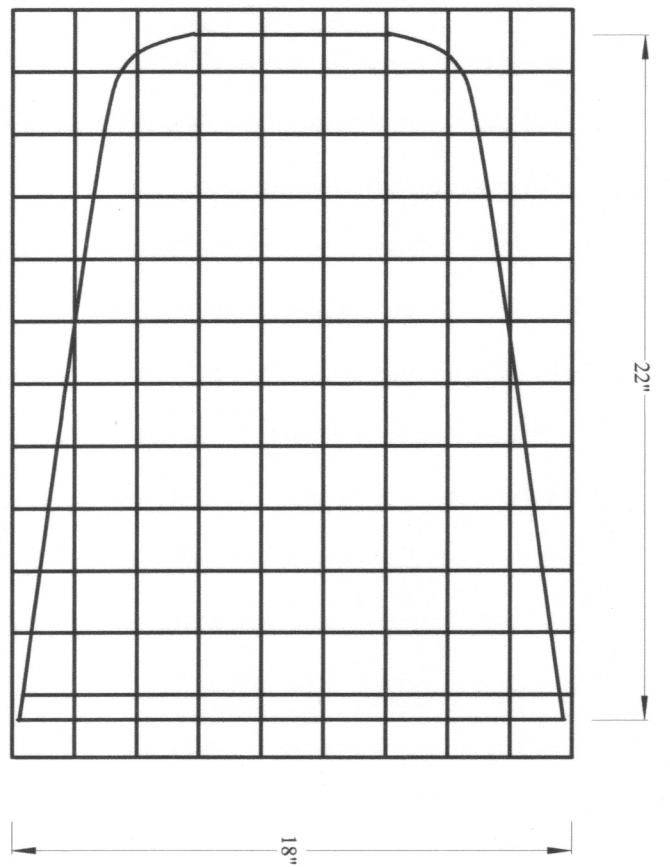
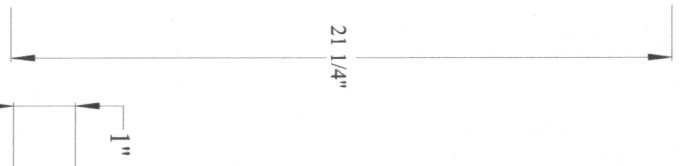


NOTE: Build one right and one left aileron.

<b>AFFORDAPLANE</b>	
Description:	Aileron
	Drawing#
	22



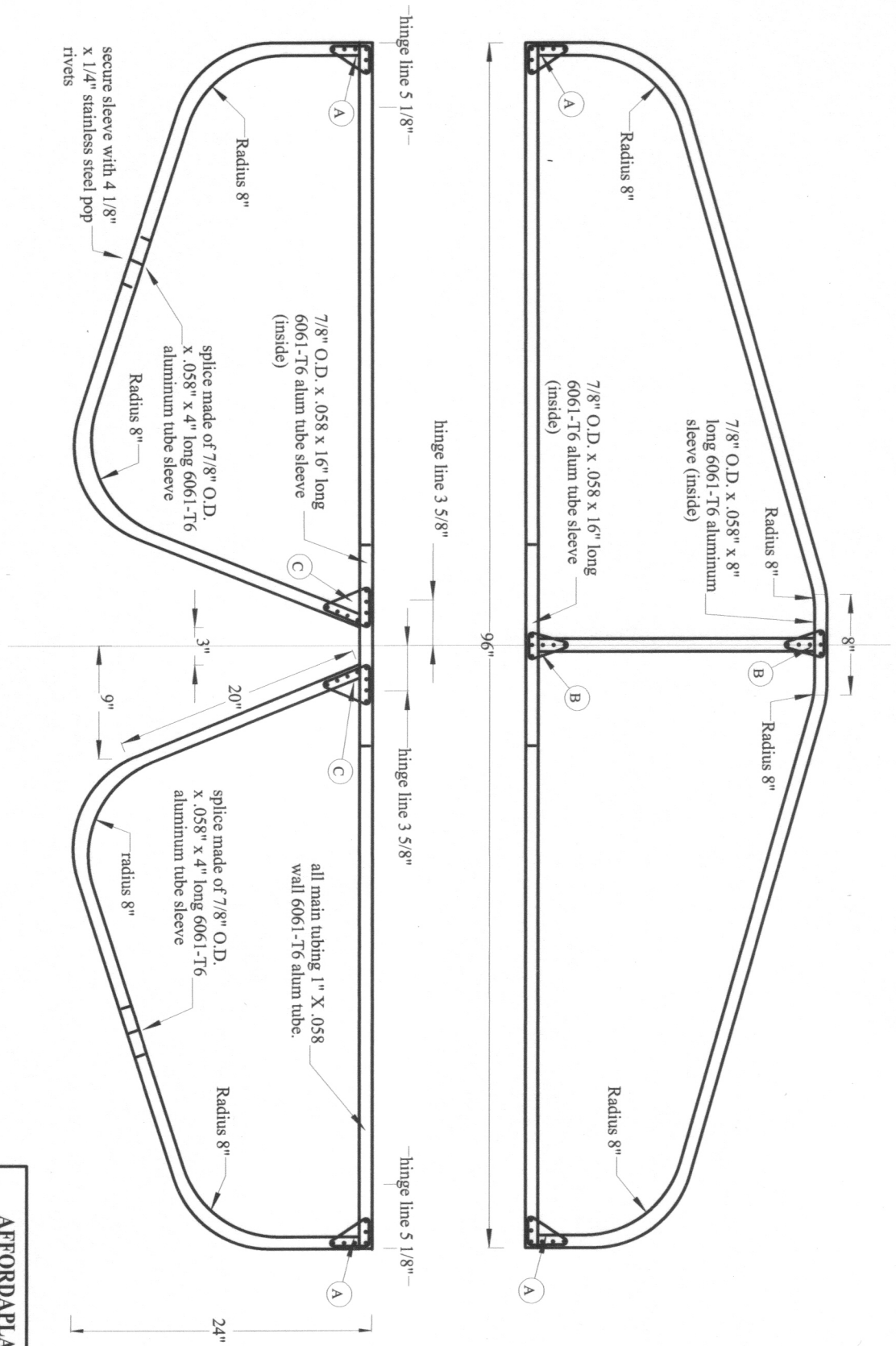
Side View



Top View

NOTE: Use three layers of medium weight boat cloth. Secure to cockpit angles with #30 pk screws spaced 1" apart.

<b>AFFORDAPLANE</b>	
<b>Description:</b> Cowling Top View / Side View	
Drawing#	23

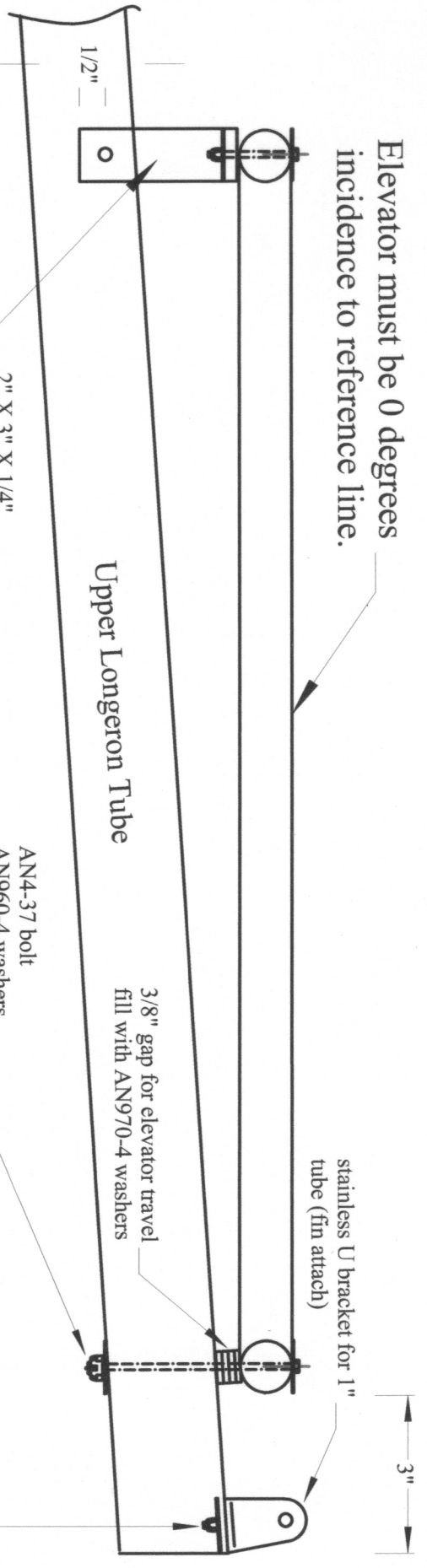


**AFFORDAPLANE**

<b>AFFORDAPLANE</b>	
<b>Description</b>	Elevator Layout
	Top View
<b>Drawing#</b>	24



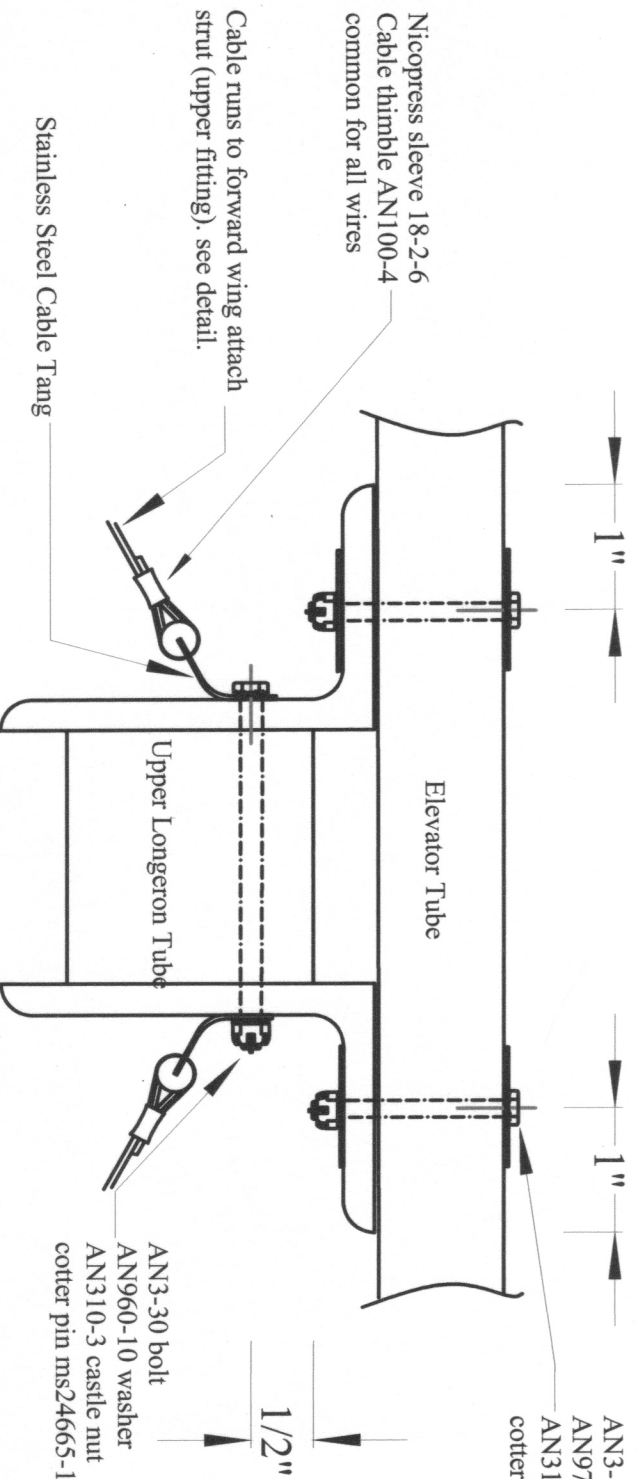
Elevator must be 0 degrees incidence to reference line.



AN4-37 bolt  
 AN960-4 washers  
 AN310-4 castle nut  
 cotter pin ms24665-132

AN4-5A bolt  
 AN960-416 washer  
 AN365-428 Nylock nut

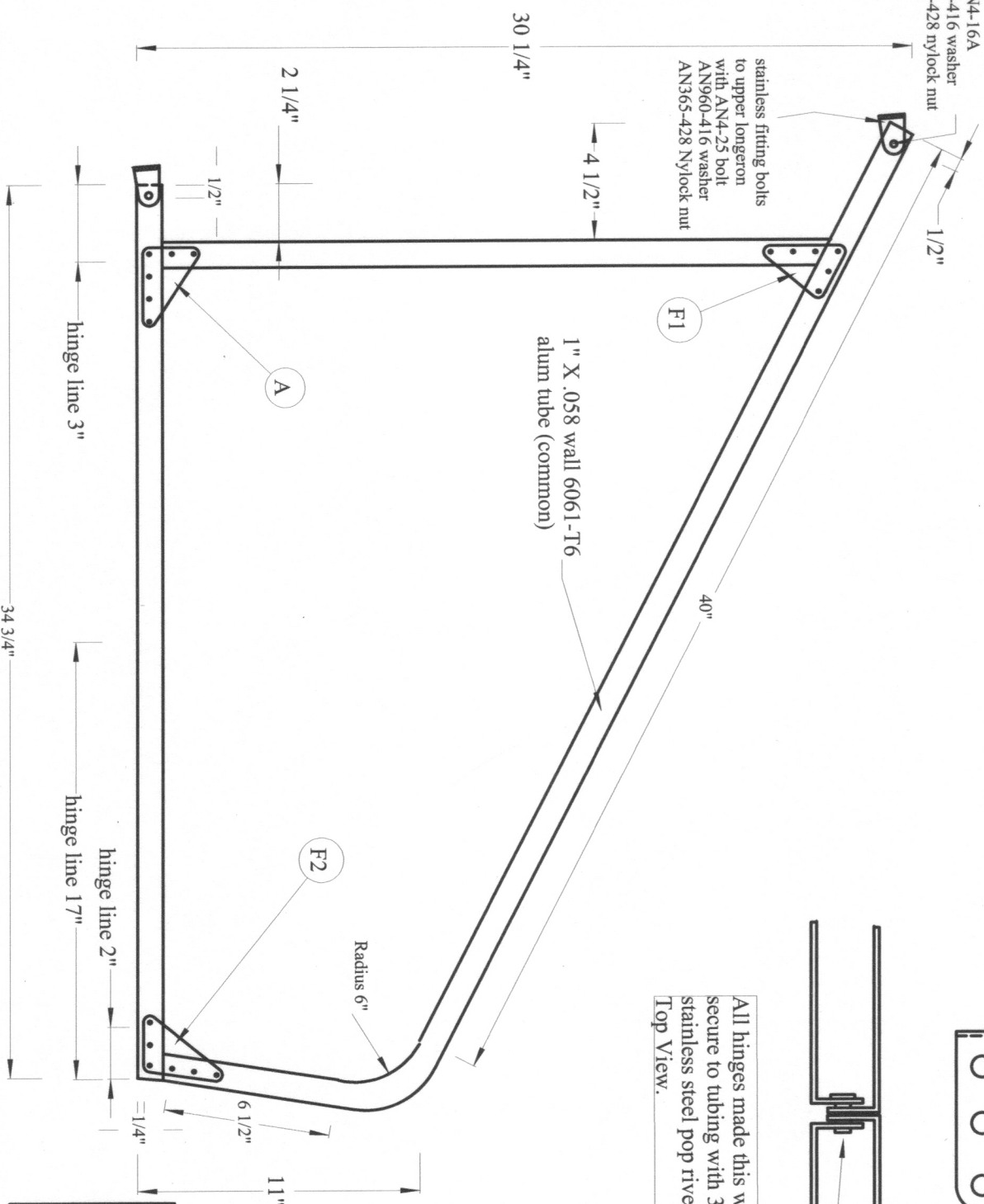
AN3-16 bolt  
 AN970-3 washers  
 AN310-3 castle nut  
 cotter pin ms24665-132



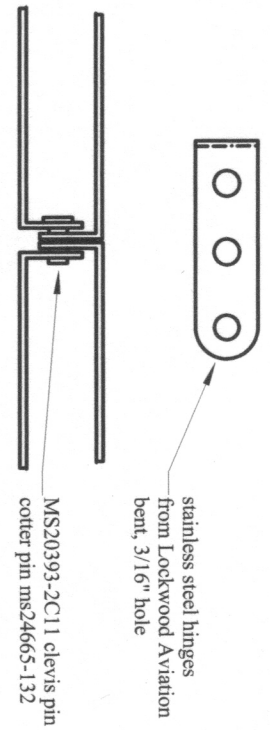
<b>AFFORDAPLANE</b>	
Description: Elevator Attach / Incidence	
Drawing#	26

Bolt AN4-16A  
AN960-416 washer  
AN365-428 nylock nut

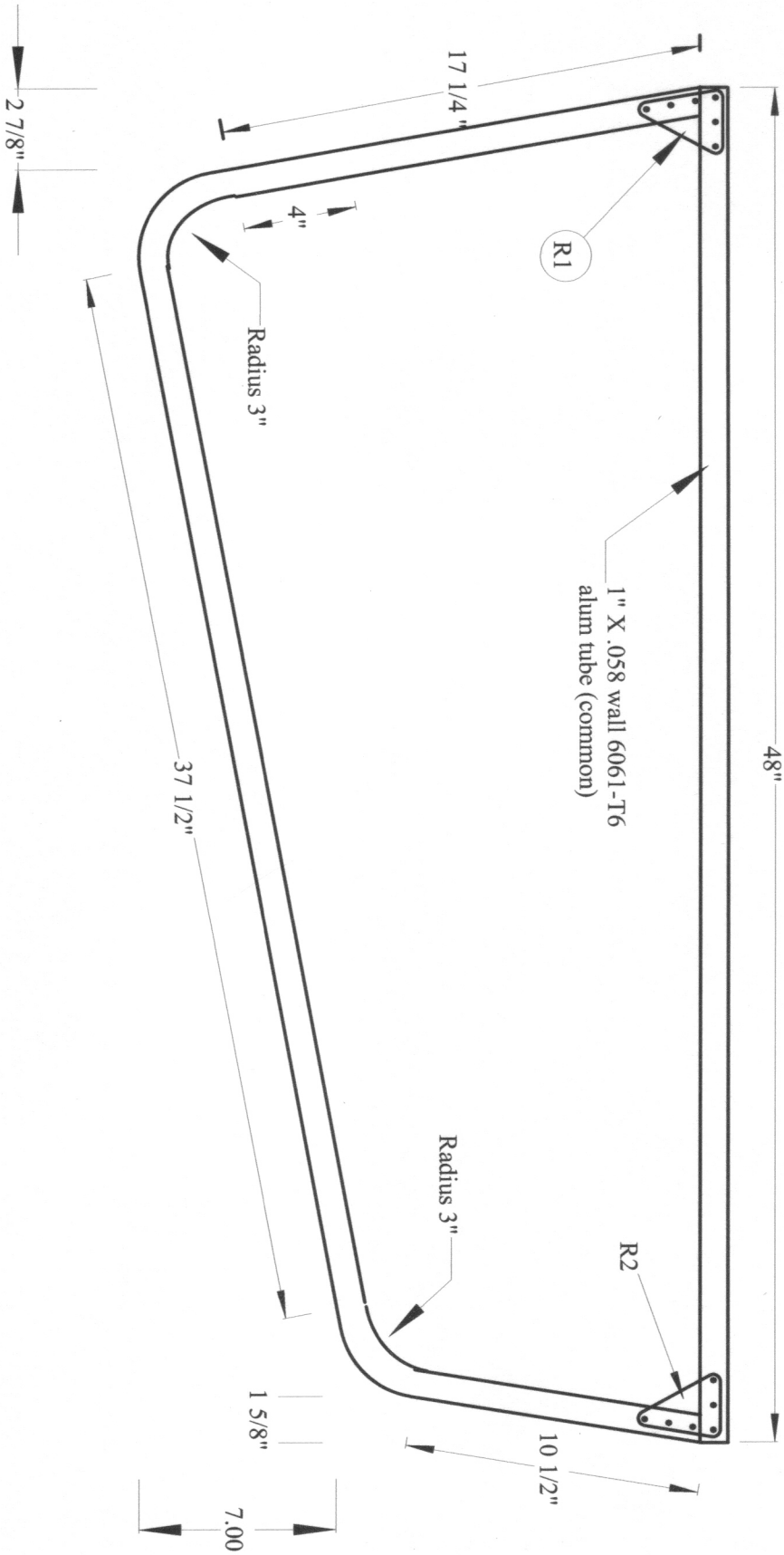
stainless fitting bolts  
to upper longeron  
with AN4-25 bolt  
AN960-416 washer  
AN365-428 Nylock nut



All hinges made this way.  
secure to tubing with 3/16"  
stainless steel pop rivets.  
Top View.

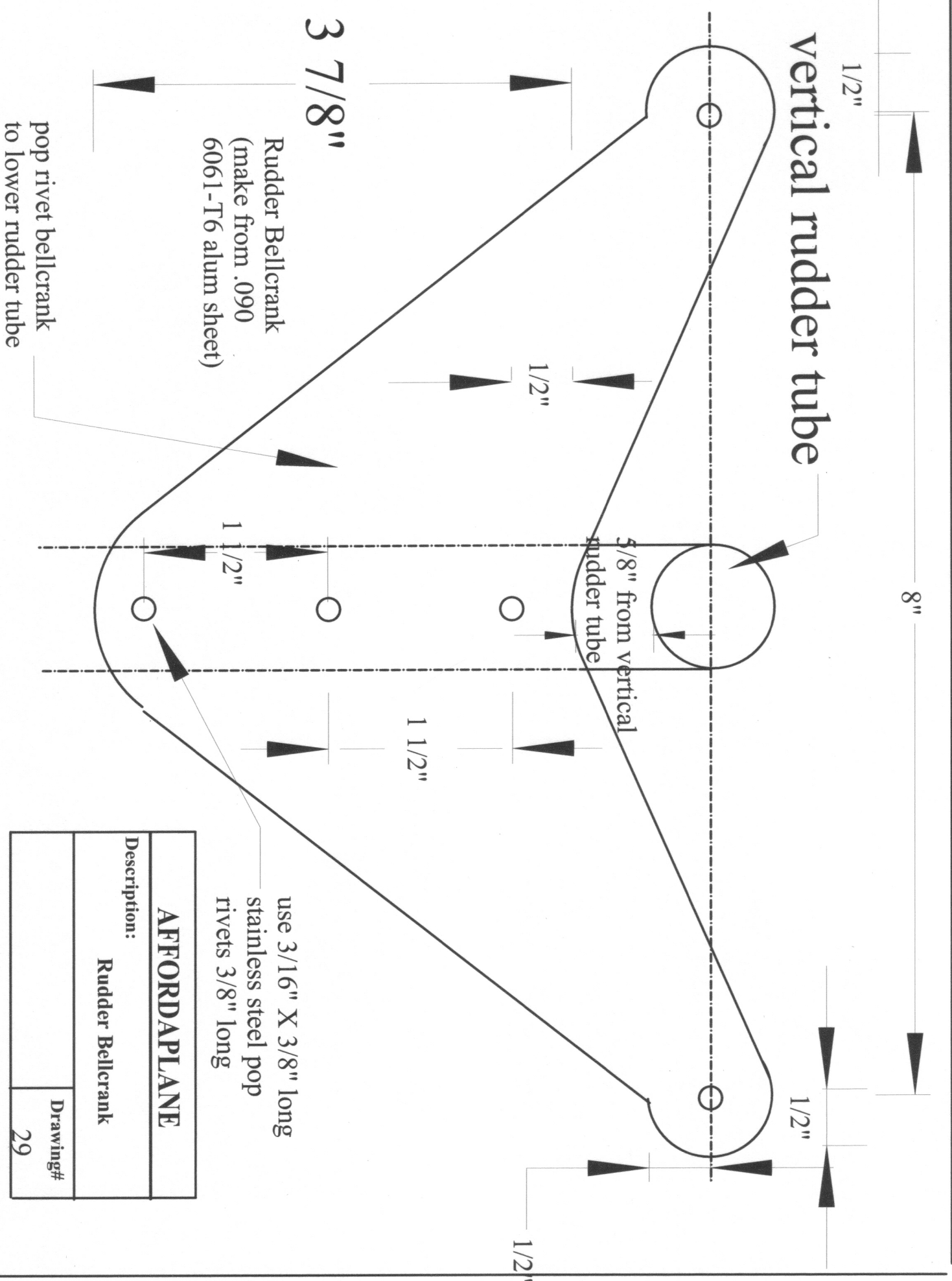


<b>AFFORDAPLANE</b>	
<b>Description:</b>	Fin
	Drawing# 27

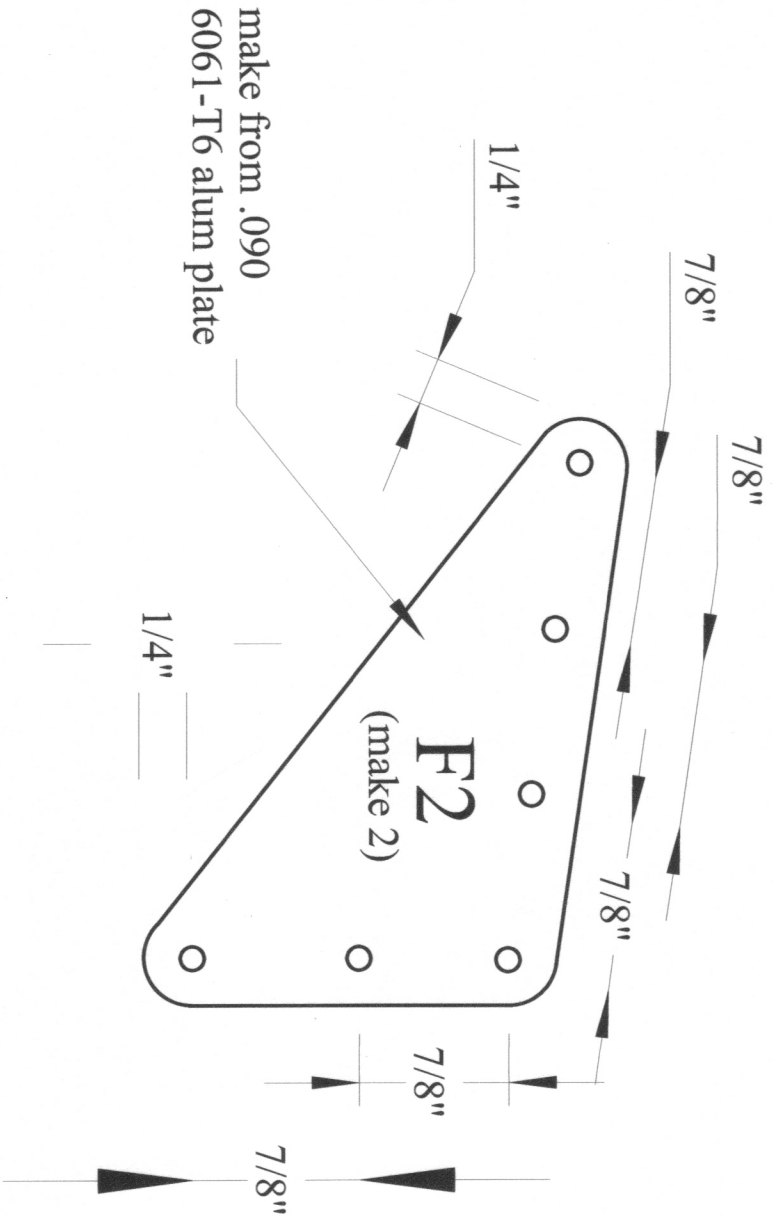


<b>AFFORDAPLANE</b>	
Description: Rudder	
Drawing#	28





<b>AFFORDAPLANE</b>	
Description: Rudder Bellcrank	
Drawing#	29



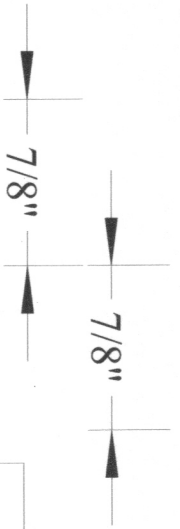
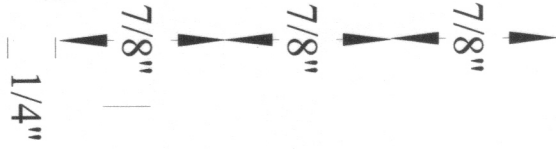
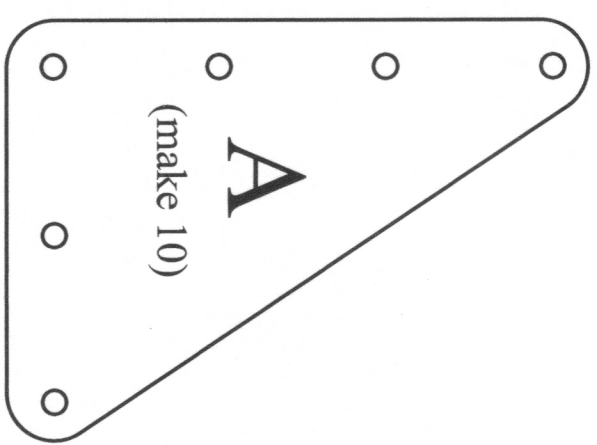
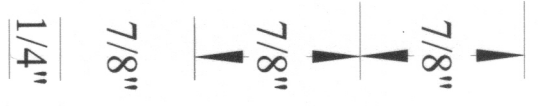
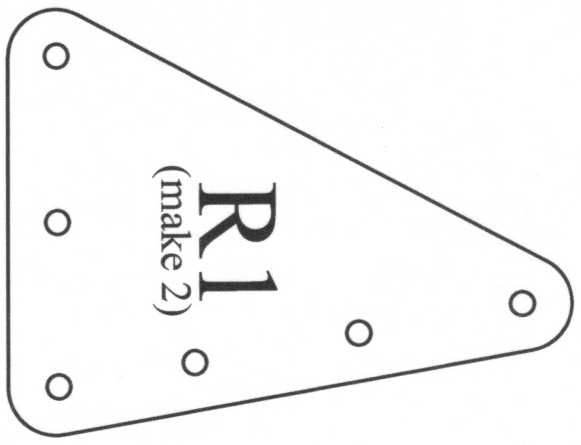
**AFFORDAPLANE**

Description:

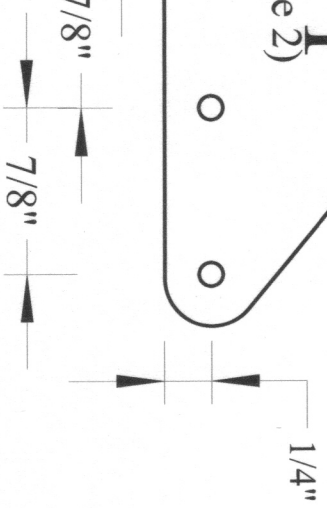
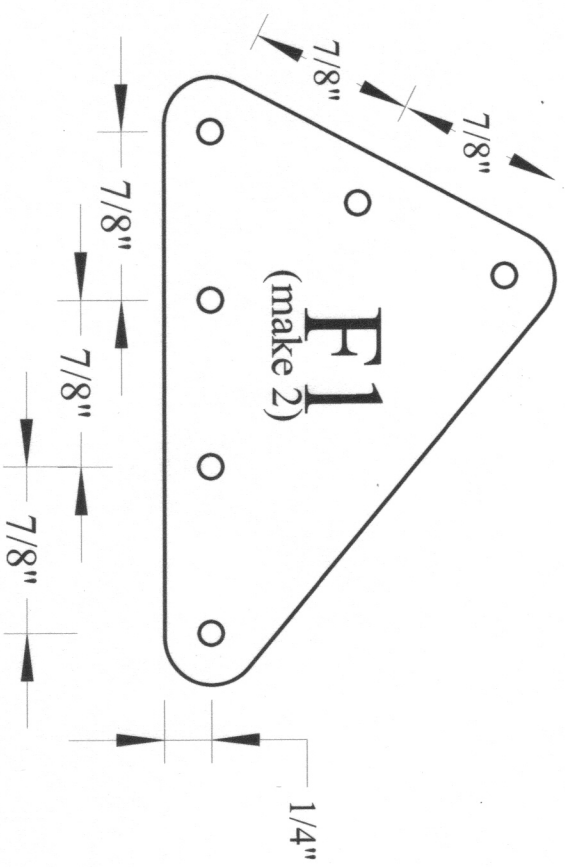
F2 Fitting

Drawing#

29A



All fittings made from  
.090 6061-T6 alum plate

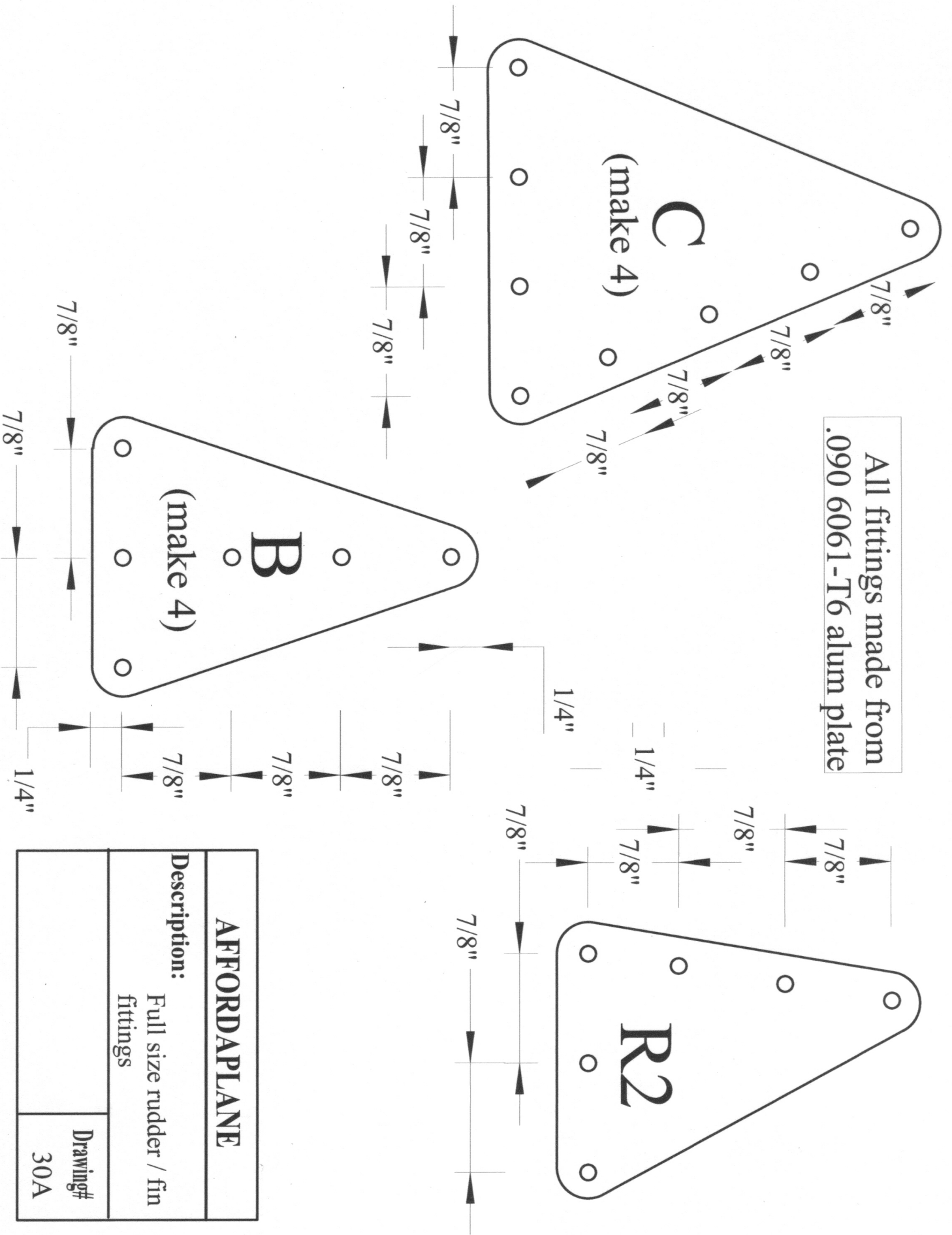


**AFFORDAPLANE**

**Description:**  
Full size rudder / fin fittings

	<b>Drawing#</b>
	30

All fittings made from  
.090 6061-T6 alum plate



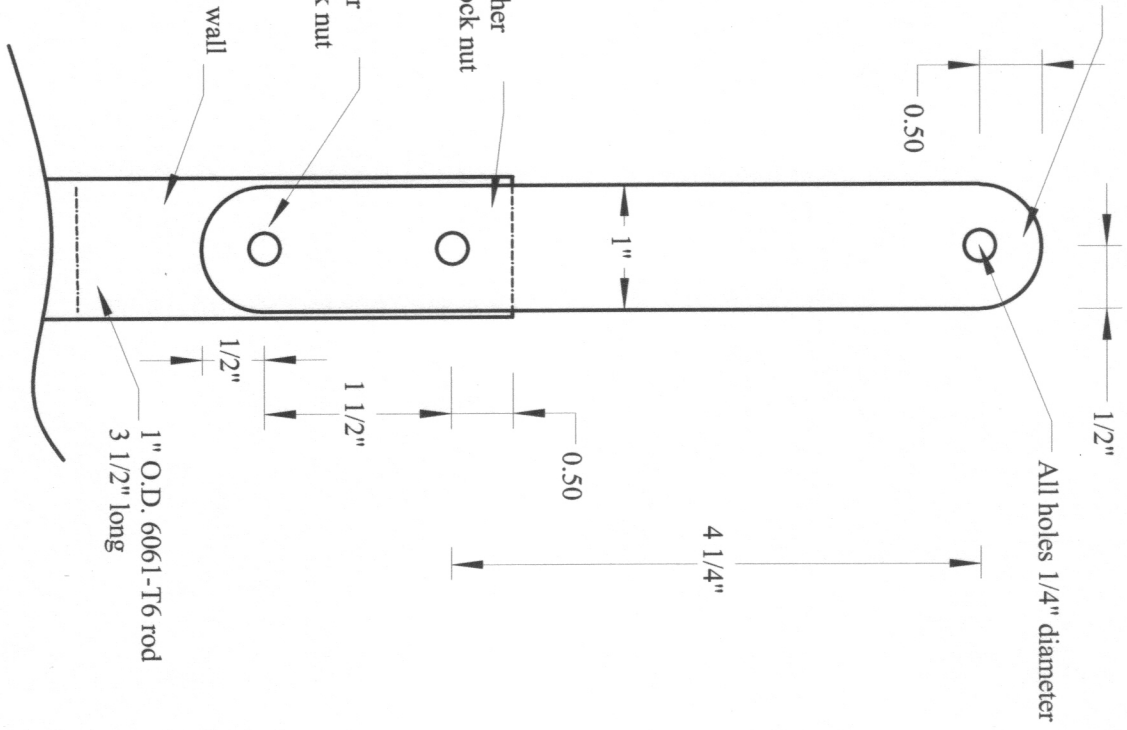
**AFFORDAPLANE**

**Description:**  
Full size rudder / fin fittings

	Drawing# 30A
--	-----------------



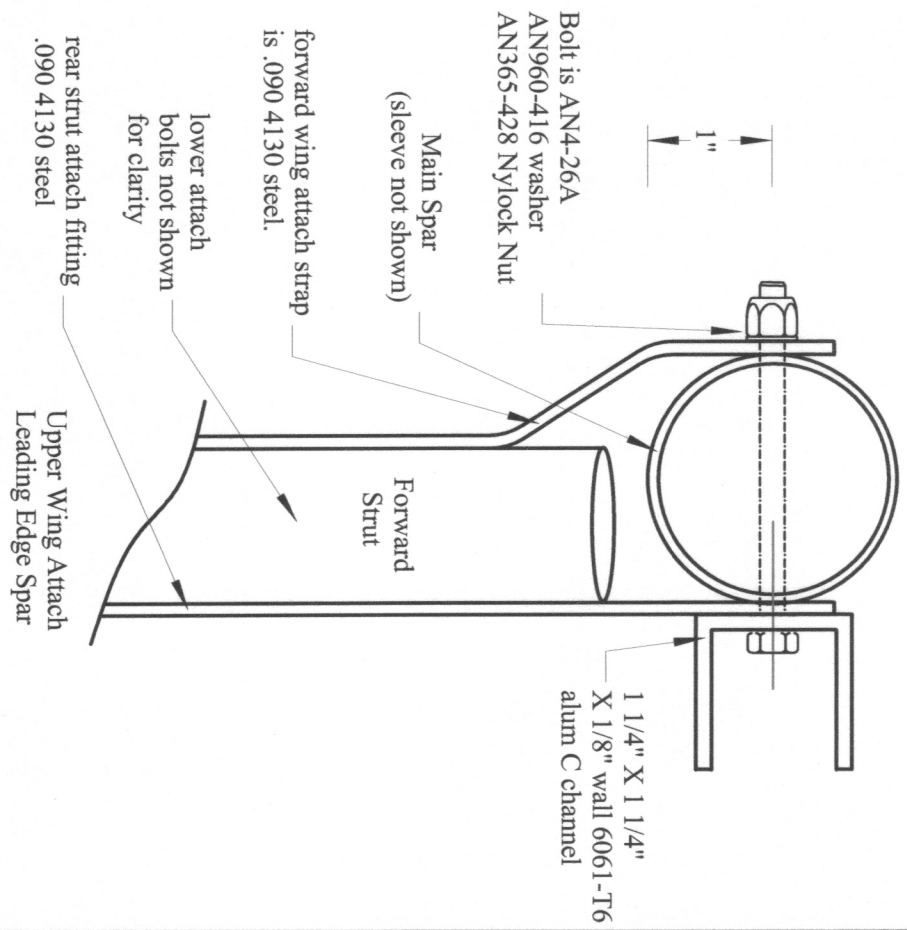
Lower strut attach fitting  
(forward strut) is .090  
thick 4130 steel



- AN4-17A bolt
- AN960-416 washer
- AN365-428 nylock nut
- AN4-16A bolt
- AN960-416 washer
- AN365-428 nylock nut
- strut is 1 1/8" X .058 wall  
6061-T6 alum tube

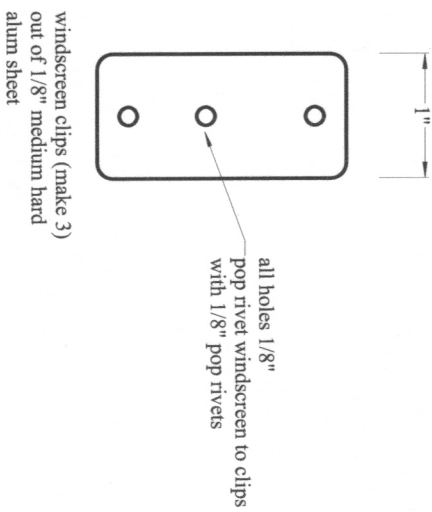
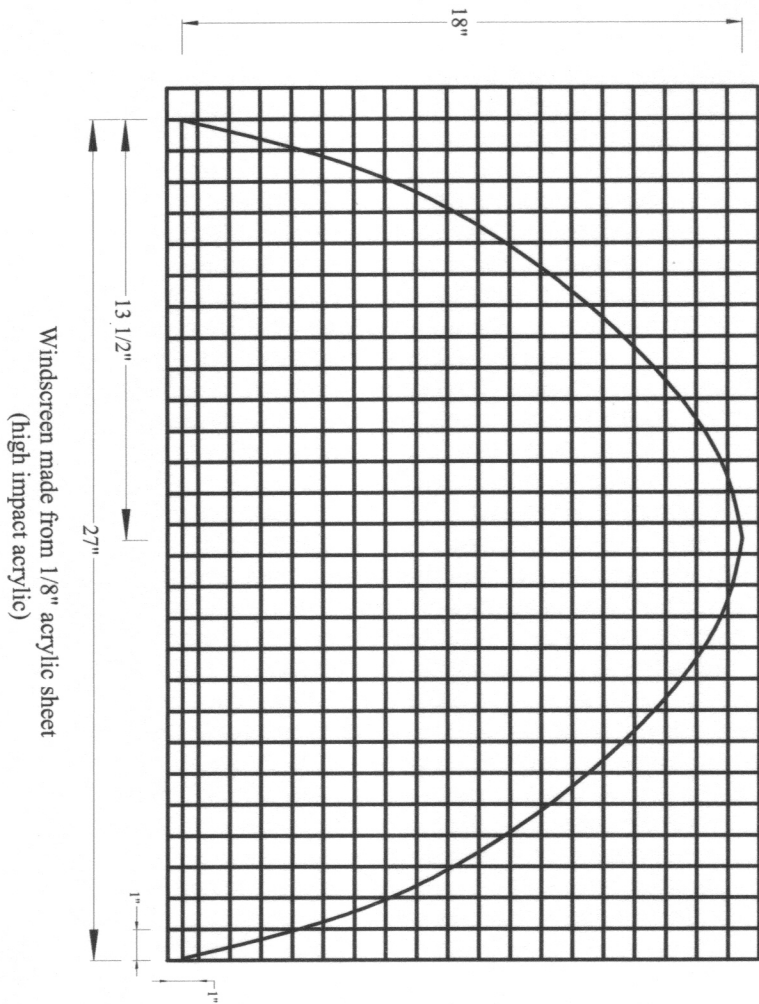
Upper Strut Attach  
(rear strut)

- Bolt is AN4-26A
- AN960-416 washer
- AN365-428 Nylock Nut



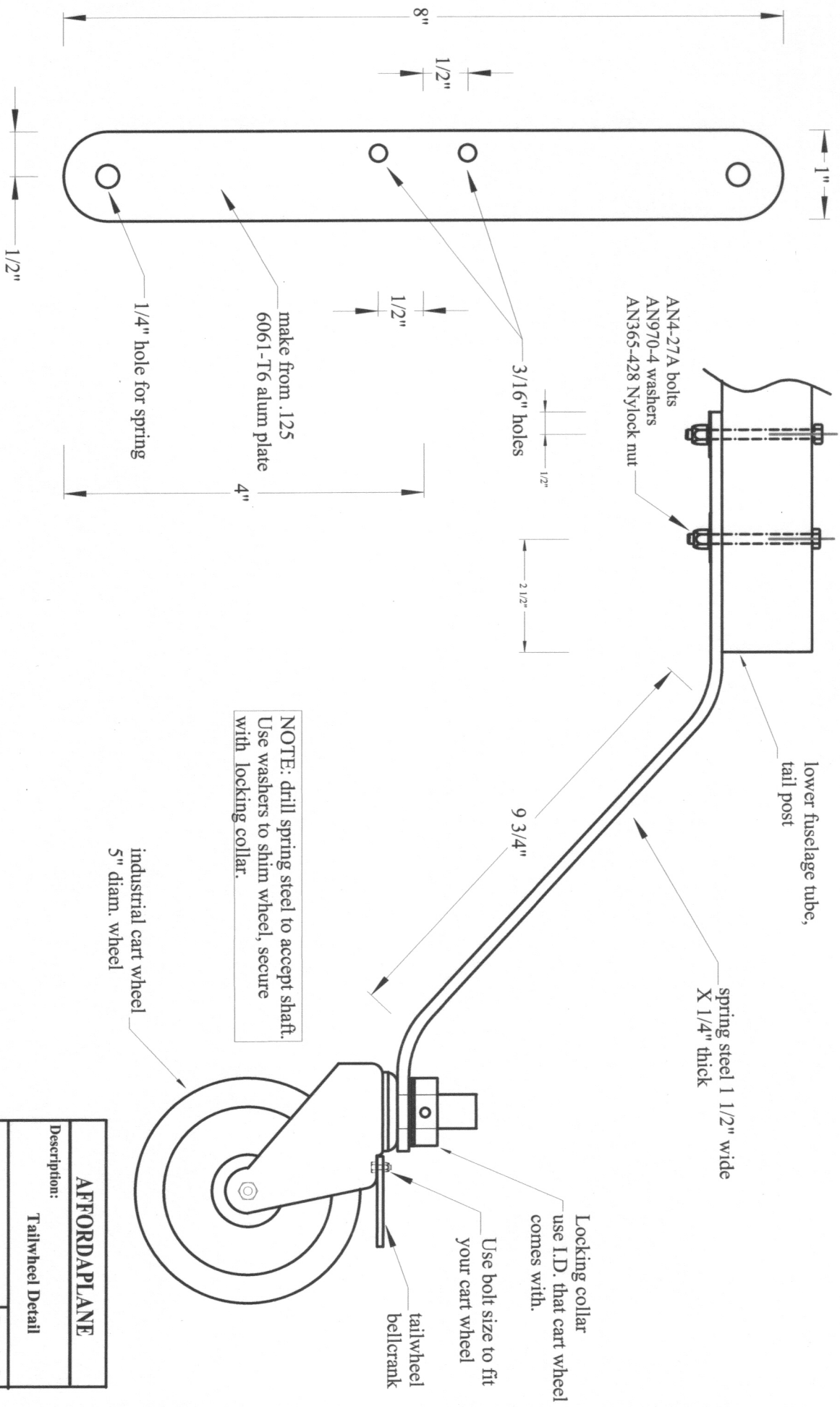
NOTE: Make front strap longer to allow for bend. Back drill through rear strap and strut to get hole locations for forward strap. Once drilled remove and clean up strap to allow 1/2" edge grain margin for lower bolt.

<b>AFFORDAPLANE</b>	
Description	Wing Attach Fittings
	Drawing#
	32



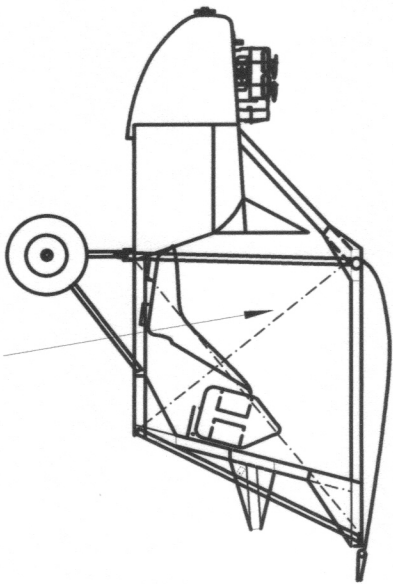
<b>AFFORDAPLANE</b>	
Description:	Windscreen
Drawing#	33

Tailwheel Bellcrank



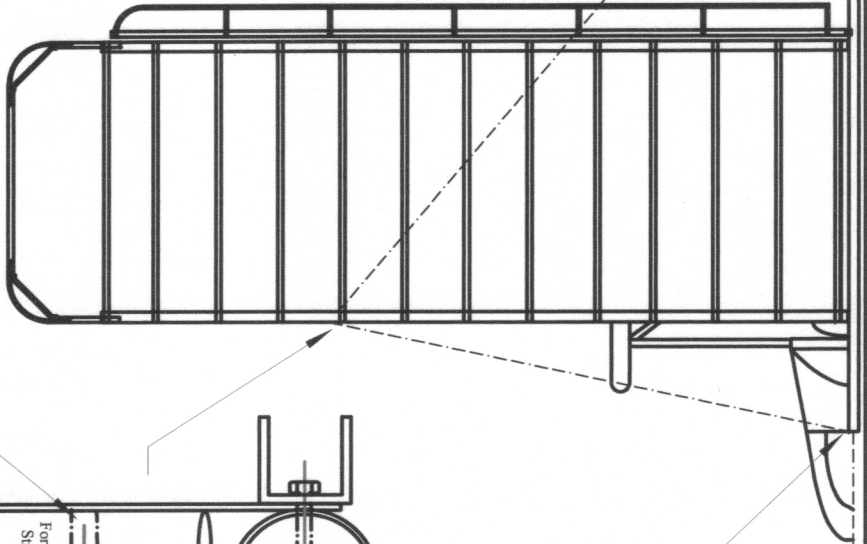
<b>AFFORDAPLANE</b>	
Description: Tailwheel Detail	
Drawing#	34





Cross bay wires 3/32" 7 X 19 strand  
Use same assembly as detail on right side of page. Tangs attach to most upper bolts and most lower bolts.

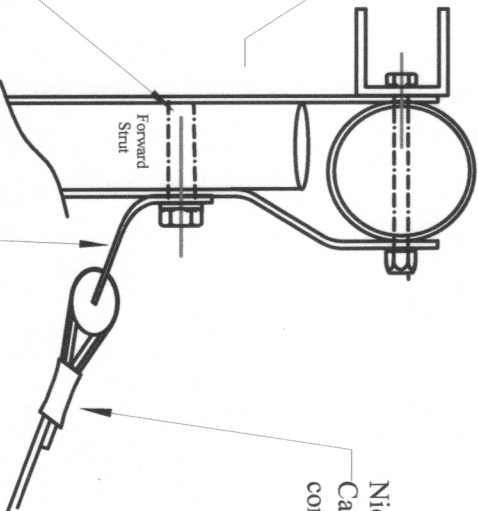
3/32" cable 7 X 19 strand  
see elevator attach detail.



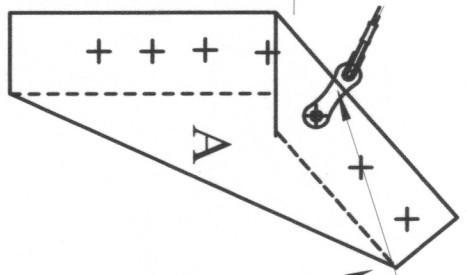
upper bolt

Upper Wing Attach  
Leading Edge Spar

Stainless Steel Cable Tang



Forward Strut

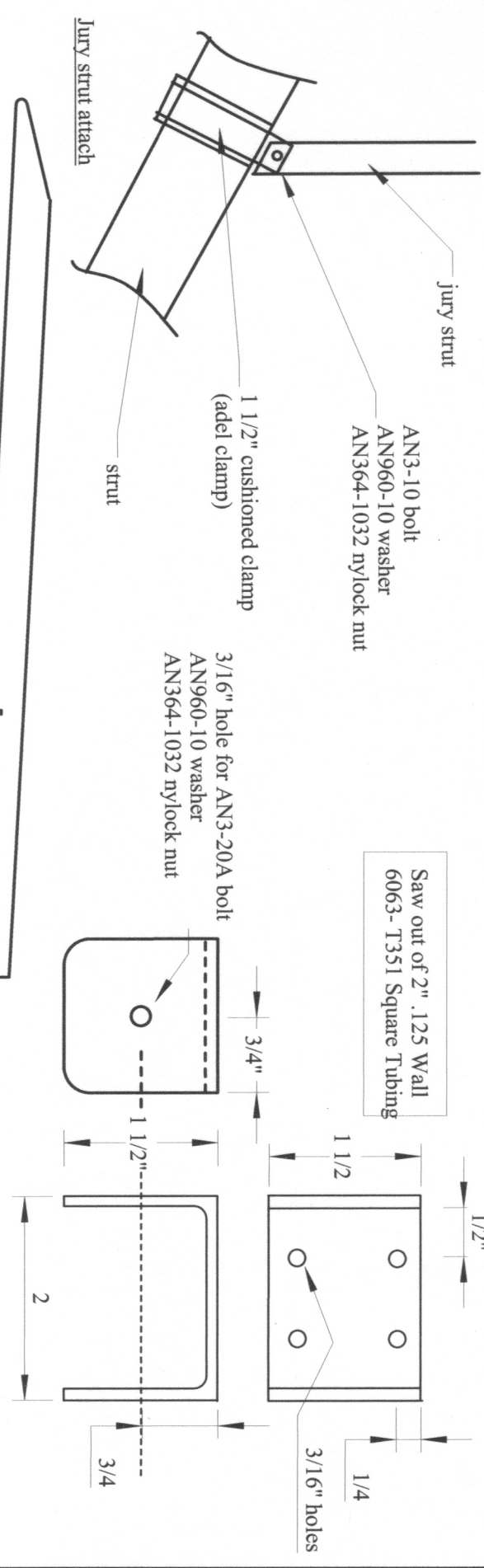


Stainless Steel Cable tangs  
from Lockwood Aviation  
3/16" holes

Nicopress sleeve 18-2-6  
Cable thimble AN100-4  
common for all wires

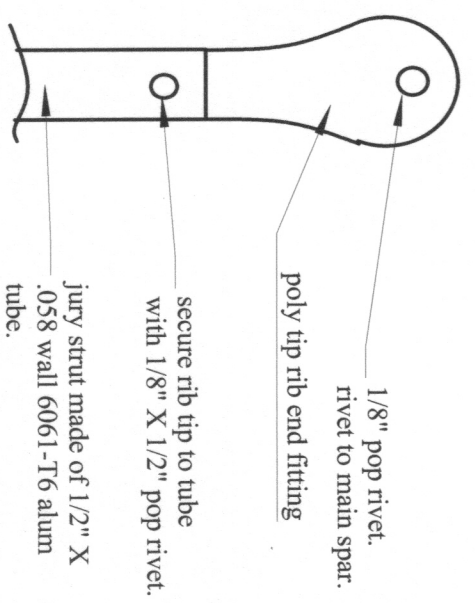
Nicopress sleeve 18-2-6  
Cable thimble AN100-4  
common for all wires

Affordaplane	
Description:	Rigging
	Drawing#
	35



**Diagonal Support Bracket**

4 Required



jury struts located 49" from top of strut. Make 2 front and two rear struts.

<b>AFFORDAPLANE</b>	
Description:	
Diagonal brackets / jury struts	
Drawing#	36

# Full Size

## Gusset A Part 1 of 2

There are two parts to A. These two parts make up ONE gusset A

Glue this line to part A



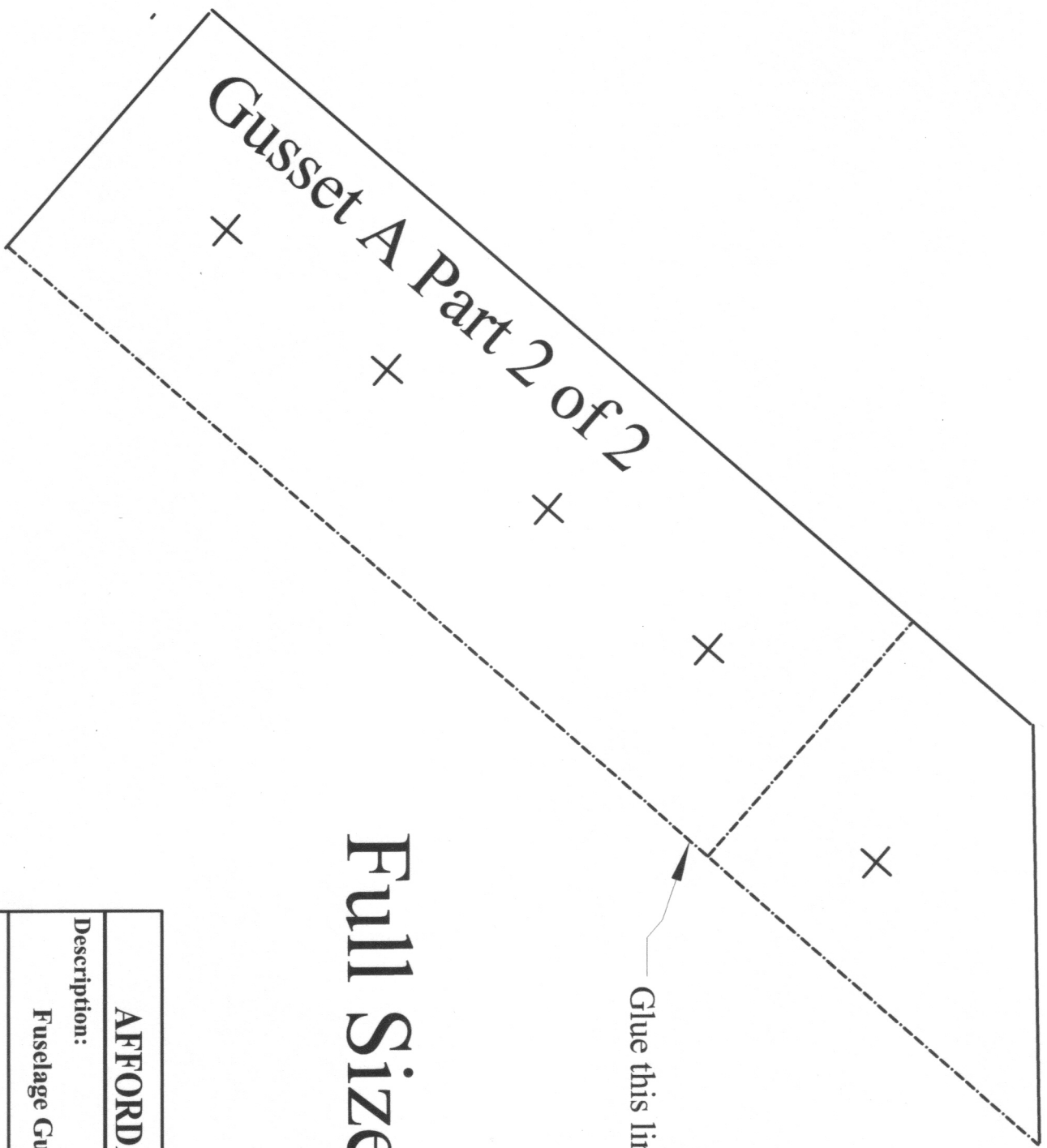
**AFFORDAPLANE**

Description:

Fuselage Gussets A, Part 2

Drawing#

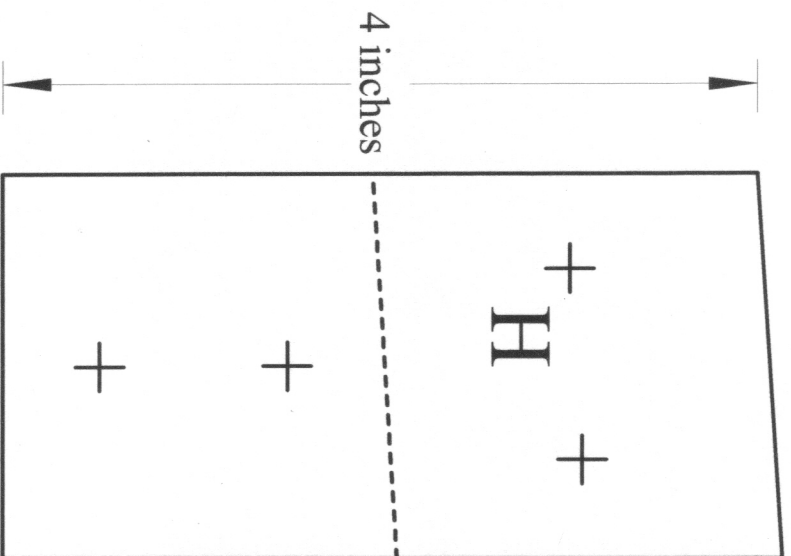
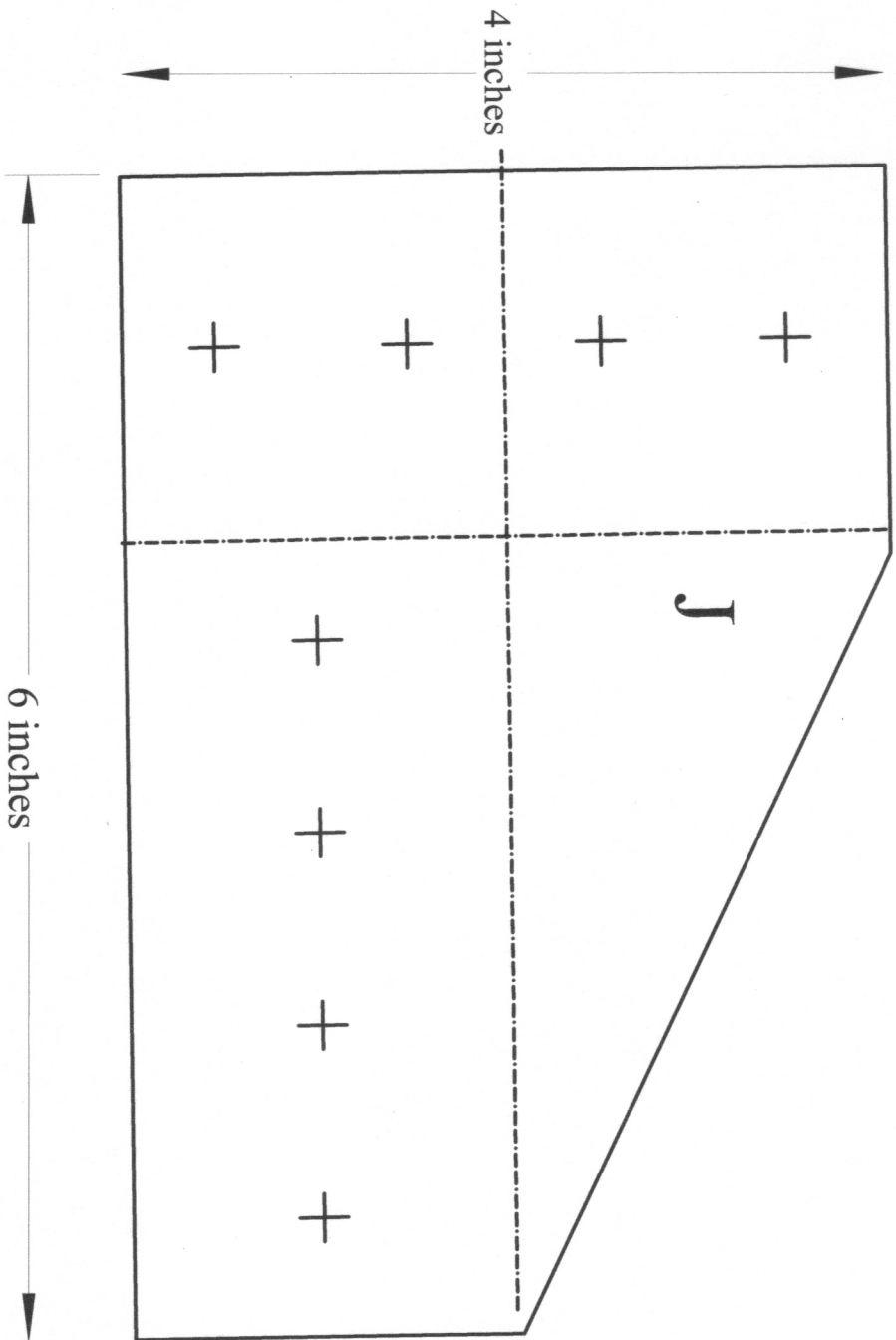
37



**Full Size**

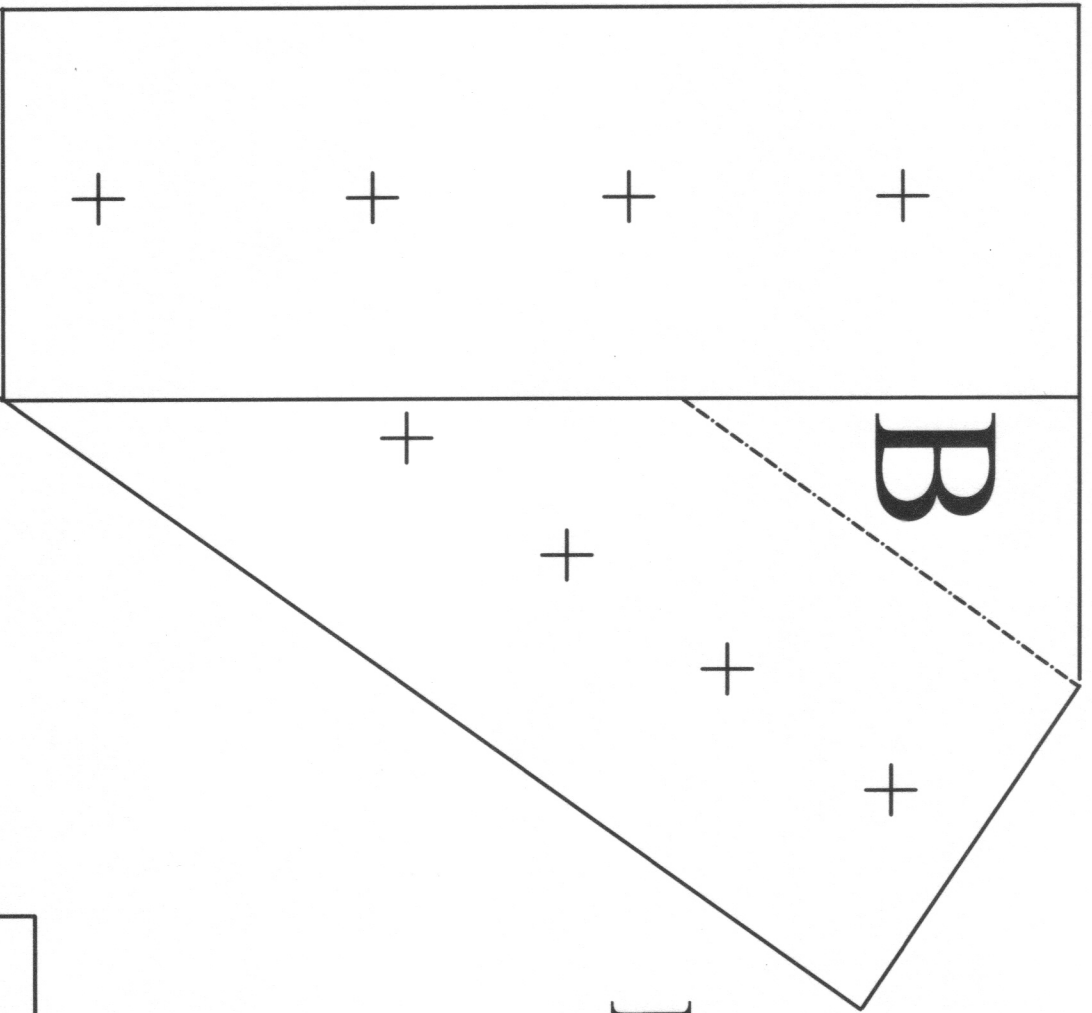
<b>AFFORDAPLANE</b>	
<b>Description:</b>	
Fuselage Gussets A, Part 2 of 2	
<b>Drawing#</b>	37A

There are two parts to A. These two parts make up ONE gusset A



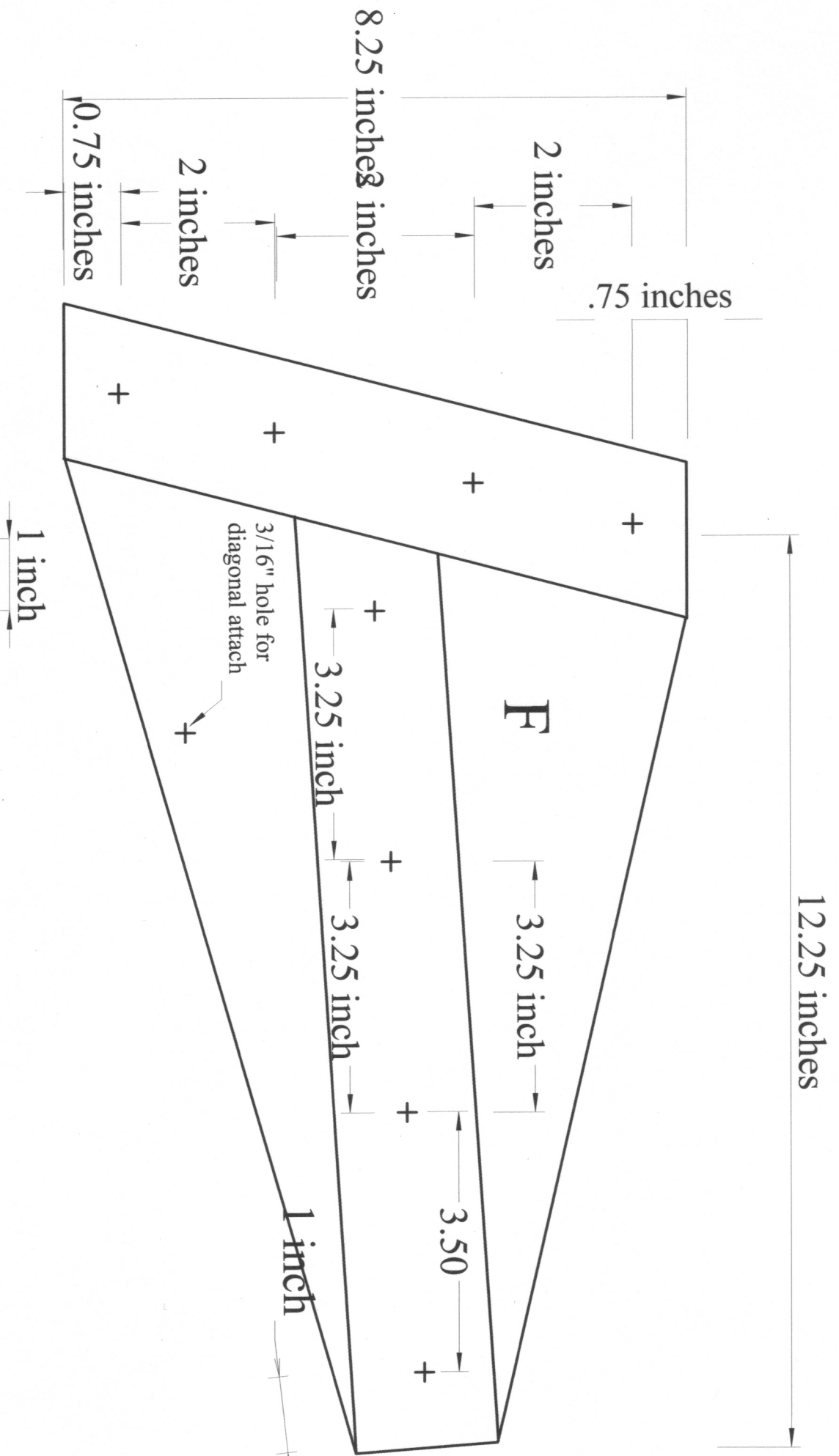
# Full Size

<b>AFFORDAPLANE</b>	
Description: Fuselage Gussets J and H	
Drawing#	38



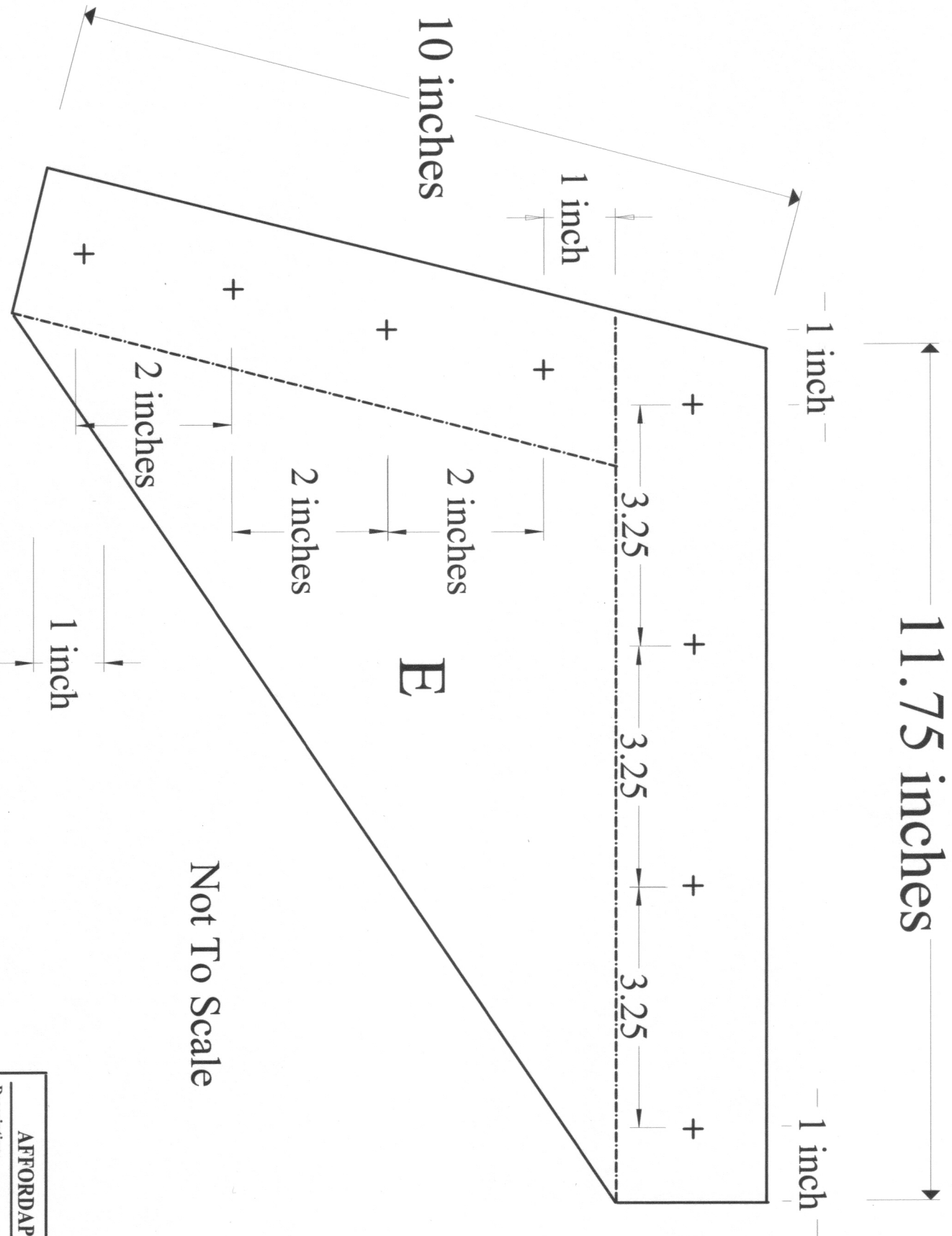
**Full Size**

<b>AFFORDAPLANE</b>	
<b>Description:</b>	
Fuselage Gusset B	
<b>Drawing#</b>	
38A	



Not to scale

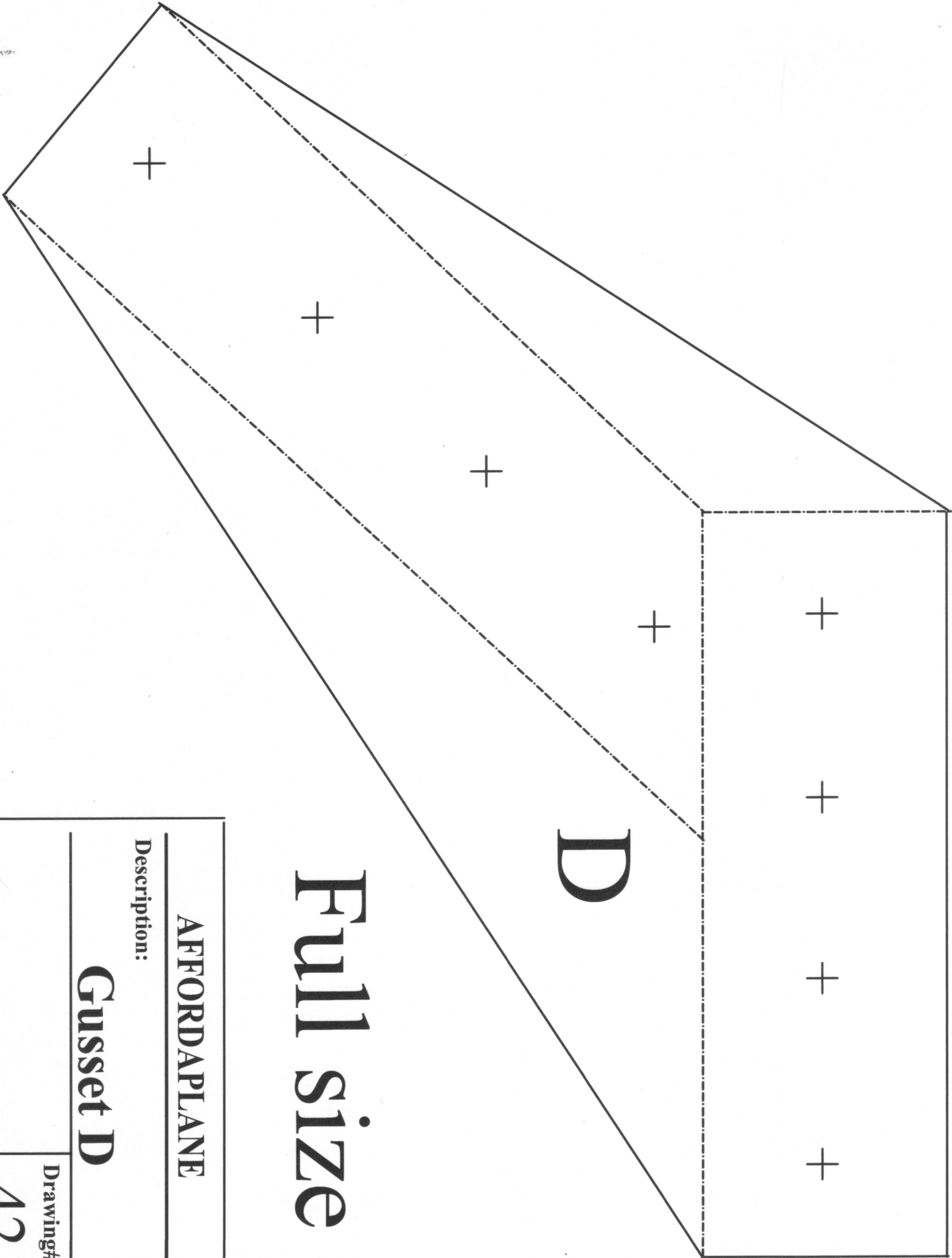
AFFORDAPLANE	
Description:	
Gusset F	
Drawing#	39



AFFORDAPLANE	
Description:	
Gusset E	
Drawing#	40







D

Full size

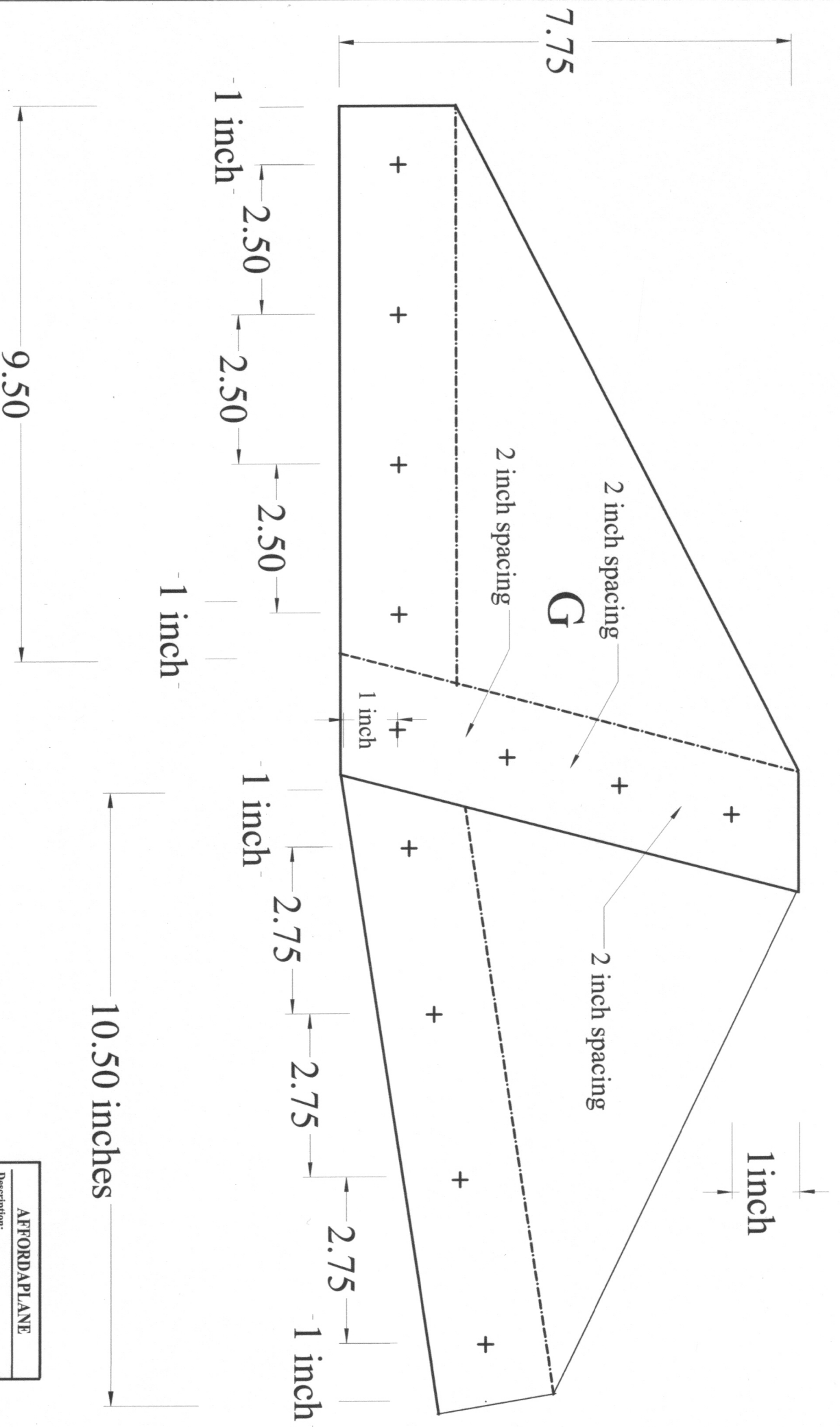
AFFORDAPLANE

Description:

Gusset D

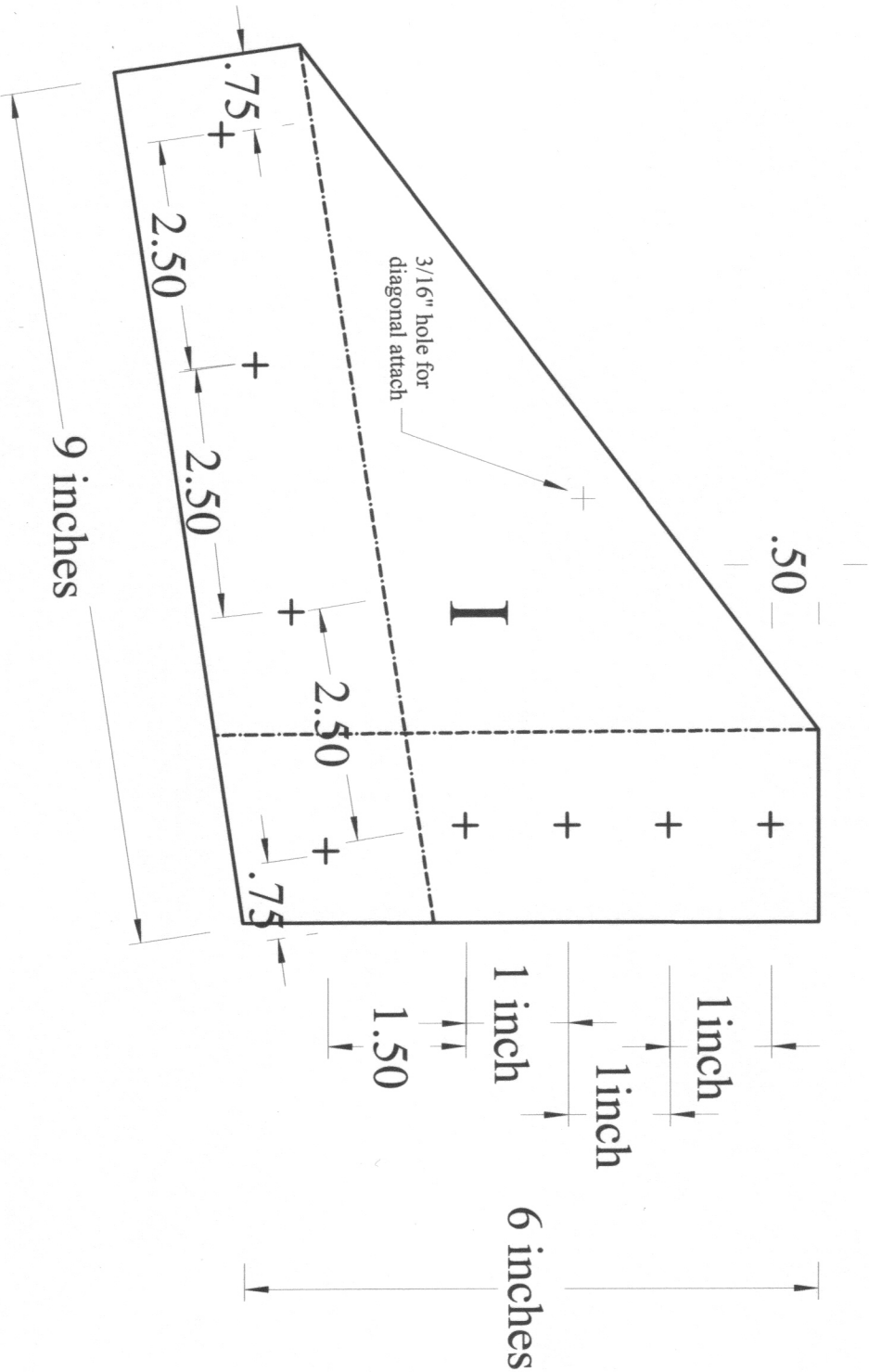
Drawing#

42



Not to scale

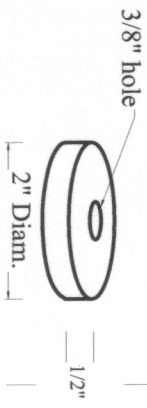
AFFORDAPLANE	
Description:	Gusset G
Drawing#	43



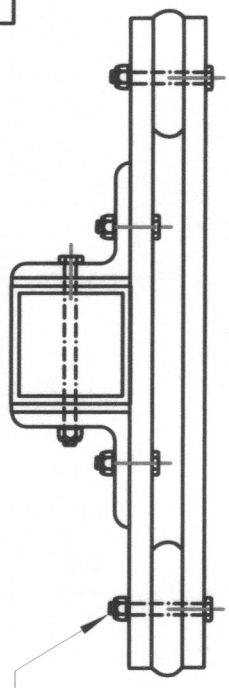
Not to scale

AFFORDAPLANE	
Description:	Gusset F
Drawing#	44

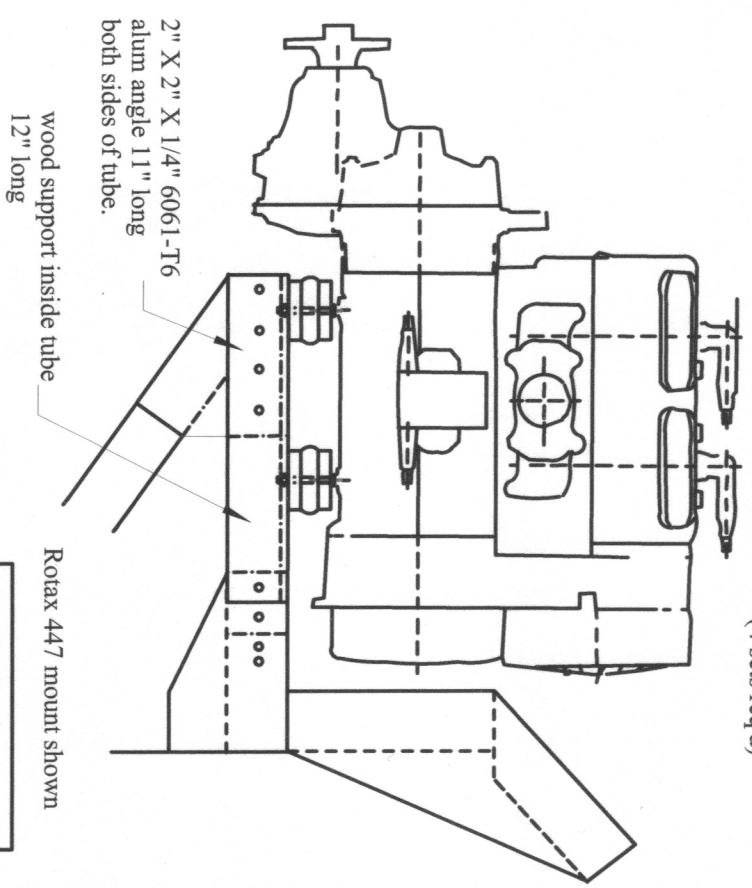




Rubber Bushing

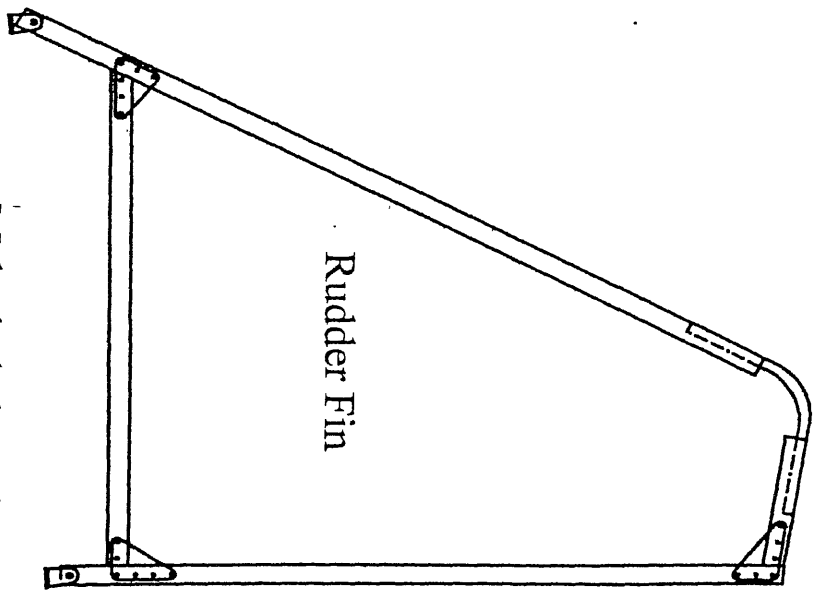


- AN4-10 bolt
- AN365-428A nut
- AN960-416 washers
- (4 sets req'd)

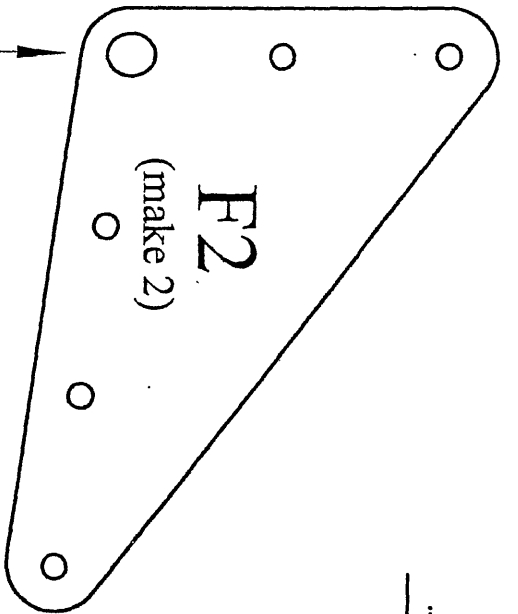


NOTE: Clamp angles in place  
and back drill through existing holes  
for correct placement.

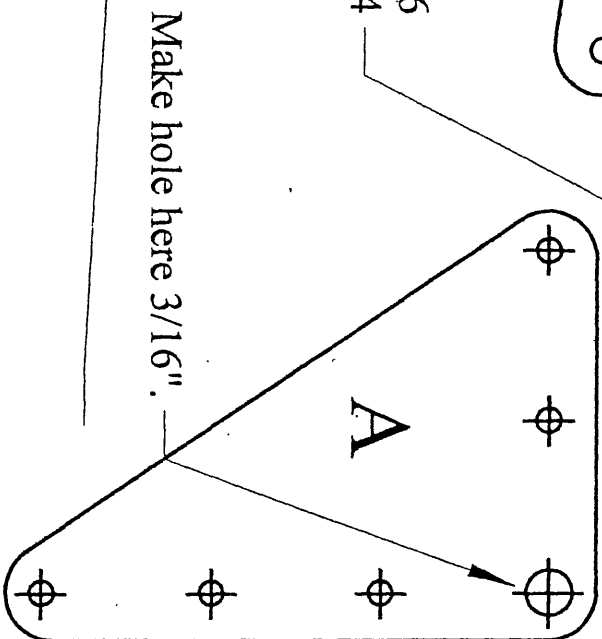
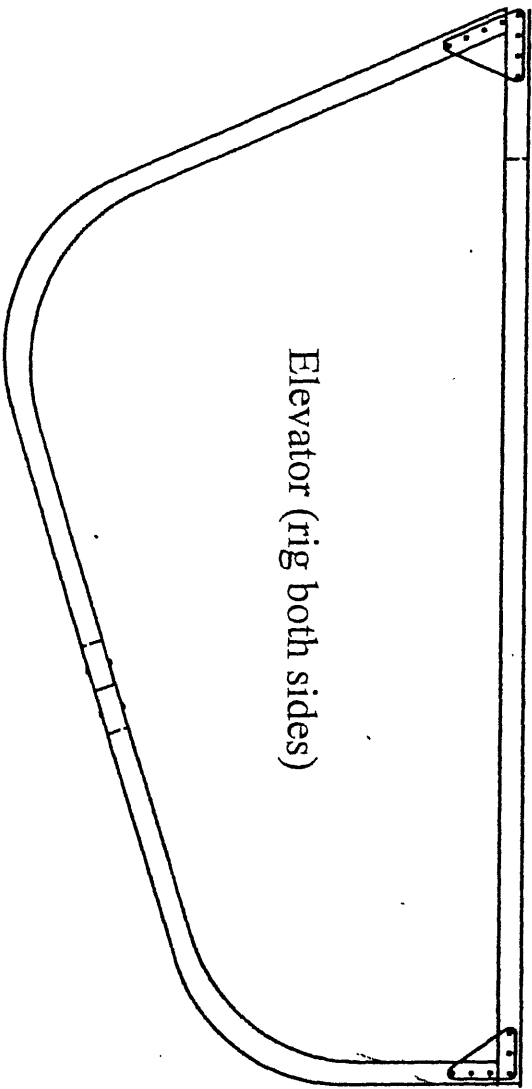
<b>Affordaplane</b>	
<b>Description:</b>	
Motor Mount Details	
Drawn By: Dave Edwards	Drawing#
Date: Aug 24, 2000	46
Copyright 2000 by Dave Edwards Working Group	



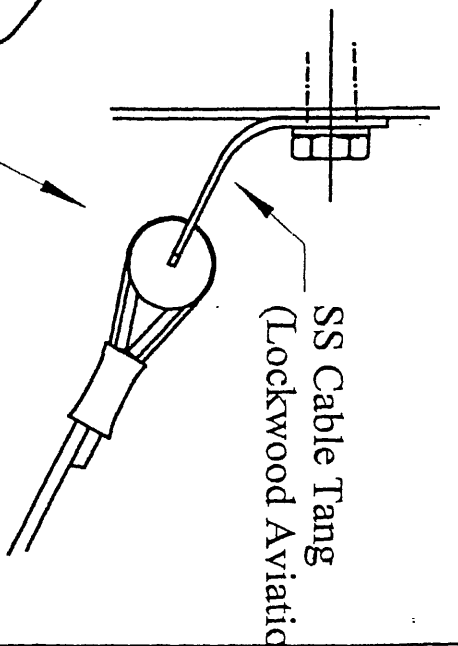
Make hole here for attach 3/16"



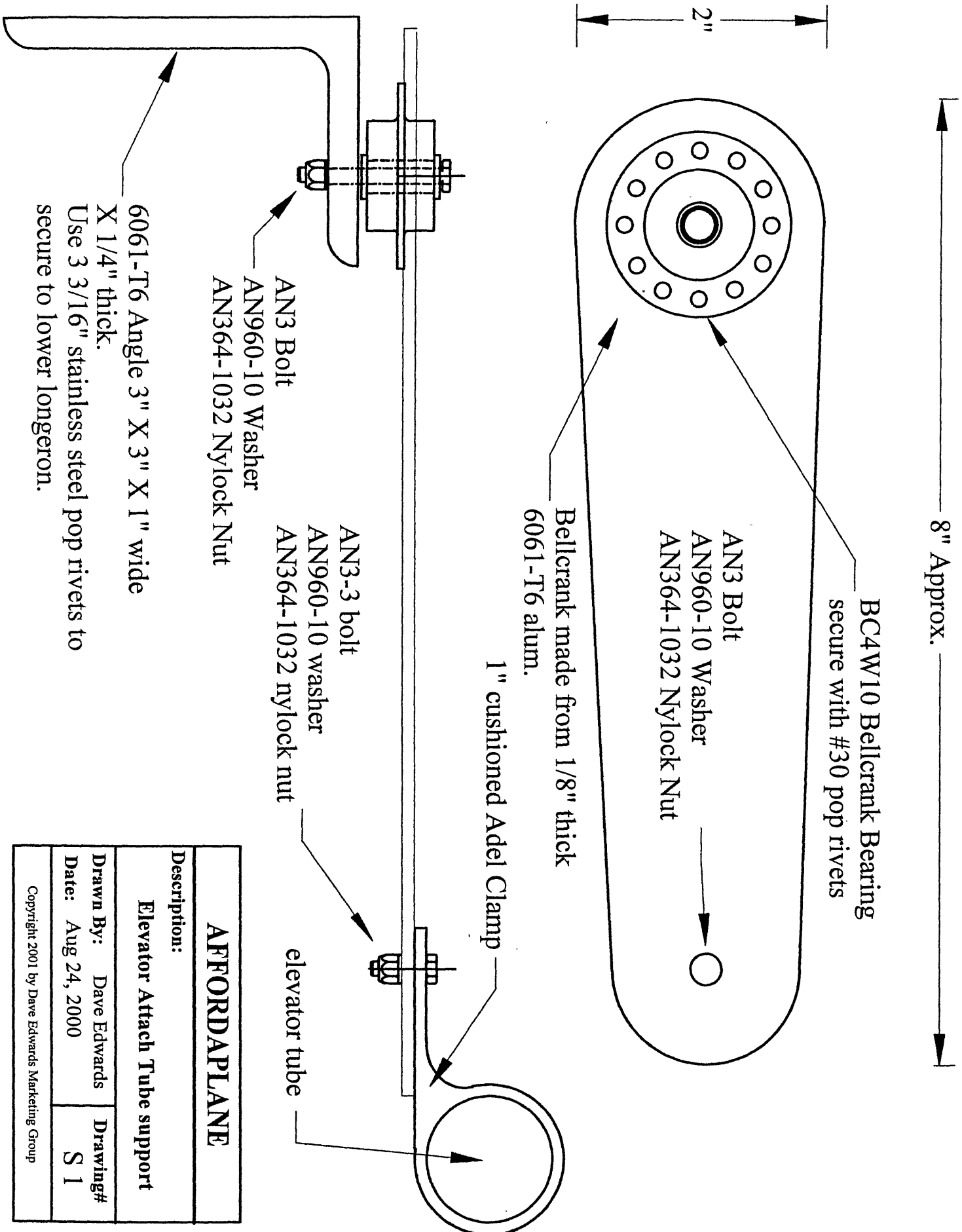
Nicopress sleeve 18-2-6  
Cable thimble AN100-4  
common for all wires



Make hole here 3/16"



<b>AFFORDAPLANE</b>	
Description: <b>Elevator &amp; Rudder Rigging</b>	
Drawn By: Dave Edwards	Drawing#
Date: Aug 24, 2000	S 1
Copyright 2001 by Dave Edwards Marketing Group	



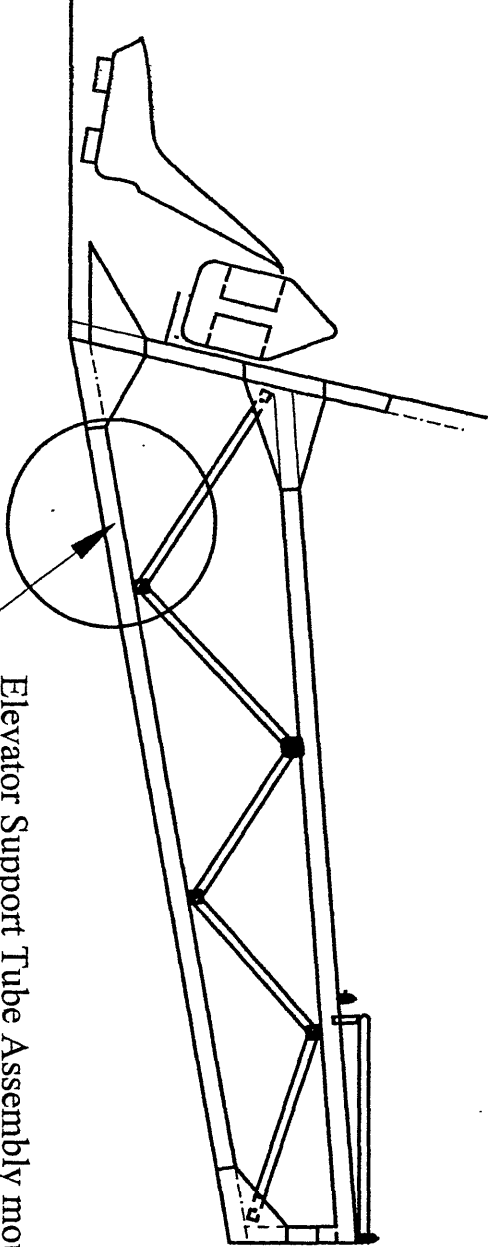
**AFFORDAPLANE**

Description:  
**Elevator Attach Tube support**

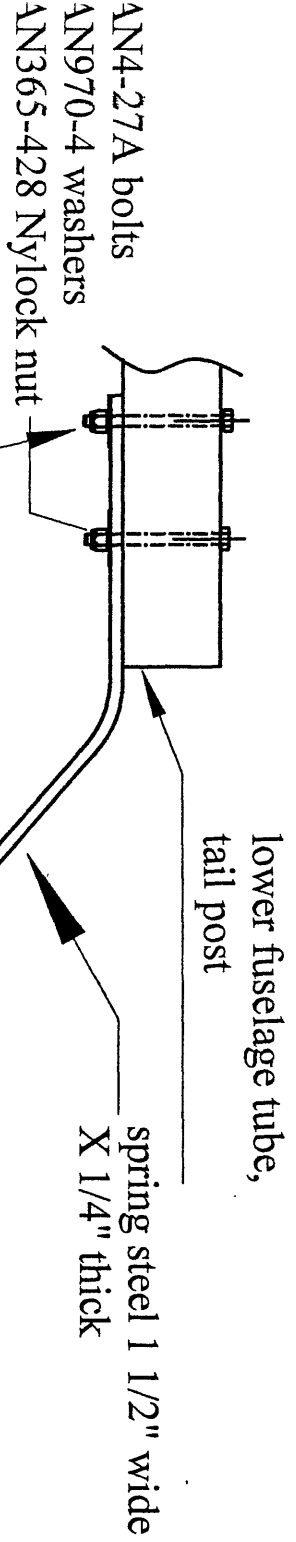
Drawn By: Dave Edwards  
Date: Aug 24, 2000

Drawing#  
S 1





Elevator Support Tube Assembly mounts in this general area.  
 Make sure the assembly supports the tube without bending the tube.  
 You want as straight as possible shot from the stick to the elevator bellcrank.



lower fuselage tube,  
 tail post  
 spring steel 1 1/2" wide  
 X 1/4" thick

Attach lower tail wires to this bolt with  
 2 SS cable tangs from Lockwood.  
 (the same cable tangs described on page 5  
 of the plans)

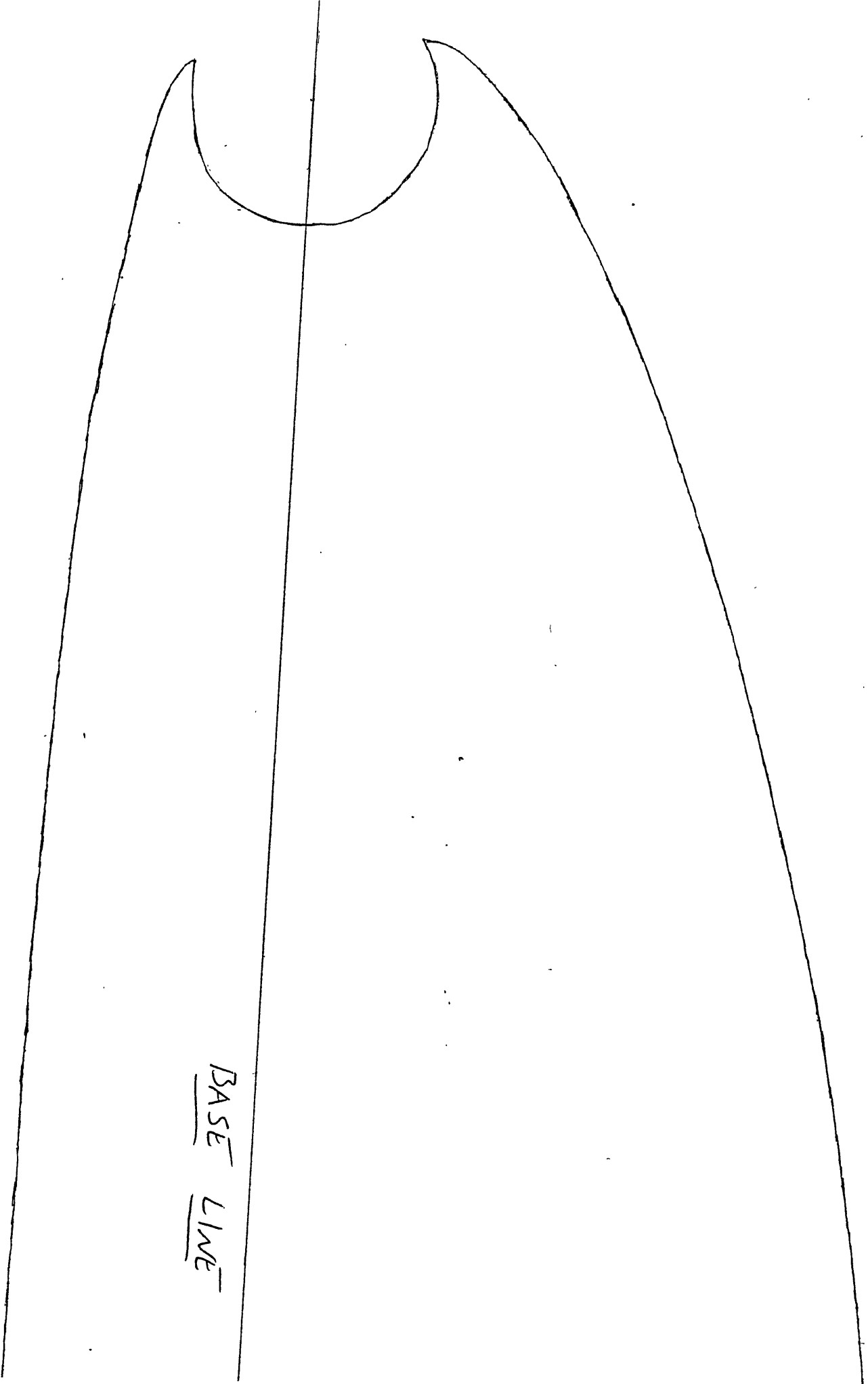
**AFFORDAPLANE**

Description:  
 Elevator Attach Tube support (location)  
 Lower elev rigging attach point

Drawn By: Dave Edwards  
 Date: Aug 24, 2000

Drawing#  
 S2

AIRFOIL



BASE LINE

1

1

2

2

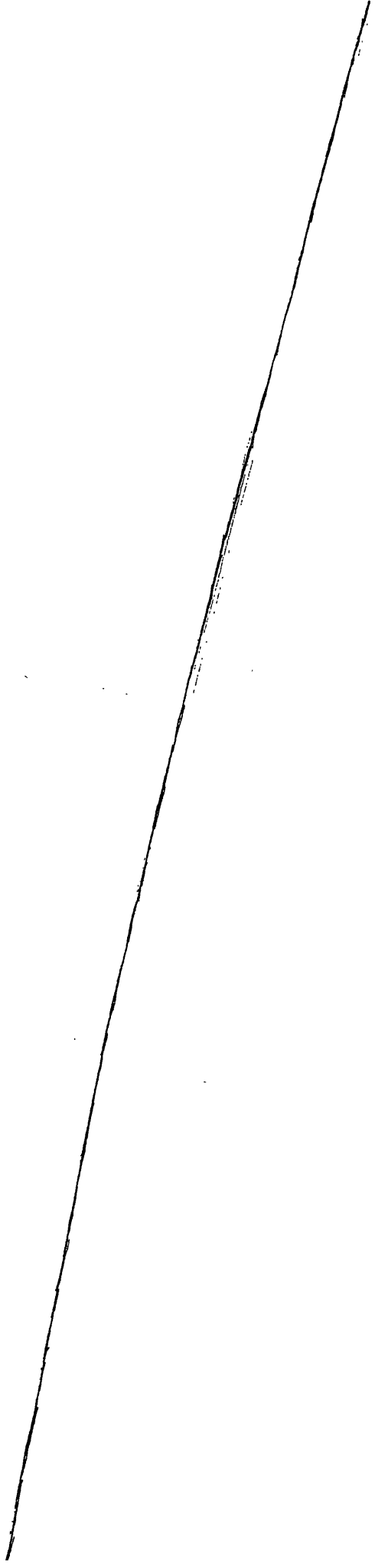
3

3

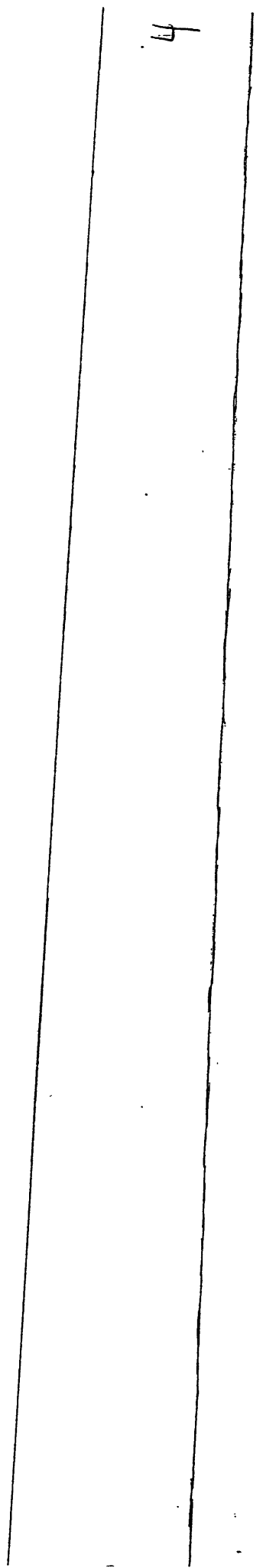
2

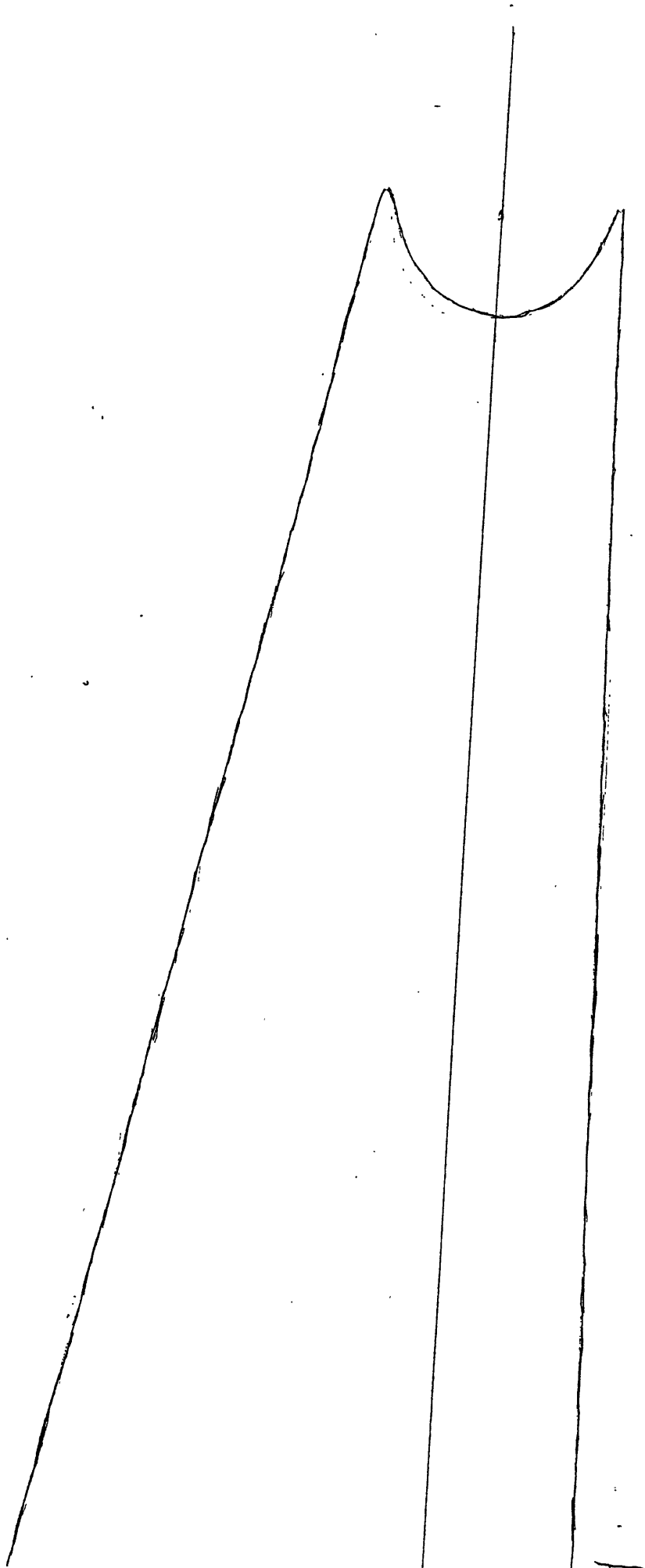
3

4



4





## Bill Of Materials

### Bolts                      Quantity

AN3-5A	4
AN3-6A	8
AN3-10A	4
AN3-14A	3
AN3-14	1
AN3-16	2
AN3-16A	4
AN3-20A	4
AN3-25A	92
AN3-27A	2
AN3-30	1
AN4-5	1
AN4-5A	1
AN4-6	2
AN4-7	2
AN4-10	4
AN4-12	1
AN4-16	4
AN4-16A	42
AN4-17A	10
AN4-21A	6
AN4-22A	2
AN4-25	2
AN4-25A	9
AN4-26	1
AN4-26A	6
AN4-27A	2
AN4-30	4
AN4-32	4
AN4-37	1

### Bolt Hardware

### Quantity

AN960-14 washer	100
AN960-10 washer	125
AN365-428 nylock nut	81
AN364-1032 nylock nut	121
AN316R nut 1/4-28 thread	6
AN960-4 washer	2
AN970-3 washer	4
AN310-3 castle nut	4

AN310-4 Castle Nut 26  
MS24665-132 Cotter Pin 30

#### Aircraft Tubing

6063-T351 Alum SQUARE Tubing QTY 3 12' pieces / 1 10' piece  
1/2" X .058 wall 6061-T6 Aluminum tube QTY 4- 12' length  
1" X .035 wall 6061-T6 Alum Tube QTY 1- 10' length  
5/16" X .035 wall 6061-T6 Alum Tube QTY 3'  
1" X .058 wall 6061-T6 Aluminum Tube QTY 11- 12' length QTY 1- 5' length  
1 1/8" X .058 wall 6061-T6 Aluminum Tube QTY 4- 10' length QTY 2- 12' length  
1 1/2" X .058 wall 6061-T6 Aluminum Tube QTY 2- 12' length  
2" X .058 wall 6061-T6 Aluminum Tube QTY 2- 12' length  
1 3/8" X .058" wall 6061-T6 Aluminum Tube QTY 6' length  
1 7/8" X .058" wall 6061-T6 Aluminum Tube QTY 6' length  
1" 6061-T6 Aluminum solid ROD QTY 4' length  
7/8" O.D. X .058 wall 6061-T6 Aluminum Tube QTY 2- 7' length

#### 6061 T-6 Aluminum Angle

2" X 2" X .125 wall 6063-T351 Aluminum Angle QTY 3'

#### Cable and related hardware

3/32" 7X19 strand stainless steel cable 134 feet  
Nicopress Oval Sleeves Milspec MS51844 or equivalent Qty 64  
Thimbles AN100 for 3/32" cable QTY 32

#### Misc. Aircraft Hardware

Stainless Cable Tangs with 3/16" hole on each end QTY 32 (Lockwood Aviation)  
Stainless U Brackets For 1" Tube (1/4" hole) QTY 21 (Lockwood Aviation)  
3/16" stainless Steel pop rivets QTY 190  
Rod Ends (female) 1/4" hole 1/4-28 thread QTY 6  
Stainless Steel Hinges bent (Drifter fittings) QTY 60 (Lockwood Aviation)  
AN115 Shackle QTY 2  
Spring Steel 1 1/2" wide X 1/4" thick 18" long  
Bellcrank Bearings BC4W10 QTY 2  
Threaded Steel Rod 1/4-28 thread QTY 3 feet  
Clevis Pin MS20392-2C19 QTY 2  
Washers 2" diameter 1/8" thick QTY 4  
Pulleys MS24566-2B 3/16" hole QTY 2



Stainless U Brackets for 2" tube 1/4" holes QTY 2  
Stainless U brackets for 1 1/2" tube 1/4" holes QTY 2  
Stainless Steel Pop Rivets 1/8" diam. QTY 300  
locking collar for tailwheel (determine ID from cart wheel)

#### MISC

Wood Block Inserts 12" X 1 3/4" X 1 3/4" QTY 3  
Door Springs QTY 2  
Fiberglass Tape 1" width 26 warp 17 fill QTY 1 roll (50 yds)  
medium weight fiberglass cloth 50" wide 7 yds  
Polyester Resin and Hardener 1/2 gallon  
1/16" plywood 90 degree 4' X 8' Sheet  
T-88 epoxy 1 quart  
Dow blue Styrofoam 1" X 4' X 8' QTY 5 sheets  
Acrylic or plexiglass sheet 1/8" X 2' X 3'  
Luan ply doorskin 1 sheet 3' X 6'  
Adel Clamps (cushioned) for 1 1/2" round tube QTY 4  
15" wheelbarrow tires and rims  
fuel line 1/4" poly 7'  
fuel line squeeze bulb  
bicycle grip  
tailwheel from industrial shopping cart 5"  
4 bungee cords with hooks on both ends  
5 gallon gas can (upright)  
1 roll alum flashing (hardware store)  
Fiberglass seat from Boat supply  
seat cushion (Wal-Mart)

# AFFORDABLE PLANE

## The Truly Affordable Ultralight!

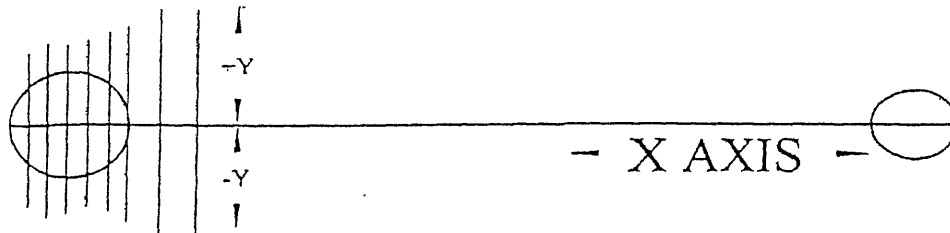
Here are the ordinates for the airfoil I used for the A-Plane. If you need help or additional reference, here is a good site that describes how to plot an airfoil:

Step 1) draw a line 54" long.

Step 2) Using your compass, draw a circle 2" diameter centered on the line, and a 1 1/2" circle at the end of the 54" line. It looks like this:



This line is called the X Axis. This is our base line reference for all the measurements.



There are three columns of co-ordinates listed below. The first column (X) is the distance from the leading edge of the wing, along the chord. This number shows the point on the reference line (X) where you will draw vertical lines.

The second column is labeled +Y. This is a measurement (in inches) showing how far above the reference line you want to make a mark.

The third column is the -Y ordinates. This measurement shows how far below the reference line you want to make a mark.

Once you have laid out the airfoil, and made marks at each station above and below the

reference line, simply fair in the airfoil outline by 'connecting the dots'.

Step 3) Start with the X column, and make a mark at each point along the X reference line.

Step 4) Using your 90 degree angle, draw vertical lines (above and below) where you made the marks for the X reference.

Step 5) Make a mark as indicated by the +Y column to get the top camber outline.

Step 6) Make a mark at each station for the -Y column (below the X line)

Step 7) Using a french curve or similar instrument, connect the dots to make a smooth airfoil shape.

Step 8) Fair in the camber lines where they intersect the spar tubes. Remember you will be laying ply capstrips around the spars and rib, and want a nice, gentle curve, with no dips or bumps.

NOTE: These measurements are in **actual inches** not a percentage of airfoil dimensions, as is the norm for presenting airfoil ordinates.

X	+Y	-Y
.50"	1.0"	-1.0"
1.0"	1.5"	-1 1/8"
1.5"	1 7/8"	-1 5/16"
2.0"	2 3/16"	-1 3/8"
2.5"	2 7/16"	-1 7/16"
3.0"	2 11/16"	-1 9/16"
4.0"	3 1/16"	-1 5/8"
5.0"	3 7/16"	-1 11/16"
6.0"	3 3/4"	-1 3/4"
7.0"	4 1/16"	-1 13/16"
8.0"	4 7/32"	-1 13/16"
9.0"	4 1/2"	-1 13/16"
10.0"	4 11/16"	-1 7/8"
11.0"	4 13/16"	-1 7/8"
12.0"	4 15/16"	-1 14/16"
13.0"	5.0"	-1 13/16"

14.0"	5 1/8"	-1 13/16"
15.0"	5 3/16"	-1 3/4"
16.0"	5 1/4"	-1 3/4"
17.0"	5 5/16"	-1 11/16"
18.0"	5 5/16"	-1 5/8"
19.0"	5 3/8"	-1 5/8"
20.0"	5 3/8"	-1 5/8"
21.0"	5 3/8"	-1 5/8"
22.0"	5 3/8"	-1 9/16"
23.0"	5 5/16"	-1 1/2"
24.0"	5 5/16"	-1 1/2"
25.0"	5 1/4"	-1 1/2"
26.0"	5 3/16"	-1 1/2"
27.0"	5 1/8"	-1 7/16"
28.0"	5 1/16"	-1 7/16"
29.0"	5.0"	-1 7/16"
30.0"	4 15/16"	-1 3/8"
31.0"	4 7/8"	-1 5/16"
32.0"	4 3/4"	-1 5/16"
33.0"	4 5/8"	-1 5/16"
34.0"	4 1/2"	-1 5/16"
35.0"	4 3/8"	-1 1/4"
36.0"	4 1/4"	-1 1/4"
37.0"	4 1/16"	-1 3/16"
38.0"	3 15/16"	-1 3/16"
39.0"	3 3/4"	-1 1/8"
40.0"	3 9/16"	-1 1/8"
41.0"	3 3/8"	-1 1/8"
42.0"	3 3/16"	-1 1/16"
43.0"	3.0"	-1 1/16"
44.0"	2 13/16"	-1.0"
45.0"	2 9/16"	-1.0"
46.0"	2 3/8"	-1.0"
47.0"	2 1/8"	-15/16"
48.0"	1 15/16"	-15/16"
49.0"	1 3/4"	-7/8"
50.0"	1 1/2"	-7/8"
51.0"	1 5/16"	-13/16"
52.0"	1 1/16"	-13/16"
53.0"	7/8"	-3/4"