GYROBEE

Ultralight Gyroplane

DOCUMENTATION

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SAFETY NOTICE

This package of text and materials is intended to document the construction of the prototype ***Gyrobee*** aircraft. It is provided free of charge as a service to the rotorcraft community to satisfy the many requests I have received for such material. *THIS MATERIAL IS NOT PROMOTED OR DISTRIBUTED AS A SET OF CONSTRUCTION PLANS AND I DO NOT ENCOURAGE YOU TO BUILD AN AIRCRAFT USING THESE MATERIALS, IN WHOLE OR IN PART. ANYONE WHO UNDERTAKES TO BUILD AN AIRCRAFT USING THESE MATERIALS DOES SO* ***AT HIS OR HER OWN RISK!***

If you choose to use the text and/or drawings as the basis for the construction of an actual aircraft, you should be aware of the following points:

- I have no training or professional credentials in the area of aircraft design or construction.

- Although I have made a reasonable effort to make these materials as complete and accurate as possible, the text and drawings may contain errors or omissions that may:
  - Result in a waste of time and materials
  - Result in an aircraft that may not have the flying qualities you desire
  - Result in structural or mechanical failures with the possibility of **financial loss**, **physical injury**, or **death**!

- Although the prototype aircraft has been flying for several years:
  - The aircraft has not been certified by any aviation regulatory or safety agency
  - There is no basis, other than regular inspection, to predict the operational lifetime of the various structural components.
  - The aircraft has not been flown in all possible conditions that you might encounter.

THERE IS TO WARRANTY, EXPRESSED OR IMPLIED, AS TO THE ACCURACY AND USEFULNESS OF THESE MATERIALS FOR ANY PURPOSE OTHER THAN DOCUMENTATION.

NO ONE SHOULD ATTEMPT TO FLY ANY SPORT GYROPLANE WITHOUT A PROGRAM OF DUAL FLIGHT INSTRUCTION, UP TO THE POINT OF SOLO FLIGHT AUTHORIZATION!!

DESIGN CONSIDERATIONS

General

Entry-level fixed-wing ultralights have a reputation for being uncomplicated aircraft that are relatively easy to fly. They tend to have definite limits with respect to wind, for example, but if flown within these limitations they handle very easily and provide a lot of pleasure to those who fly them. The goal of the ***Gyrobee*** project was to achieve something similar in the area of sport gyroplanes. This effort was highly successful, but if you are intent on duplicating the aircraft, **despite all my earlier warnings**, you must have a solid understanding of why the aircraft is configured the way it is. If you don't understand some of the critical design choices that were made, it is quite possible that you will make modifications that would ***result in an aircraft that is dangerous to fly***!

Many pilots take a very casual attitude toward the FAA requirements established in Part 103. They may have all sorts of justifications for flying an aircraft that is too heavy or too fast, but the only consequences they see is the remote possibility that they might run into an FAA official. Part 103 issues with respect to the ***Gyrobee*** have nothing directly to do with legality! Let's take the top speed issue, since it is the major one with respect to flight handling and stability. Since the goal was to have the ***Gyrobee*** be strictly legal, it was designed so that it would not exceed the **63 mph** (55 knot) **maximum level flying speed** mandated in the regulations. Because it could not be flown any faster in level flight, other decisions could be made with respect to making the aircraft more stable and easier to fly. These design features are not appropriate for an aircraft that can fly at 75-90 mph! If I had been designing an aircraft that would fly faster than 63 mph in level flight, I would have done it completely differently.

The ***Gyrobee*** feels extremely stable and handles nicely, but **if it were set up to fly faster, the pitch stability would degrade very rapidly** to the point where the aircraft would become dangerous to fly in all but the most expert hands! Set up properly, the ***Gyrobee*** is limited to a top level flying speed in the low 60's and handles well up to that maximum speed. In a steep descent, the aircraft might even reach 70-75 mph, but it still handles well because it is **descending**. In contrast, if you set the aircraft up so it will reach 75 mph in level flight, the result is increasingly marginal pitch stability and the feeling that the aircraft could bite you with the slightest mis-handling of the stick! There is no magic in the "set-up" area. If the aircraft is built and equipped like the prototype, it **cannot fly too fast** and you would be extremely pleased with its stability in flight. If an aircraft with Part 103-legal performance is too "tame" for you, **do not modify the *Gyrobee***! There are plenty of suitable gyros out there if you want to fly faster or heavier, but **this one isn't for you**! In the sections which follow, I will outline those areas that are most sensitive to modification.

Engines

Power is king in the area of sport gyroplanes and most experienced pilots find it difficult to believe that you can get decent performance out of the 40 hp. Rotax 447 used on the prototype. I weight 220 pounds and I certainly would not fly an aircraft with marginal climb performance! Since the aircraft is designed to fly well on comparatively low power, there are other advantages as well. The ***Gyrobee*** is a "floater" compared to almost all other gyros out there, which means you get optimum glide performance should the engine fail. This not only improves your chance of finding a suitable spot to land, it means that you can fly your approach at a significantly lower airspeed and that you can execute a no-roll landing much more easily, even without a stiff breeze to help. You don't have to use a Rotax as other manufacturers make perfectly suitable engines in the 40-45 hp range that would do just as well, assuming the use of a reduction drive that would let you swing an efficient 60 inch prop! Unless you are very heavy or routinely fly from high elevation fields, 40-45 hp should do just fine. If you have an altitude or weight problem, the design will accommodate a Rotax 503, but that is absolutely the biggest engine you should use!

Rotor Blades

Most gyro pilots assume that blades are basically inter-changeable and the only thing they impact is performance. While this may be true for most Experimental machines, blade selection is absolutely critical for the ***Gyrobee***. You may assume that the design requires the most efficient blades available, but this is not the case. Highly efficient blades are characterized by relatively low drag. **The *Gyrobee* requires a certain amount of blade drag to limit the maximum level flying speed!** Really efficient blades, such as Ernie Boyette's Dragon Wings, will let the aircraft reach 75-80 mph in level flight! These are superb blades for most gyros, but not the ***Gyrobee***! Given that the maximum level flying speed was to be no more than 63 mph (give or take a few mph), the rotor was placed on a tall mast with the pilot positioned low on the airframe. This maximizes pendulum stability and contributes to the mellow handling of the aircraft. At or below 63 mph, the aircraft drag profile is always rotor-dominated and the aircraft is quite stable. With high efficiency blades, rotor drag is lower at any airspeed and the aircraft will fly much faster. The high mast/low seat combination that works so well at low speeds is now a serious problem, due to a low vertical CG, relatively high engine thrust line, and relatively low rotor drag.

For the aircraft to fly as intended, **you must use blades with a higher drag profile**. Originally the prototype was flown on **Rotordyne** blades. These are bonded aluminum blades, which would suggest a low drag profile, but they have a relatively inefficient airfoil section, so they do the job very nicely. They are relatively heavy, so you will only have a few pounds of weight margin with respect to the 254 pound empty weight limit. Set at 0.75 degrees pitch, the blades are moderately easy to hand-start, but to require a solid pre-spin to get them moving. Unfortunately, as far as I can tell, Rotordyne blades are no longer being made, but you may be able to find a good used set.

Similarly, **Brock** blades have an efficient airfoil section but lots of rivets. As a consequence, they fly the aircraft very well but produce enough drag to slow the aircraft down and contribute a very high measure of stability. If you are buying new blades for this project, the Brock blades represent a good tradeoff between performance and drag. They are very light blades hand-start easily, which is a plus if you have no prerotator, or the prerotator is not working for some reason.

Rotor Hawk blades also work very well. Use a 24 foot rotor disc and set the pitch to 1.75 degrees. They are lighter than the Rotordyne blades, spin-up easily when hand-starting, and seem to retain energy very well.

The low-drag **Dragon Wings** blades are not recommended. This is strictly a function of the way the ***Gyrobee*** is designed, for these blades are probably the lightest and most efficient blades you can buy. They also hand-start with some difficulty, which is not optimum if you fly without a prerotator. These would be the blades of choice, based on performance, for an ultralight tractor design, such as the Lite Wing **Roto Pup**, or a machine with high-pilot seating and a lower engine thrust-line, much like the **Dominator** Experimental machines.

The **Sky Wheels** composite blades have an excellent reputation, but they are heavy enough that you would have a problem meeting the 254 pound empty-weight limit required by Part 103.

We have not had the opportunity to test fly the aircraft with other blades and, for reasons that should be obvious by now, I cannot recommend any blades that have not been test flown on the ***Gyrobee***.

Rotor Diameter

The major problem early in the flight-testing of the prototype was how to get a good climb rate when using blades of moderate performance and an engine of only 40 hp. Fixed-wing ultralights solve the problem by having a relatively high wing area for their weight, resulting in low wing loading. The solution with the ***Gyrobee*** was similar - increase the diameter of the rotor disc to improve the disc loading. The typical single-seat gyro flies at a disc loading of 1.2 to 1.4 pounds/square foot (psf) with engines in the 65-90 hp range. In the case of the original Rotordyne blades, we used with a 5 foot hub bar, producing a 25 foot rotor disc and a disc loading of about 1.0 psf. This produced excellent performance yet the aircraft could easily be flown in winds up to 30 mph, assuming a reasonable level of pilot experience. The ten-foot Brock blades were lighter and were flown with a 4 foot hub bar, producing essentially identical disc loading on a 24 foot rotor disc. The tall mast provides ample rotor clearance in either case. Although the aircraft will fly at a disc loading of 1.2 psf, I do not consider the climb performance margin acceptable.

Wide Main Gear

The main gear of the ***Gyrobee*** is quite wide, over seven feet, compared to most gyros. This wide stance makes it a bit harder to design a trailer for transporting the machine, but you should resist the temptation to narrow the stance by shortening the axle struts. This would have no impact on flight characteristics, but would degrade the ground **roll-over** angle. Most damage in typical gyro accidents occurs when a pilot touches down in a "crabbed" angle, often when executing an off-field landing with the engine out. All-too-commonly, the gyro will tip over, destroying the blades and severely damaging other parts of the airframe. The wide gear stance makes the ***Gyrobee*** highly immune to such roll-over accidents. It has been landed at the most bizarre angles and never shown the slightest tendency toward tipping over. I would suggest that you keep the main gear as documented on the drawings!

Fuel Tank

The fuel tank mounting looks a bit unusual to many and might appear to be insecure or cause major trim changes as fuel is burned off. In fact, the fuel tank stays solidly in place in the air or when the aircraft is jolted around on a rough field. There is no detectable trim change with fuel burn either. The major convenience of the approach taken in the prototype is that the entire tank can be removed and taken to the nearest gas pump if no fuel can is available!

Is it possible to use a seat tank on the ***Gyrobee***? The answer is yes, but some thought and work would have to go into the installation. The fiberglass bucket seat (far more comfortable than any seat tank), along with the aluminum back plates, functions as a shear web that reinforces the seat braces. Seat tanks are not structural members, and you would have to add a substantial shear web (3/32 to 1/8 inch thick aluminum sheet stock) to provide the needed reinforcement. This would have to be integrated with adequate attachment hardware for the lower seat **U tube** as well as hard points for the attachment of the upper seat back to the structure. It can be done but you will have some homework to do it right. If you plan to try, work with an experienced gyro builder if you have any doubts about the problems to be solved! If you do mount a seat tank, the fuel tank mounting shown in the drawings can be eliminated.

CRAFTSMANSHIP

If you watch experienced pilots examining home-built aircraft at a fly-in, you will notice that they tend to be very picky about craftsmanship. The reason is quite simple. Sloppy work doesn't just impair the appearance of an aircraft, it can render it unsafe. Building your own aircraft can be immensely satisfying, but you shouldn't even start such a project unless you are committed to doing the job right. This means the highest standards of craftsmanship using the proper tools for the job. Sloppy work can ruin up to $700 of quality aircraft materials. If you mess things up, you will not even be able to sell what's left, for no one who knows what they are doing would touch the material. If you've done this sort of project before, you can skip what follows, otherwise stay with me for some detailed advice.

Just because there are no mandated inspection requirements for Part 103 aircraft, this does not mean that we are not dealing with life and death issues. Nature and gravity don't know about the regulations!

Materials

Only aircraft grade steel and aluminum alloys and hardware should be used to build an aircraft. Materials and hardware available from other sources such as hardware stores are not suitable. This is a gentle way of saying that **something will eventually fail and kill you!** Legitimate aircraft suppliers such as **Aircraft Spruce and Specialty Company**, **Wickes Aircraft Supply**, **Leading Edge Airfoils** (**LEAF**), **California Power Systems**, and other suppliers advertising in magazines such as ***Kitplanes*** and ***Rotorcraft*** stock the proper materials and should be your only source for materials and hardware unless you are really know what you are doing.

Cutting Tubing and Angle Stock

Although you can cut everything needed with a hacksaw, the job would not be fun and it would also take forever! A powered bandsaw is the ideal took for most of the work. Since it doesn't pay to buy such a tool for building one aircraft, see the later section on Getting Help if you don't have a bandsaw. Be sure to allow for the width of the cut when making all pieces - the **finished size** should match the prints! All cuts should be carefully-dressed with a fine file and steel wool since sharp edges can concentrate stress and lead to the formation of cracks.

Drilling

Drilling tubing, sheet, and angle stock is the most critical operation you will do on an aircraft construction project. Holes must be placed with **absolute precision** or the parts **will not fit** when assembled. You cannot do this job with a hand drill. A good drill press with an adjustable fence is ideal. Holes, particularly those drilled through tubing, must be absolutely true. This is particularly so with holes drilled near the edge of square tubing. These are positioned with only 1/32 clearance from the tubing wall. **If you score a side-wall when drilling, the entire piece must be discarded!** If you are not sure about the precision of the drill press, take the time to make some simple drilling jigs to assure proper placement of holes. Alternatively, you can center-punch the hole location on both sides of a tube (assuming you do the job very accurately), pilot drill from both sides with a 1/16 bit, and then finish-drill to size from both sides. If you don't have the proper equipment or are unsure about your skills, see the later section on **Getting Help**.

Quality drill bits and how you use then are important. Finished holes you will drill will be either 3/16 or 1/4 inch. Invest in half-a-dozen **carbide** drill bits of each size. Drill the holes gently so the bit **cuts the metal** instead of punching through. Use cutting oil to make for an even cleaner job and the bits will last longer. Once holes are drilled, de-burr them, both to assure a snug fit for the attachment hardware and to avoid concentration of stresses that can lead to cracks.

Machining and Welding

The number of machined parts and the need for welding has been minimized, but you will still have to have some parts made up unless you have your own shop and know how to do the work. If builders interact on the Internet, it is possible that sources for these parts can be developed where the costs would be lower than doing the job locally.

Getting Help

Your best source of help on a project of this sort is your nearest PRA or EAA chapter. Members will often have the proper shop tools (or the Chapter may be so-equipped), they know how to use them, and they can give you advice at all stages of construction. If that sort of assistance is not available locally, consider checking in with the metal shop at your local high school, vocational center, or community college. You may be able to get training on and use of the equipment. It is also possible that the teachers may think that the project would be a good one for students, so you might end up with some help. You **must get an experienced PRA member or EAA designee to look over your project** prior to test flying. They may be able to spot problems you have overlooked! Even if it is not convenient, arranging for periodic inspections as the project proceeds can usually spot problems earlier, where they will take less time and money to fix!

COMMERCIAL COMPONENTS

Standard gyroplane and ultralight components were used whenever possible to speed up construction or to assure the required safety in the case of components that are too difficult for fabrication by the typical builder. All of these suppliers advertise in either ***Rotorcraft*** and/or ***Kitplanes*** magazine.

Ken Brock Manufacturing, Inc. (11852 Western Avenue, Stanton, CA 90680, Ph. 714-898-4366)

- KB-2 wheel set (**20300**)
- KB-2 Joystick (**20500**)
- KB-2 factory-built tail group (**20540**)

Leading Edge Airfoils, Inc. (LEAF)

- Rotax 447 engine and 2.58 B gearbox (**R 447 FC SC SM GB 2.5**)
- 2-blade 60-38 wood prop (**P6038L16R**)
- Fiberglass bucket seat (**J7155**) and cover (**J7156**)
- Eipper GT-style fuel tank (**30249**)
- Airframe brackets
- Some engine mount, airframe materials, and AN hardware

Aircraft Spruce and Specialty Company, Inc.

- Seat belt (**G6573-5**)
- Shoulder harness (**E-2884-1**)

Rotor Blades

Although it is possible for a builder to fabricate his/her own rotor blades and head, I do not recommend it! The blades you select for this aircraft have a critical impact on both the legality of the machine with respect to Part 103 *weight and speed limits*, and on the *stability* of the aircraft. Please read the earlier section on DESIGN CONSIDERATIONS carefully.

The prototype originally used 10 foot **Rotordyne** blades (**RC 1014 A**) on a 60 inch hub bar (**RC 1-16 C**). As far as I can tell, these are no longer being made. **The recommended alternative** is either a set of 10-foot blades from **Ken Brock Manufacturing** along with a matching four-foot hub bar or a set of 10-foot **Rotor Hawk** blades with a 4-foot bar.

Rotor Head

The prototype used a **Rotordyne** head (**RC 1019 A**), but I don't think these are still being manufactured. Any standard single-bearing head from Ken Brock, Rotor Flight Dynamics. Snow Bird, Air Command, Rotor Hawk, or most other vendors should be a satisfactory substitute.

KITS AND COMPONENTS

GyroTech Inc. (see their web page on the net at **http://www.gyrotech.iserv.net**) are now producing a kit for the ***HoneyBee***, the “next generation” aircraft in the ***Gyrobee*** line. Although I have no financial connection with the company, I did design the ***HoneyBee***, based on the basic characteristics of the ***Gyrobee*** but incorporating some new ideas which make it a very innovative little aircraft. This is a strictly-legal ultralight and the kit has been produced to the highest standards, including CNC machine work and powder-coating or anodizing of all metal components. If you order a complete kit, it can literally be assembled in one or two weekends. They have financing available for kit purchases and they also offer sub-kits and plans.

Materials Kits and Components

Complete component materials kits, sub-kits, and individual machined parts for the ***Gyrobee*** are available from **Aerotec Inc.** (49 Hayden Parkway, Burlington, VT 05403 Ph. 802-864-5496). Contact Doug Riley for details. Doug has bent over backwards to accomodate the needs of ***Gyrobee*** builders, all of whom will vouch for the quality of his components and materials.

NOTES

CONSTRUCTION SEQUENCING

The documentation is organized into discrete phases or stages, each involving one or more pages of supporting text and typically three to five drawings. These phases represent logical, defined steps in the overall construction sequence and should be followed in order.

If adequate funds were available to purchase all the required materials, hardware, and components at one time, I would use the following construction sequence:

- Farm out the machining work so the parts would be ready when needed.
- Cut all the required tubing and sheet-metal components and label each with masking tape to keep track of the pieces.
- Do all the required drilling work.
- Finish the pieces (see **FINISHING NOTES** below)
- Do the needed assembly, following the phases in the documentation.

If I had to work on a budget, I would treat each phase as a sub-kit, obtaining the materials, cutting and drilling, and performing the assembly steps for each phase in turn. In this way, the project could be paced to meet the available funds. Since the blades and engine are the most expensive items, I would budget set-aside funds as the project proceeded, to minimize the delay in obtaining these parts once the rest of the work was finished.

FINISHING NOTES

Bare aluminum will oxidize, become dirty, and show fingerprints from handling if not finished prior to parts assembly. In order of difficulty and cost, the finishing options are:

- **Clear Urethane**. Polish the parts with fine steel wool, degrease, and finish with one or more coats of clear urethane paint. This will provide a natural-metal finish, yet protect the metal surface. Since the finish is clear, this option has the least potential to show defects in application and is thus suited for hand application.
- **Anodizing**. The aluminum parts can be anodized to provide a color finish. The color options are limited and not vivid, but the effect is excellent, as is corrosion protection.
- **Painting**. The parts can be painted in any colors desired. Each piece will need to be polished, degreased, primed, and then color-painted. You may be able to arrange for painting at a local auto body shop. This eliminates a lot of work, there is a very wide range of possible color combinations, and auto paints are very durable.
- **Powder Coating**. This is probably the most expensive option but will probably provide the best results.

PHASE 1 - FRAME TRIANGULATION

Prints:

- **G1-1** Keel Tube
- **G1-2** Mast Pieces
- **G1-3** Mast/keel Cluster Plate
- **G1-4** Seat Braces
- **G1-5** Side View

Fabrication Notes

- **Keel Tube** (G1-1). The tube was carefully cut to length using a band-saw, with special attention to keep the ends square. All cut edges were de-burred and filed smooth to eliminate stress points. It was very critical that all holes were located with extreme care, drilled cleanly through, and de-burred. An accurate drill press with a fence is a great help. It was very important that the holes be drilled true and that the bit **not** score the inside tube walls when drilling holes near the edge of the tube. Clearance is a nominal 1/32 inch, so care was required. If the sidewalls are scored, we would have had to discard the piece. The holes on the top and bottom are based on the use of the Brock control stick.

- **Mast** (G1-2). See notes for the Keel (above) for general issues. Since the mast is made of two pieces of 2 x 1 extruded tube, the mast segments should be solidly clamped for all cutting, trimming, or drilling operations. When the mast pieces were complete, we temporarily secured the two pieces using 1/4 inch bolts (standard hardware store bolts are OK for **temporary** service) at the two 1/4 inch holes at the top of the mast and the last 1/4 inch hole toward the base (the one located at 28.5 inches on G1-2).

- **Cluster Plate** (G1-3). Since this part is thick (1.8 inch) stainless sheet, it was easier to have it fabricated at a machine shop.

- **Seat Braces** (G1-4).The drawings showed the right hand brace - the left is opposite.

Hardware

The basic airframe is a triangular truss made up the keel tube, the two mast segments, and the two seat braces. The following hardware was required to connect these pieces:

- **AN4-26A** bolts (2)
- **AN960-416** washers (4)
- **AN365-428** nylock nuts (2)
- **AN3-26A** bolts (7)
- **AN960-316** washers (14)
- **AN365-1032** nylock nuts (7)

Assembly

NOTE: *As a general rule, all bolts are installed so that a washer is located immediately under the head of the bolt with another under the nut.*

- The two mast/keel cluster plates (G1-3) were mounted on either side of the keel at the cluster of four 3/16 holes near the rear of the keel using four AN3-26A bolts, eight AN960-316 washers, and four AN365-1032 nylock nuts. The cluster plates were oriented so that the ends with the four 3/16 inch holes was above the keel while the end with the two 1/4 inch holes was below the keel (see G1-5). The nuts were torqued to the equivalent of hand-tight at this stage.

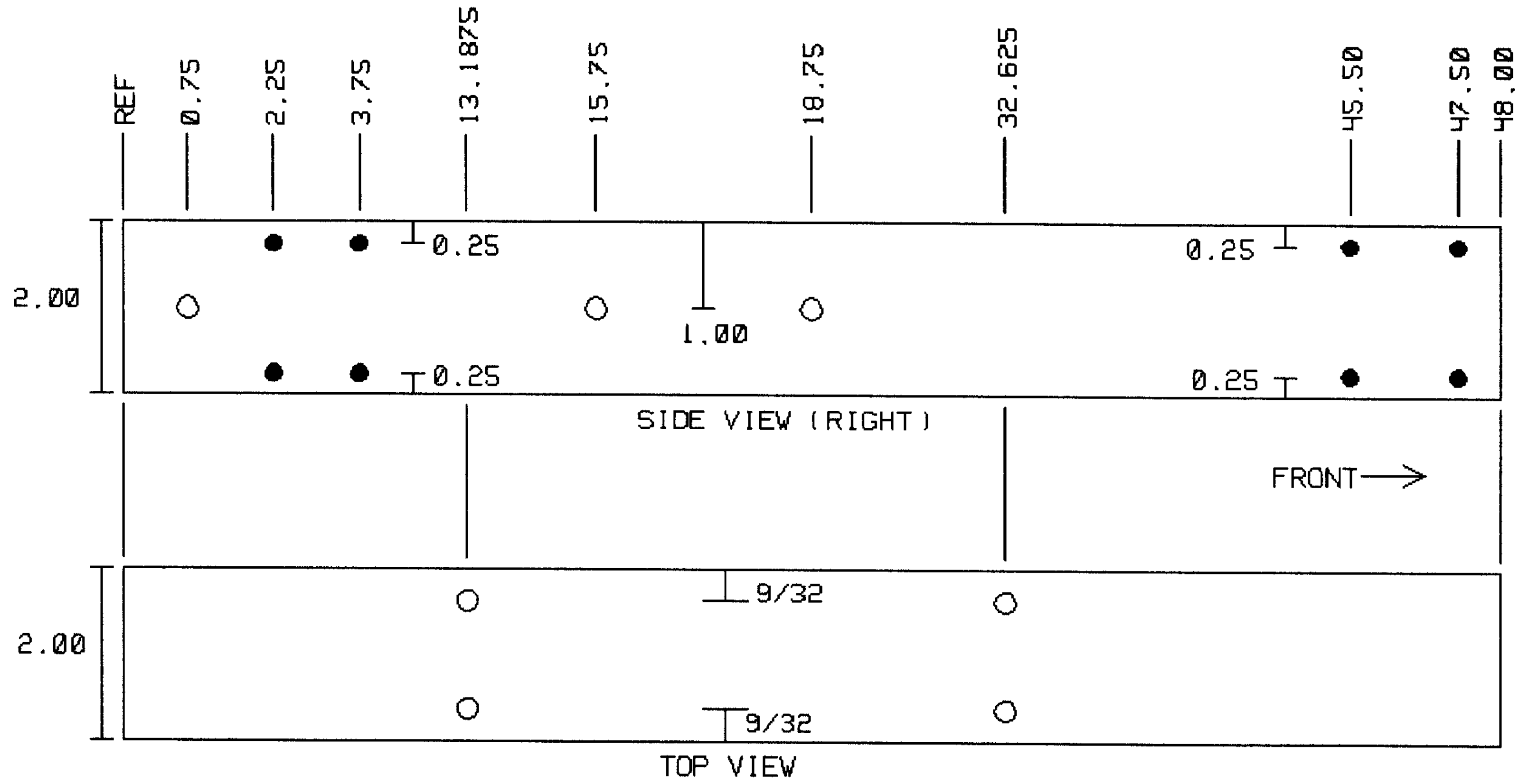
- The **bottom** end of the mast was positioned between the **upper** ends of the cluster plates and secured with remaining cluster hardware (see G1-5). Note that **upper rear** hole of the cluster plate was not bolted at this time. The nuts were torqued to the equivalent of hand-tight at this stage.

- The 1/4 inch hole at the **top** of the seat braces was secured to the 1/4 inch hole **37 inches** above the base of the mast using an AN4-26A bolt, two AN960-416 washers, and an AN365-428 nylock nut. At this point, the nut was tightened just enough to secure the parts but loose enough that the mast braces could be easily rotated.

- The **second** 1/4 inch hole from the **bottom** of the seat braces was secured to the 1/4 inch hole located **18.75 inches** from the **rear** of the keel using an AN4-26A bolt, two AN960-416 washers, and an AN365-428 nut.

- When all pieces were properly aligned, all nylock nuts were torqued for a tight fit.

Note that the lower ends of both the cluster plates and seat braces extended below the keel at this point. We blocked the frame upright at this stage so the ends of these pieces would not be damaged.

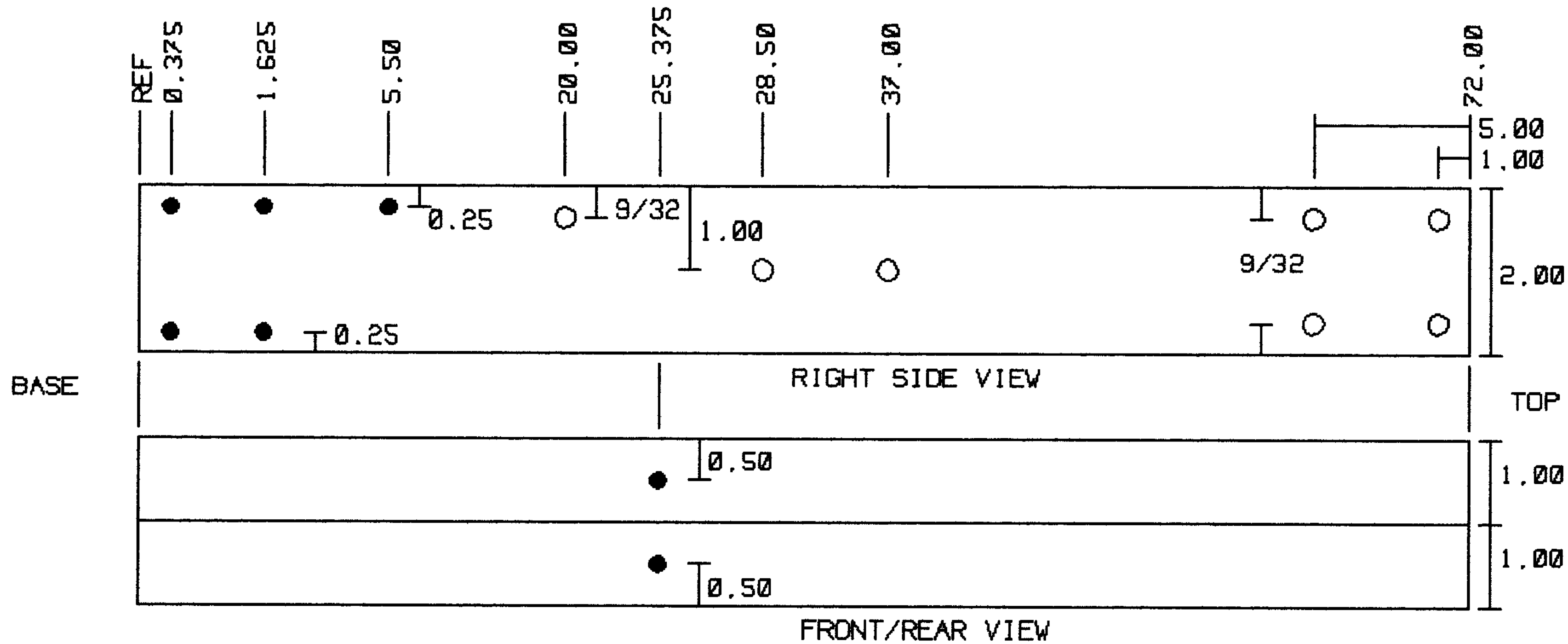


MATERIAL: 2 x 2 x 1/8 WALL 6061-T6
EXTRUDED TUBE STOCK

NOTE: ALL HOLES DRILLED THROUGH -
SEE TEXT FOR CAUTIONARY NOTES

HOLE KEY
○ = 0.25
● = 3/16

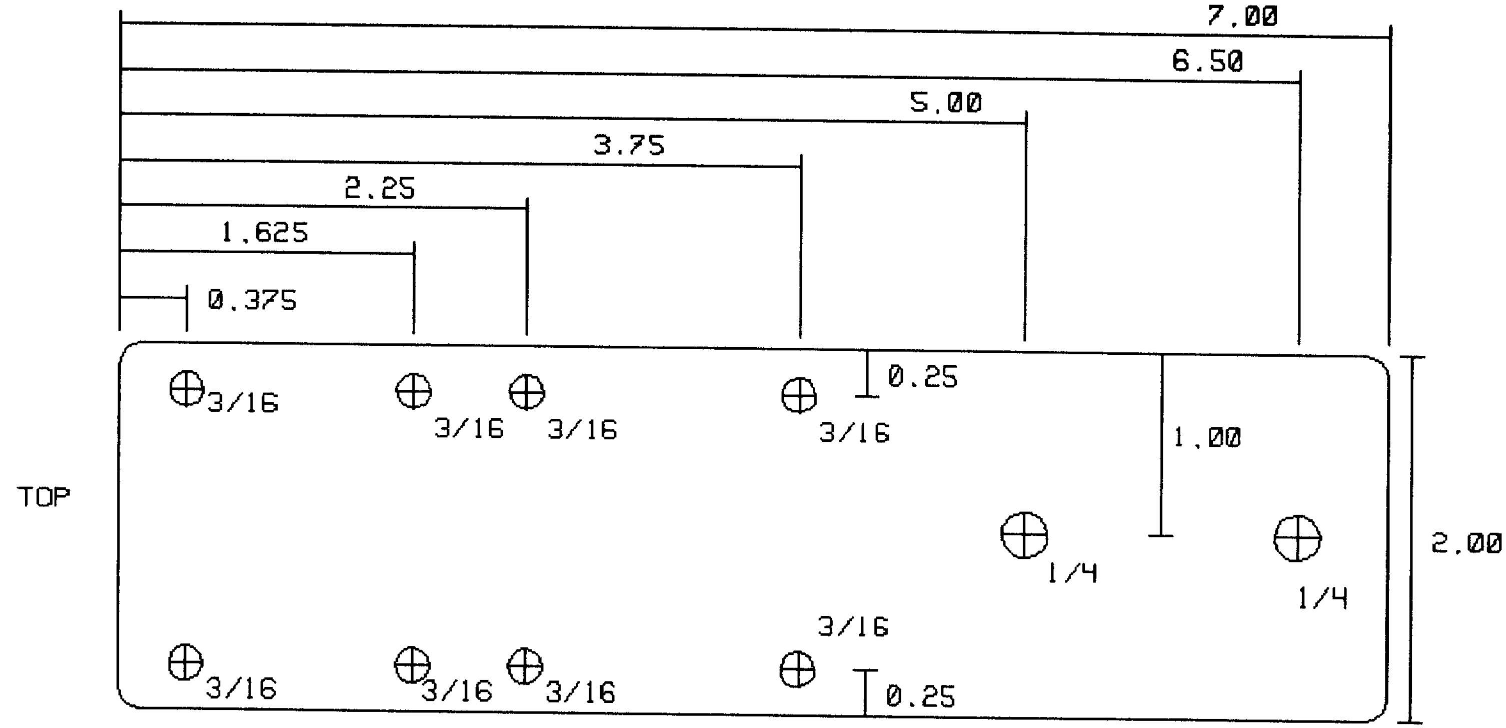
The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: KEEL TUBE (1 ROD) G1-1	SCALE: PAGE OF



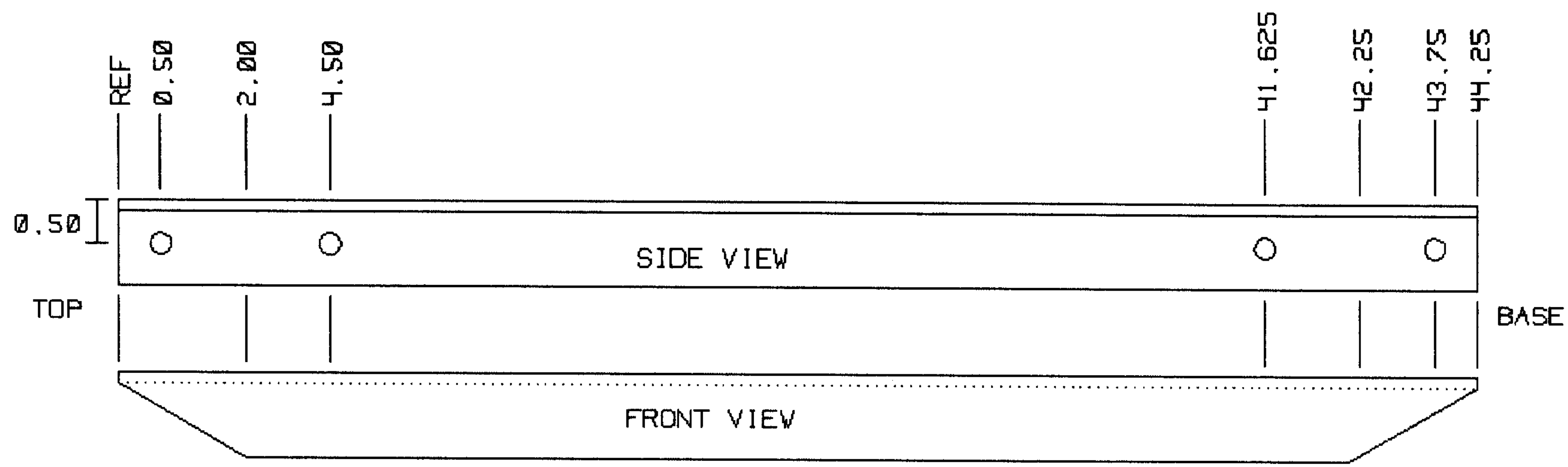
MATERIAL: 2 PIECES OF 2 × 1 × 1/8 WALL 6061-T6 EXTRUDED TUBE STOCK

HOLE KEY
○ = 0.25
● = 3/16

The GYROBEE	DATE: MAY 98 REV: 3.10
DRAWING: MAST PIECES (2 RQD) G1-2	SCALE: PAGE OF



The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: CLUSTER PLATE (2 ROD) GI-3 1/8 INCH STAINLESS SHEET	SCALE: PAGE OF

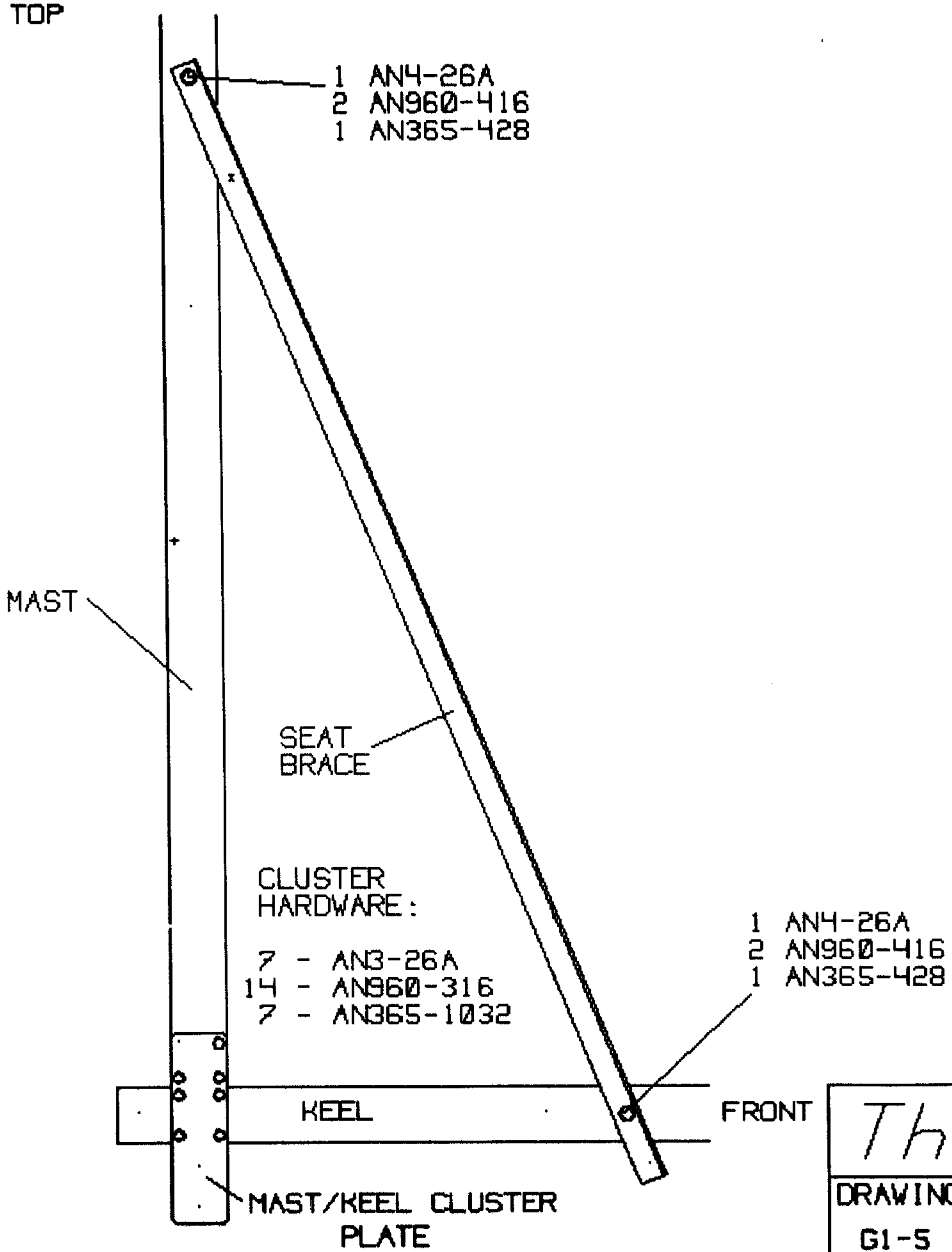


MATERIAL: 1 x 1 x 1/8 6061-T6 EXTRUDED ANGLE STOCK

RIGHT SIDE PIECE SHOWN - LEFT IS OPPOSITE

HOLE KEY
○ = 0.25
● = 3/16

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: SEAT BRACES (2 RQD) G1-4	SCALE: PAGE OF



The GYROBEE	DATE: SEP 97 REV: 1.0
DRAWING: FRAME ASSEMBLY G1-5	SCALE: INCHES PAGE OF

PHASE 2 - AXLE STRUT ASSEMBLY

Prints:

- **G2-1** Axle Strut
- **G2-2** Brackets
- **G2-3** Saddle Fittings
- **G2-4** Assembly

Fabrication Notes:

- **G2-1 Axle Strut**. The struts had to be bent as indicated to improve ground clearance with the KB-2 main wheels. This is a tough job given the 1/8 inch wall thickness of the axle strut tubing. We accomplished the bend by anchoring one end of the strut against a wall and used a truck wheel as a bending mandrel using a come-along to provide the bending force. It is important that both struts have the same final offset, even if the absolute value is a little off the 3.75 inches shown on the print.
- **G2-2 Brackets**. These can be fabricated from stainless sheet stock or the indicated brackets can be ordered from LEAF.
- **G2-3** Saddle Fittings. We farmed these parts out to a local machine shop.

Hardware:

- **AN4-21A** bolt (4)
- **AN960-416** washer (8)
- **AN365-428** nylock nut (4)

Assembly:

The following steps were used to assemble the **right** axle strut as shown in print G2-5, then repeat for the left strut:

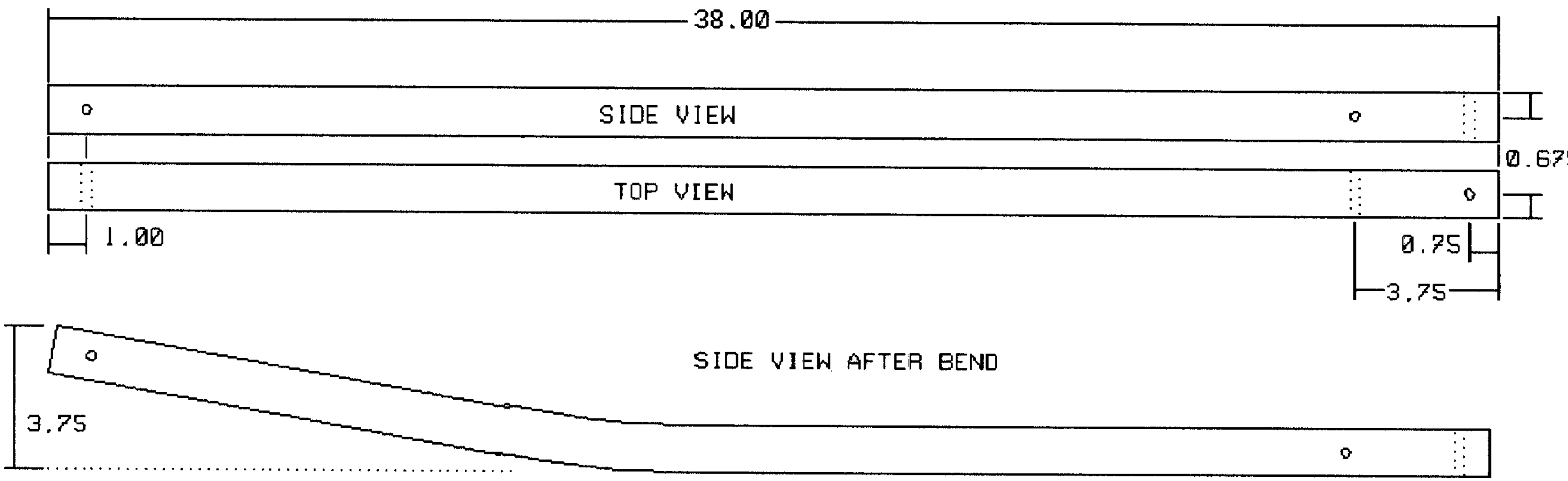
- At the outboard end of the strut (the end with two holes), insert a KB-2 axle (comes with the KB-2 wheel set) so that the shoulder extends 0.25 inch beyond the tube end.

- Secure the axle and strut and match-drill through the axle at the outboard 1/4 inch hole. This job should be done slowly and carefully with oil to assure a clean drill cut.

- Temporarily pin the axle in place with a 1/4 inch bolt, rotate the strut 90 degrees and match-drill the second 1/4 inch hole at the outboard end of the strut.

- Place saddle fittings on either side of the outboard axle hole and secure a small bracket with the indicated hardware. Note that the outboard bracket should face **up**!

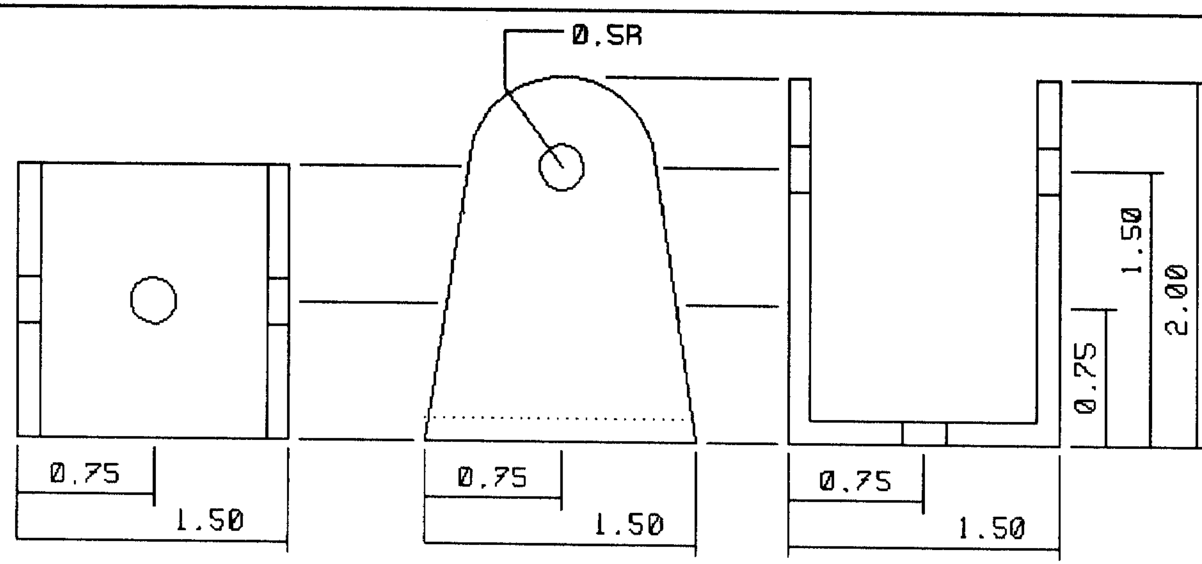
Repeat with the inboard saddle fittings and another small bracket, with the bracket facing **forward**.



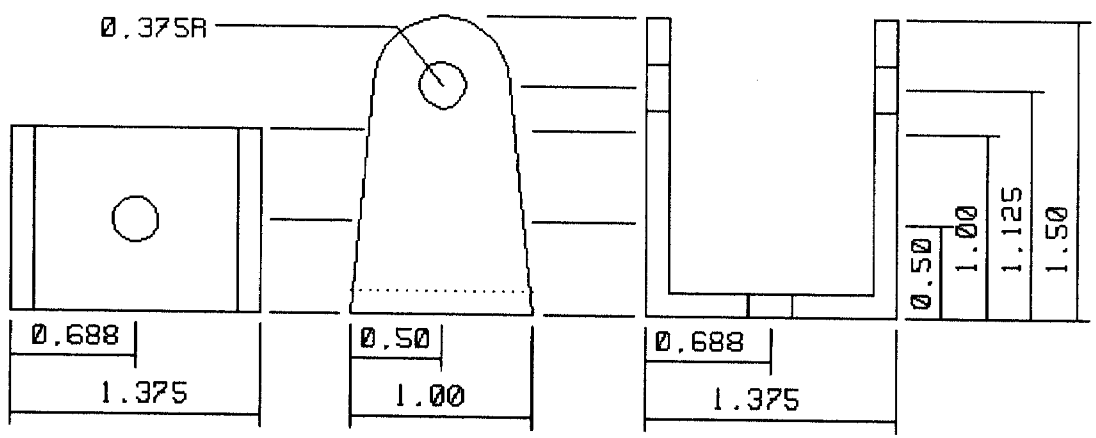
MATERIAL: 1.25 INCH OD (0.120 WALL) 6061-T6 ALUM TUBE
ALL HOLES 1/4 INCH

SEE TEXT FOR BENDING INSTRUCTIONS

The GYROBEE	DATE: JUNE 88 REV: 1.0
DRAWING: AXLE STRUT (2 RQD) G2-1	SCALE: INCHES PAGE OF



LARGE BRACKET
EQUIV. LEAF E1520

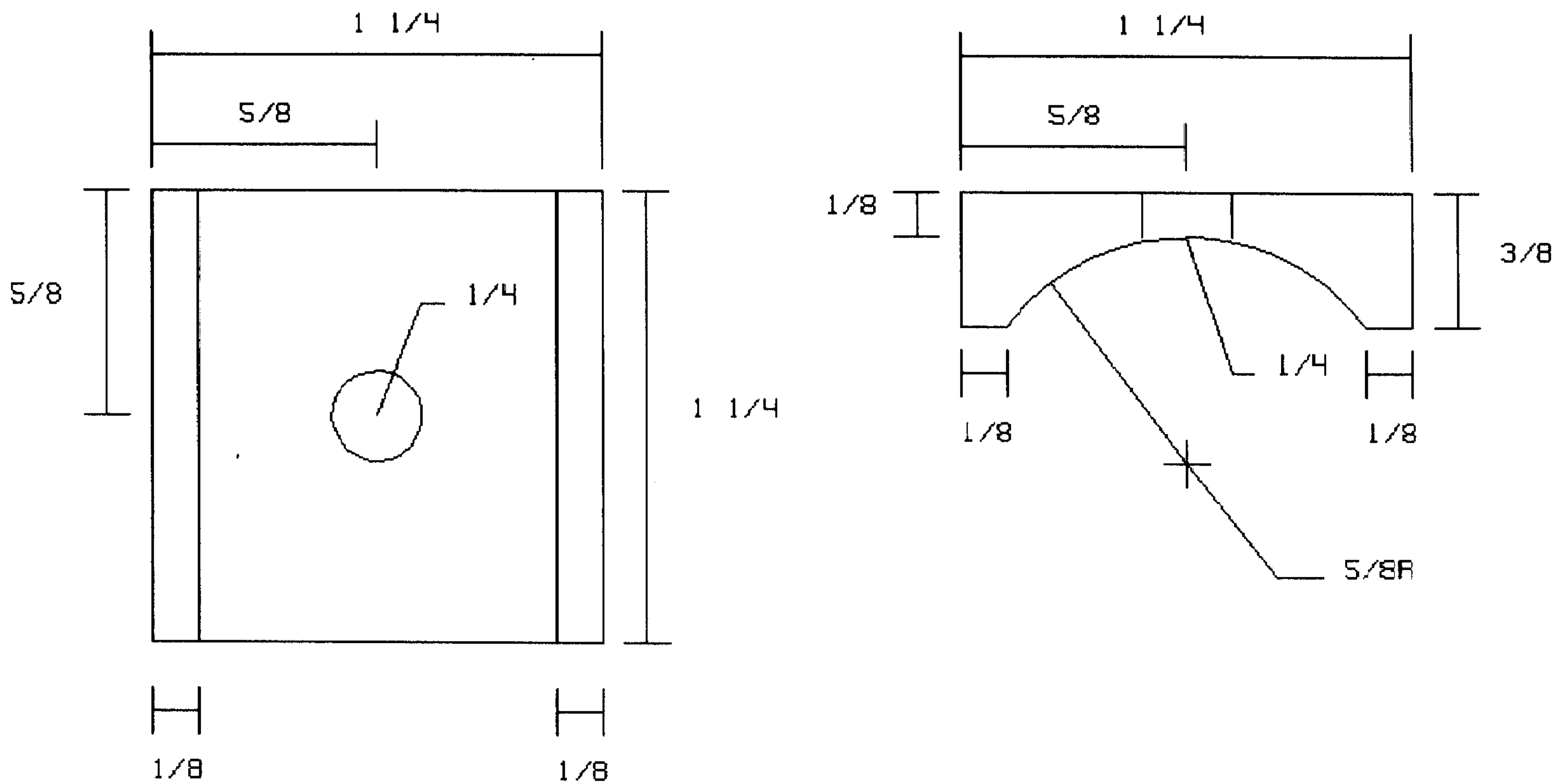


SMALL BRACKET
EQUIV. LEAF E1500

MATERIAL: BOTH BRACKETS 1/8 THK STAINLESS SHT.

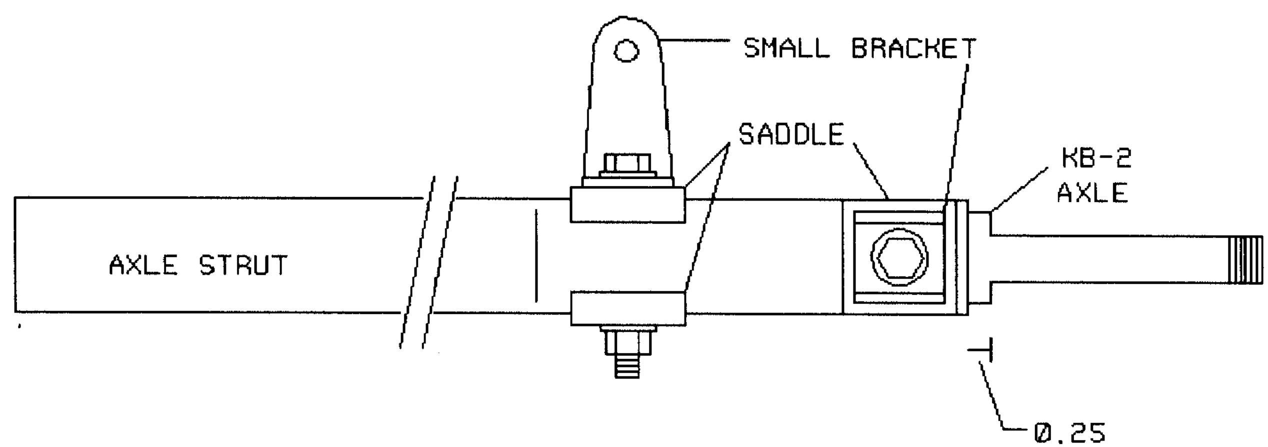
ALL HOLES 1/4 INCH

The GYROBEE	DATE: SEP 94 REV: 1.1
DRAWING: AIRFRAME BRACKETS G2-2	SCALE: INCHES PAGE OF



MATERIAL: ALUMINUM (6061-T6) BAR STOCK

The GYROBEE	DATE: APRIL 88 REV: 2.0
DRAWING: AXLE SADDLE FITTINGS G2-3 10 ROD	SCALE: INCHES PAGE OF



BRACKET/SADDLE HARDWARE:

AN4-21A - 1
AN960-416 - 2
AN365-428 - 1

NOTE: OUTBOARD BRACKET SHOULD FACE UP
WHILE INBOARD BRACKET FACES FORWARD

RIGHT AXLE STRUT IS SHOWN - LEFT IS OPPOSITE

The GYROBEE	DATE: SEP 90 REV: 3.0
DRAWING: AXLE STRUT ASSEMBLY G2-4	SCALE: INCHES PAGE OF

PHASE 3 - MAIN GEAR MOUNTING

Prints:

- **G3-1 -** Axle Drag Struts
- **G3-2 -** Lap Belt End Fitting
- **G3-3 -** Main Gear Mounting

Fabrication Notes:

- **G3-1 - Axle Drag Struts.** Once the chromoly tubes have been cut to length and de-burred, insert the AN490HT8P fittings in both ends and center-drill the tube and fitting (3/16) at 0.5 inches in from each tube end. Secure the fittings in the tubes with the AN3 hardware indicated on the print. Thread the AN316-4 stop nuts onto each fitting and then screw on the HF-4 Heim fittings. Adjust the position of the Heim fittings so they are threaded approximately half way down the threaded shaft.
- **G3-2 - Lap Belt End Fitting**. This fitting will anchor the end of the lap belt to the keel. Since the fitting is made of 1/8 inch stainless sheet stock, you may wish to have it made at a local machine shop. Corner radius is not critical, but you do want to avoid sharp corners.

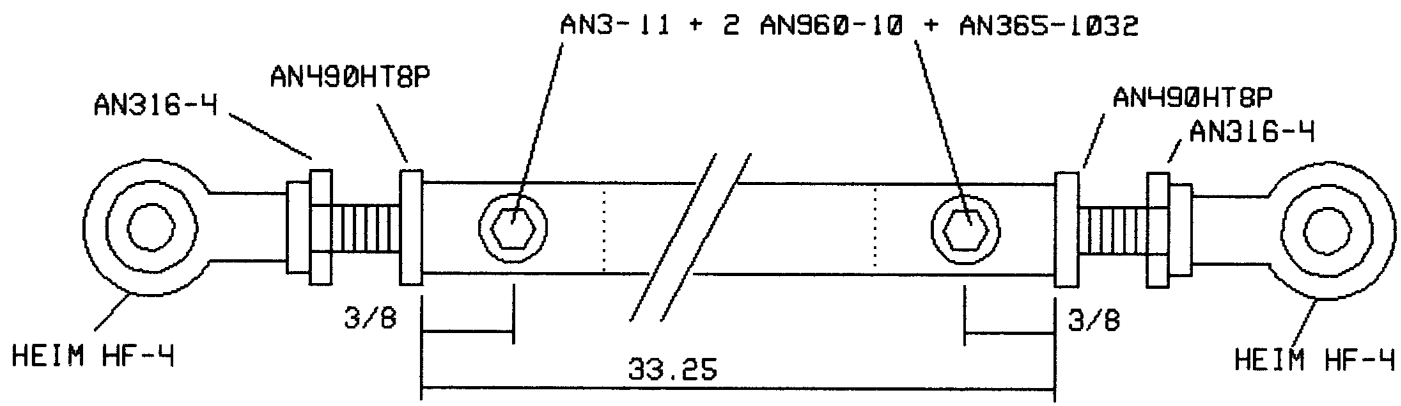
Hardware:

- **AN490HT8P** rod-end inserts (4)
- **Heim HF-4** female rod ends (4)
- **AN3-11A** bolt (4)
- **AN960-318** washers (8)
- **AN365-1032** nylock nuts (4)
- **AN4-17A** bolt (4)
- **AN4-20A** bolt (2)
- **AN4-26A** bolt (1)
- **AN4-31A** bolt (1)
- **AN960-416** washer (24)
- **AN970-4** washers (2)
- **AN365-428** nylock nut (8)

Assembly:

- Attach the two large brackets at the rear 1/4 inch hole on the keel as indicated in G3-3.
- Attach the remaining two small brackets at the 1/4 inch hole in the keel just behind the seat braces as indicated in G3-3. Note that there is an AN970 washer against the keel, followed by the lap belt end fittings (use the lower hole), and finally the bracket on each side.
- Wrap the axle threads with several layers of masking tape to prevent thread damage as you work with the airframe. Attach the right and left axle struts to the large brackets using the hardware indicated in G3-3. Use additional washers between the tube wall and the brackets, as needed, to minimize side play.

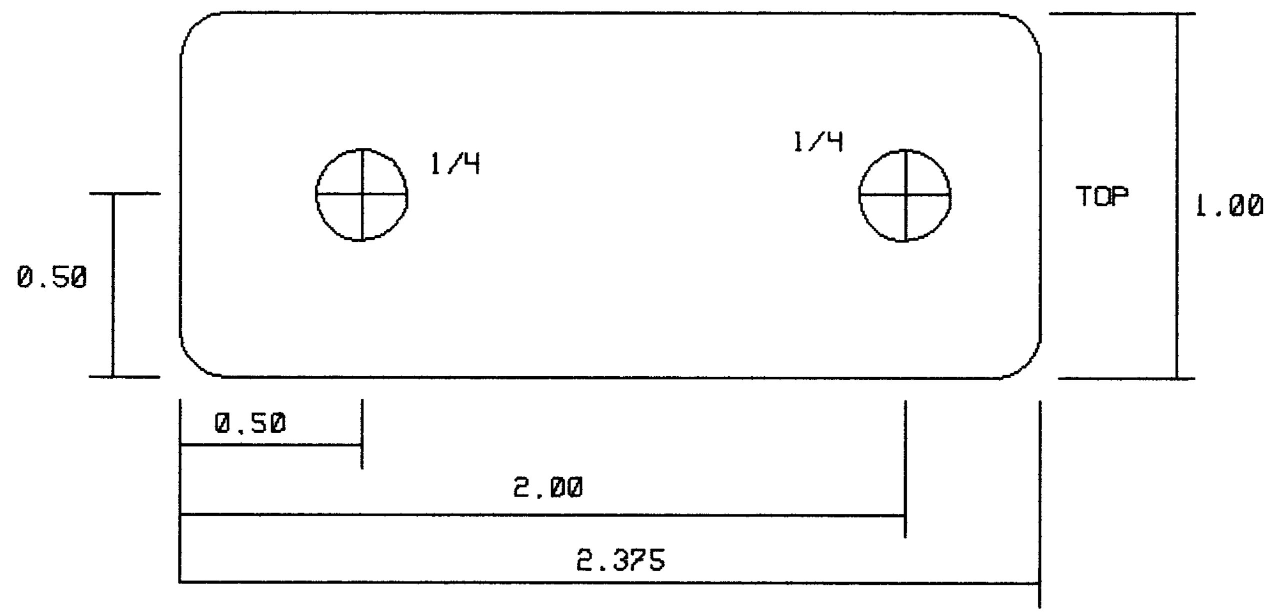
- Follow the printed instructions on G3-3 to attach the drag struts, on each side of the aircraft, between the small bracket on the keel and the forward-facing bracket on the axle strut. Adjust the length of the struts using the threaded Heim fittings at both ends of each strut so the gear legs are essentially at right angles to the keel with the struts in place. We will fine-tune this later when the vertical struts and nose wheel have been installed.
- Grease the two main axles and install the KB-2 main gear wheels with the hardware provided. **Be sure to install the cotter pins in each axle to secure the castle nuts.**



MATERIAL: 9/16 DIA. .065 WALL 4130 CHROMOLY TUBE STOCK

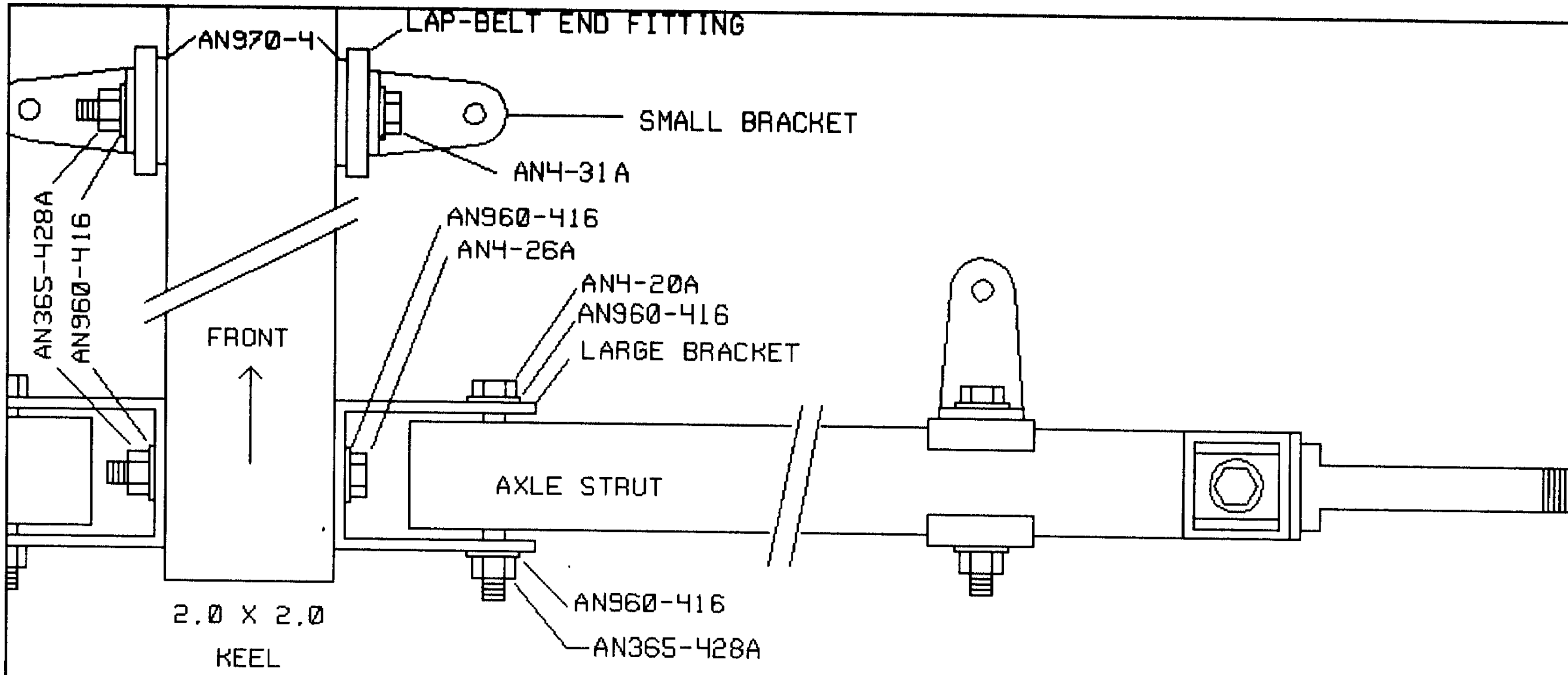
PRIOR TO DRILLING THE HOLES TO SECURE THE TUBE END FITTINGS, IT IS SUGGESTED THAT YOU CHECK THE STRUTS FOR OPTIMUM LENGTH. SET ONE OF THE GEAR AXLE STRUTS AS CLOSE TO 90 DEGREES TO THE KEEL AT POSSIBLE. TEMPORARILY SCREW THE HEIM ENDS TO THE END FITTINGS AT ABOUT THE HALF-WAY POINT AND SLIDE THE FITTINGS INTO THE ENDS OF THE STRUT. AT THIS POINT, CHECK THE TOTAL LENGTH AGAINST THE DISTANCE BETWEEN THE DRAG STRUT ATTACHMENT BRACKETS (SEE G3-3). SHORTEN THE LENGTH OF THE DRAG STRUT, IF REQUIRED, FOR A GOOD FIT. TRIM BOTH STRUTS TO THE SAME LENGTH AND THEN DRILL THE HOLES FOR THE ROD END FITTINGS AND INSTALL.

The GYROBEE	DATE: MAY 98 REV: 2.10
DRAWING: AXLE DRAG STRUTS (2 RQD) G3-1	SCALE: INCHES PAGE OF



MATERIAL; 1/8 THK STAINLESS SHEET STOCK

The GYROBEE	DATE: SEP 97 REV: 1.00
DRAWING: LAP BELT END FITTING G3-2 (2 REQUIRED)	SCALE: PAGE OF



HORIZONTAL STRUT ATTACHMENTS NOT SHOWN. EACH STRUT IS SECURED TO THE SMALL BRACKETS ON THE AXLE AND KEEL WITH AN AN4-17 BOLT, 2 AN960-416 WASHERS, AND AN AN365-428A NUT. ADDITIONAL AN960-416 WASHERS SHOULD BE USED INTERNAL TO THE BRACKETS AS SPACERS TO PROVIDE A SNUG FIT.

RIGHT SIDE SHOWN - LEFT IS OPPOSITE

The GYROBEE	DATE: REV:
DRAWING: MAIN GEAR MOUNTING G3-3	SCALE: INCHES PAGE OF

PHASE 4 - MAIN GEAR SHOCK STRUTS

Prints:

- **G4-1** - Temporary Shock Plate
- **G4-2** - Shock Plate
- **G4-3** - Upper strut Fittings
- **G4-4** - Main Gear Vertical Struts

Fabrication Notes:

- **G4-1 - Temporary Shock Plate**. This part can be made from any alloy as it is only used as a temporary anchor for the struts during construction.
- **G4-2 - Shock Plate.** Since this piece is fabricated from 1/8 inch stainless sheet stock, you may wish to have it made by a machine shop**.** Put this part aside for later use.
- **G4-3 - Upper Strut Fittings.** These are machined parts.
- **G4-4 - Main Gear Vertical Struts**

Hardware:

- **AN3-14A** bolt (2)
- **AN960-316** washer (4)
- **AN365-1032** nylock nuts (2)
- **AN4-17A** bolt (2)
- **AN960-416** washers (12)
- **AN365-428** nylock nuts (2)

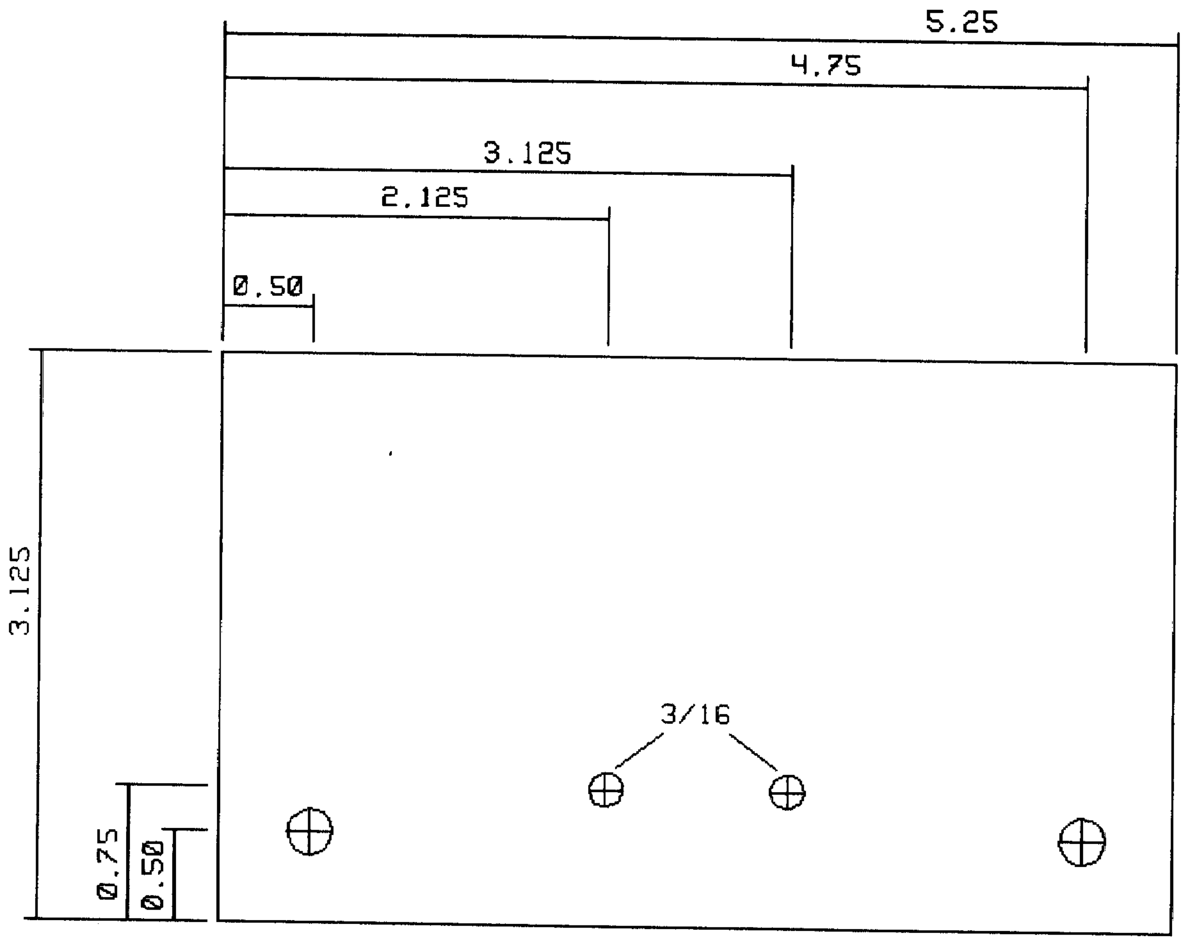
Assembly:

- Attach the temporary shock plate to the rear of the mast at the 3/16 inch holes. The edge of the plate without the holes should be oriented upward. Secure with hardware-store quality 3/16 bolts. The plate and hardware will be replaced later in assembly.

- Slide an upper strut fitting into the end of each vertical strut (the end with the 3/16 hole). Rotate the fitting to align the holes and secure with the AN3 hardware indicated in G4-4.

- Secure the other end of each vertical strut to the small vertical bracket at the far end of each axle strut. Use an AN4-17A bolts, two AN960-416 washers, and an AN365-428 nut at each point. Use additional washers, as needed, between the tube wall and the bracket to minimize side play.

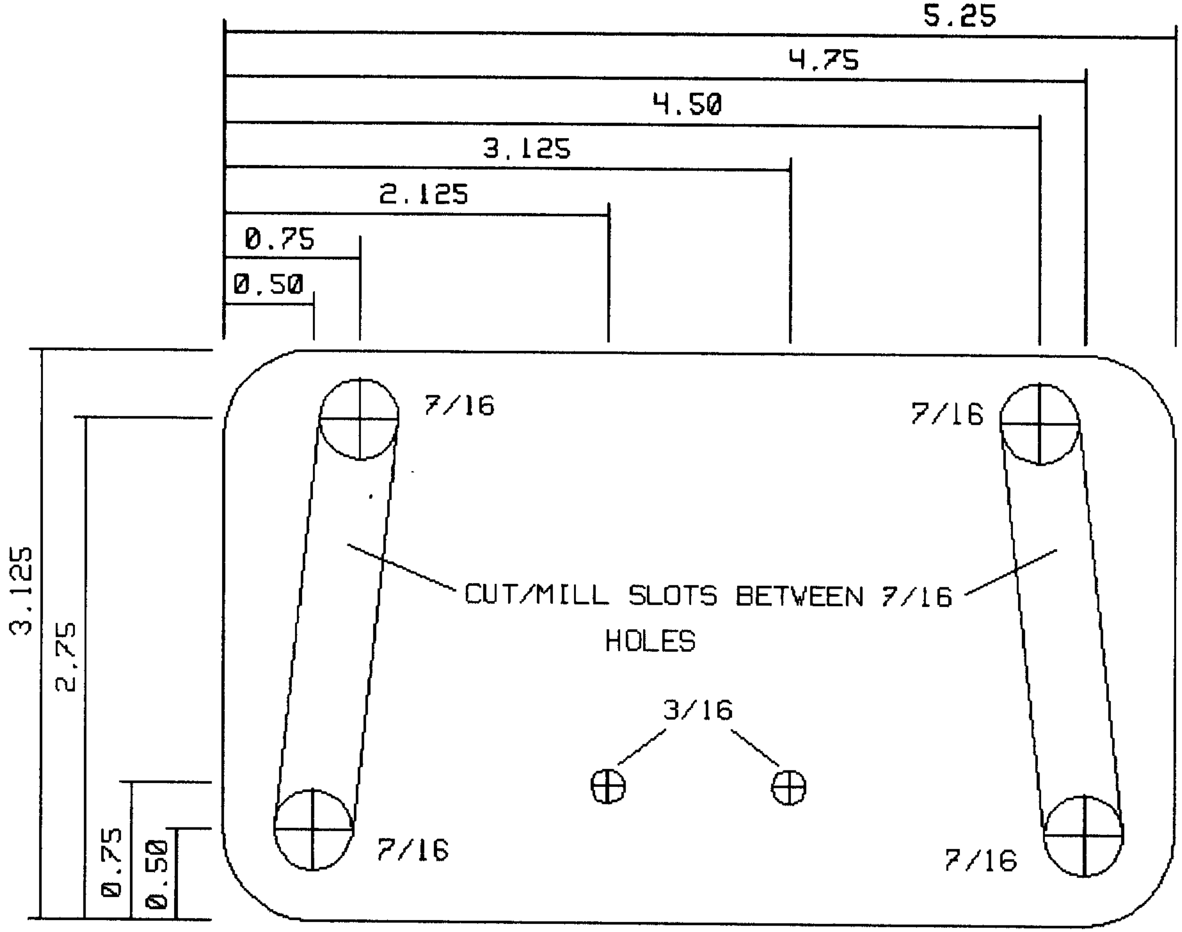
For each vertical strut, slide the slotted end of the upper strut fitting over the edge of the temporary shock plate and pin to the plate with a hardware-store quality 1/4 inch bolt. This hardware will be replaced later in assembly. The frame can now be allowed to rest on the main gear.



MATERIAL: 1/8 INCH ALUM SHEET STOCK

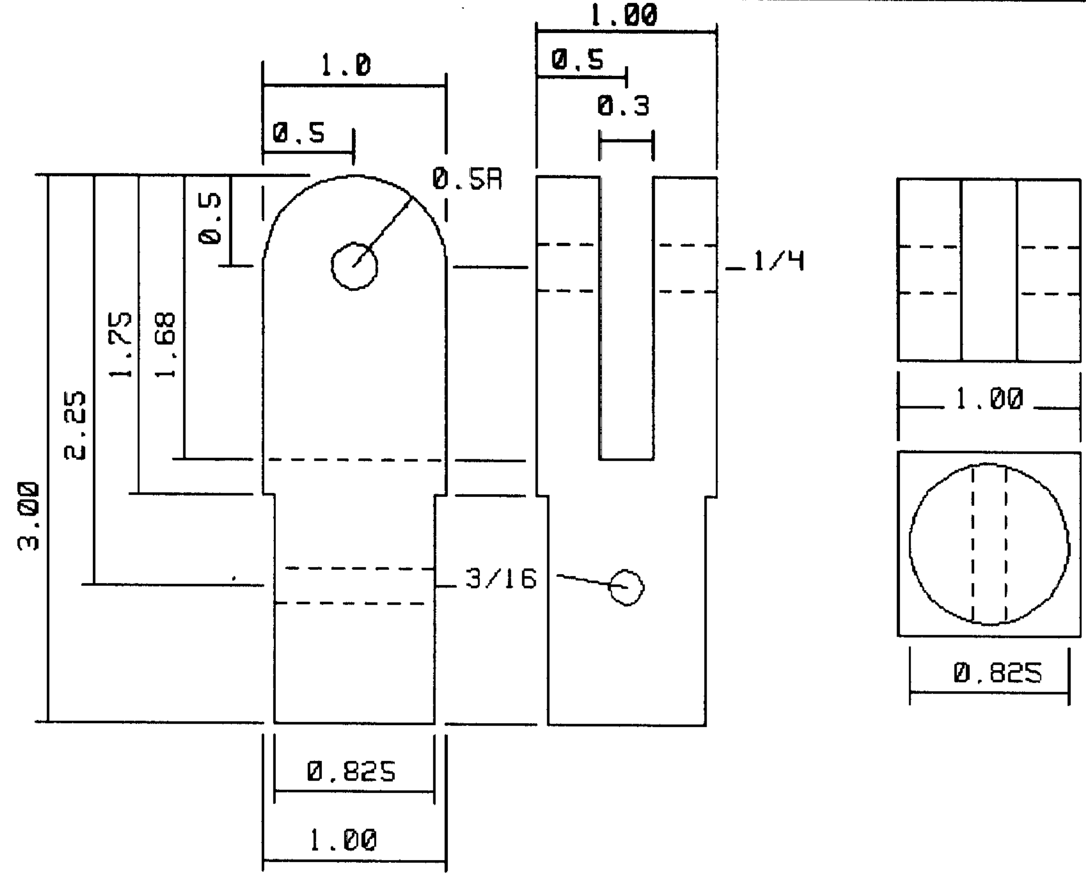
ANY GRADE OF ALUMINUM SHEET STOCK CAN BE USED AS THIS IS NOT A FLIGHT-READY COMPONENT

The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: TEMPORARY SHOCK PLATE GH-1	SCALE: INCHES PAGE OF



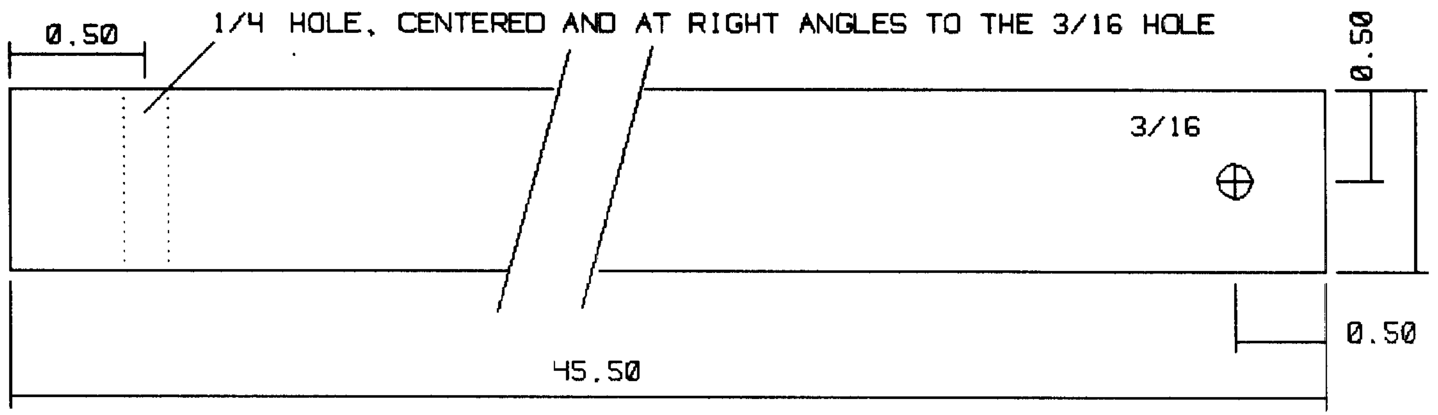
MATERIAL: 1/8 INCH STAINLESS SHEET
CORNERS ROUNDED ON 1/2 INCH RADIUS

The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: SHOCK PLATE (1 RQD) G4-2	SCALE: INCHES PAGE OF

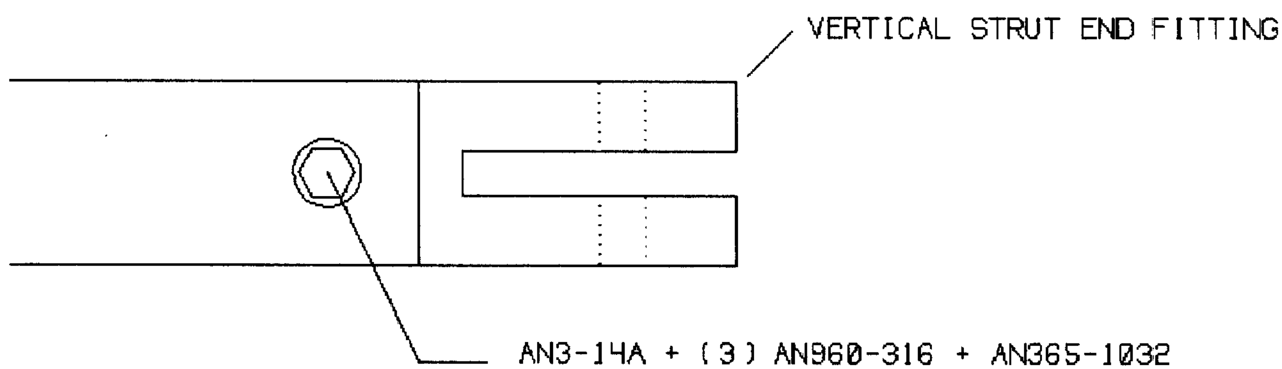


MATERIAL: ALUMINUM (6061-T6) BAR STOCK

The GYROBEE		DATE: APRIL 88 REV: 1.0
DRAWING: G4-3	MACHINED PARTS UPPER STRUT FITTING (2 RQD)	SCALE: INCHES PAGE OF



MATERIAL: 1 INCH O.D. 0.063 WALL 6061-T6 ALUM. TUBE STOCK



END FITTING MOUNTING DETAIL

The GYROBEE	DATE: MAY 88 REV: 1.0
DRAWING: MAIN GEAR VERTICAL STRUT G4-4 (2 RQD)	SCALE: INCHES PAGE OF

PHASE 5 - NOSE BLOCK INSTALLATION

Prints:

- **G5-1** - Nose Block
- **G5-2** - Nose Block Cheek Plates
- **G5-3** - Nose Block Installation

Fabrication Notes:

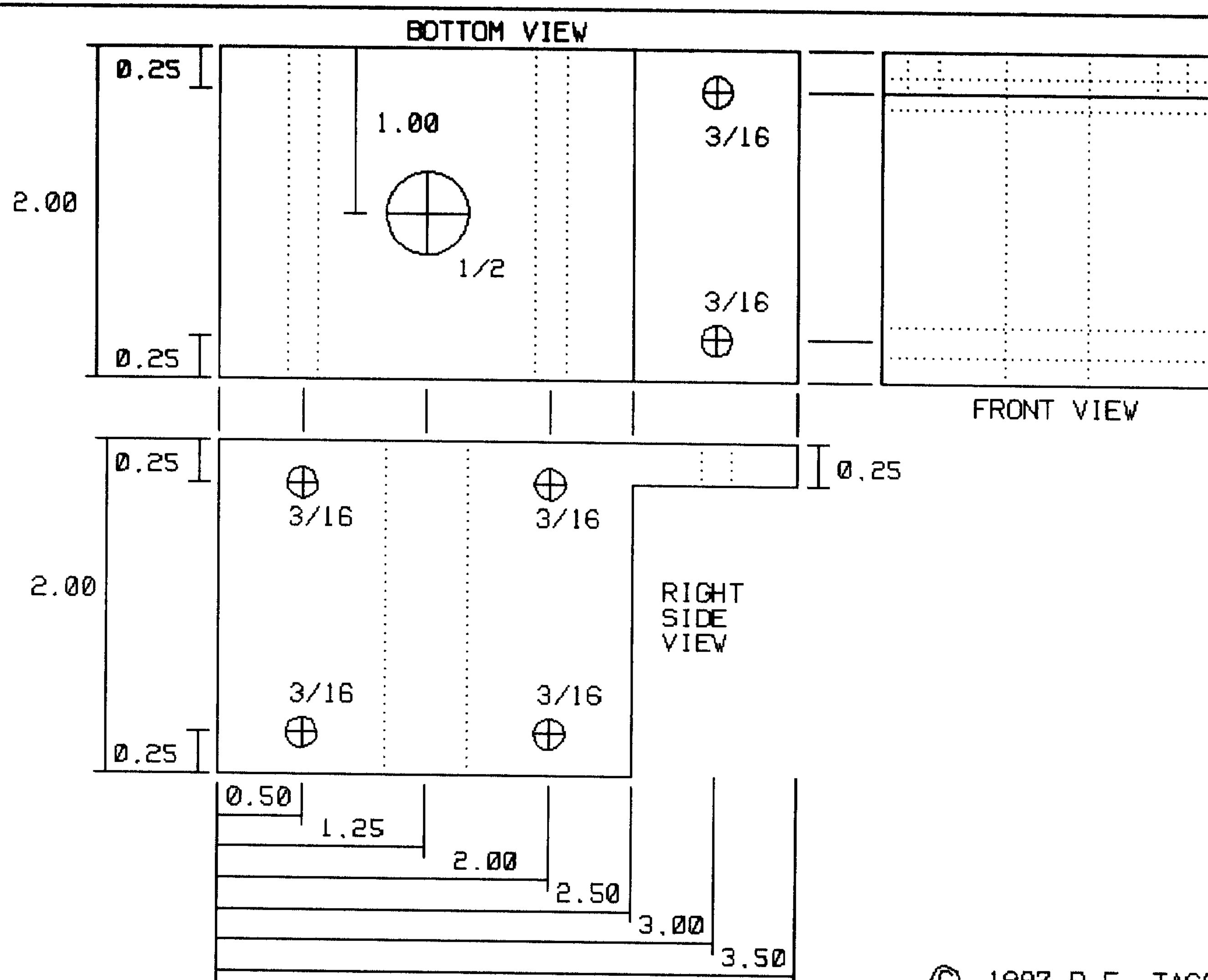
- **G5-1 - Nose Block**. This is a machined component. This part could be made of 6061-T6 aluminum, but the steel is stronger and provides needed nose weight.

Hardware:

- **AN3-26A** bolts (8)
- **AN960-316** washers (16)
- **AN365-1032** nylock nuts (8)

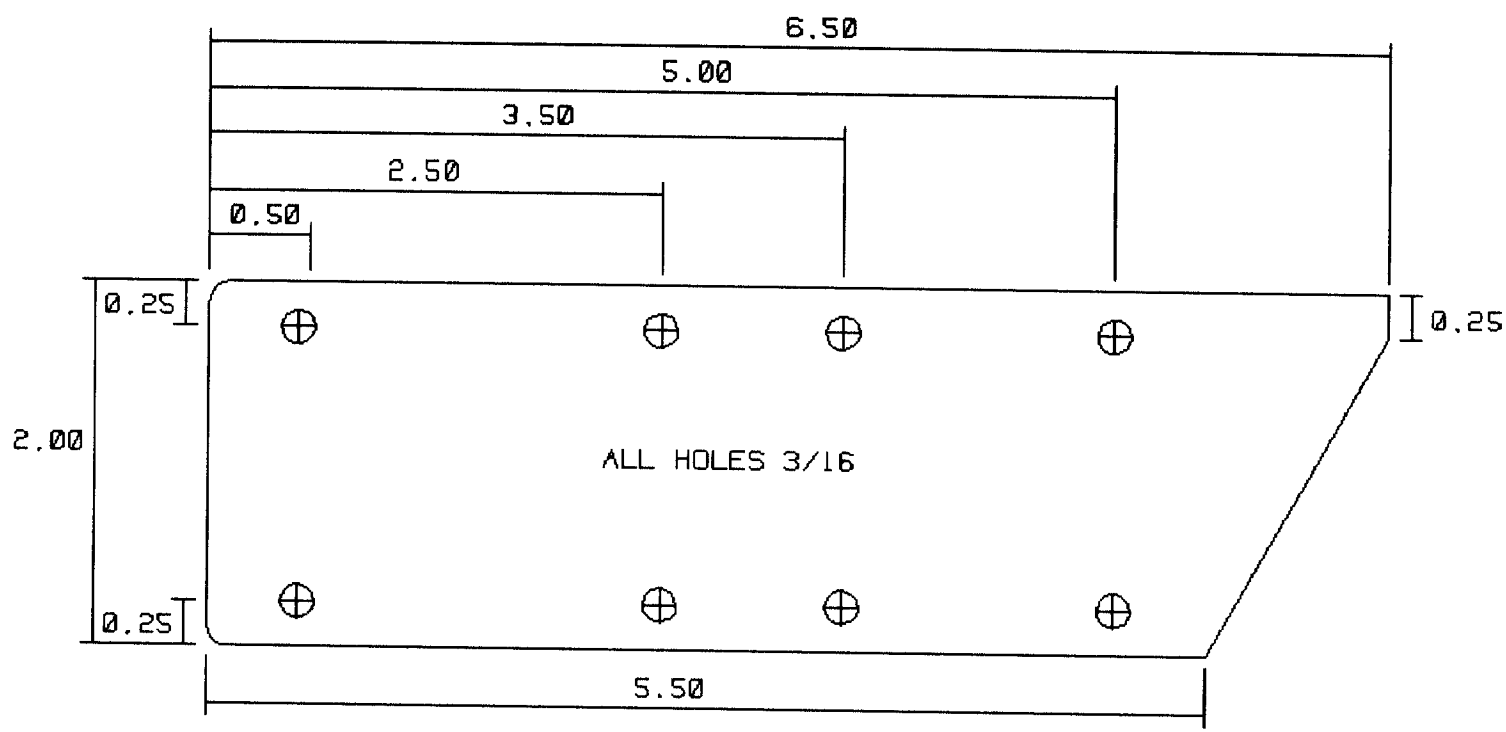
Assembly:

- Loosely bolt the cheek plates on either side of the nose block.
- Place the rear of the nose block flush with the front of the keel tube and insert the remaining four AN3 bolts.
- Making sure to maintain alignment, tighten all nuts.
- At this point, the nose wheel assembly can be temporarily attached to the nose block using a hardware-store-grade 1/2 inch bolt. This makes it easier to move the airframe around. The nosewheel will be permanently mounted later.



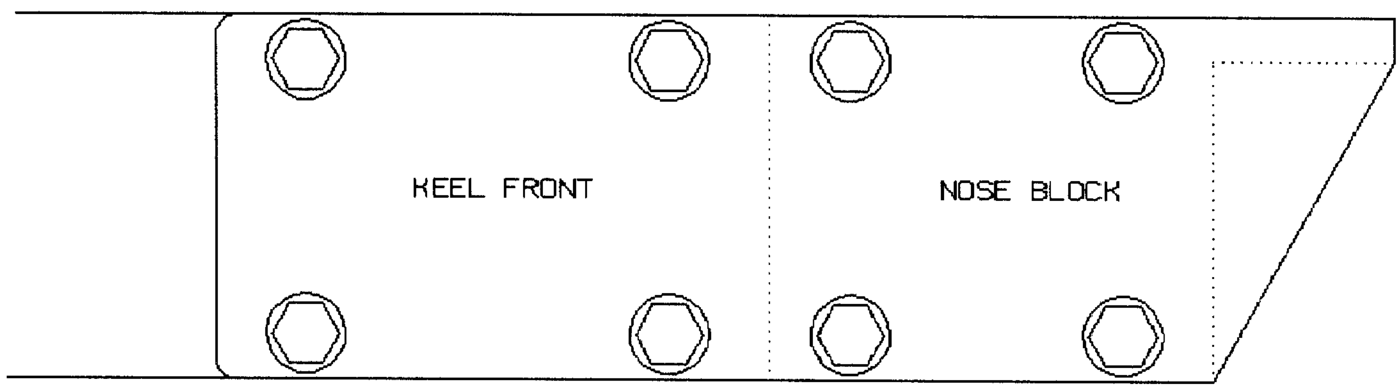
VIRTUALLY ANY GRADE OF STEEL CAN BE USED FOR THIS COMPONENT. PRIME AND PAINT PRIOR TO ASSEMBLY TO INHIBIT RUST.

The GYROBEE	DATE: SEP 97 REV: 3.0
DRAWING: NOSE BLOCK (1 ROD) G5-1 MATERIAL: STEEL	SCALE: PAGE OF



NOSE BLOCK CHEEK PLATES (2 RQD) - 1/8 INCH 6061-T6 SHEET.

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: NOSE WHEEL CHEEK PLATES GS-2	SCALE: PAGE OF



MOUNTING HARDWARE:

8 - AN3-26A BOLTS

16 - AN960-316 WASHERS

8 - AN365-1032 NUTS

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: NOSE BLOCK ASSEMBLY GS-3	SCALE: PAGE OF

PHASE 6 - ENGINE MOUNT

Prints:

- **G6-1** - Horizontal Engine Strut
- **G6-2** - Diagonal Engine Strut
- **G6-3** - Engine Mount Assembly

Fabrication Notes:

- In addition to the four struts shown on G6-1 and G6-2, you will have to make two one inch spacers from 3/8 O.D. (1/4 I.D.) 6061-T6 aluminum tube stock. Both ends of each spacer should be square with respect to the tube wall.

Hardware:

- **AN3-6A** bolt (2)
- **AN960-316** washers (6)
- **AN4-6A** bolt (2)
- **AN4-30A** bolts (1)
- **AN4-52A** bolt (1)
- **AN960-416** washers (6)
- **AN970-4** washers (14)
- **AN365-428** nylock nuts (6)

Assembly:

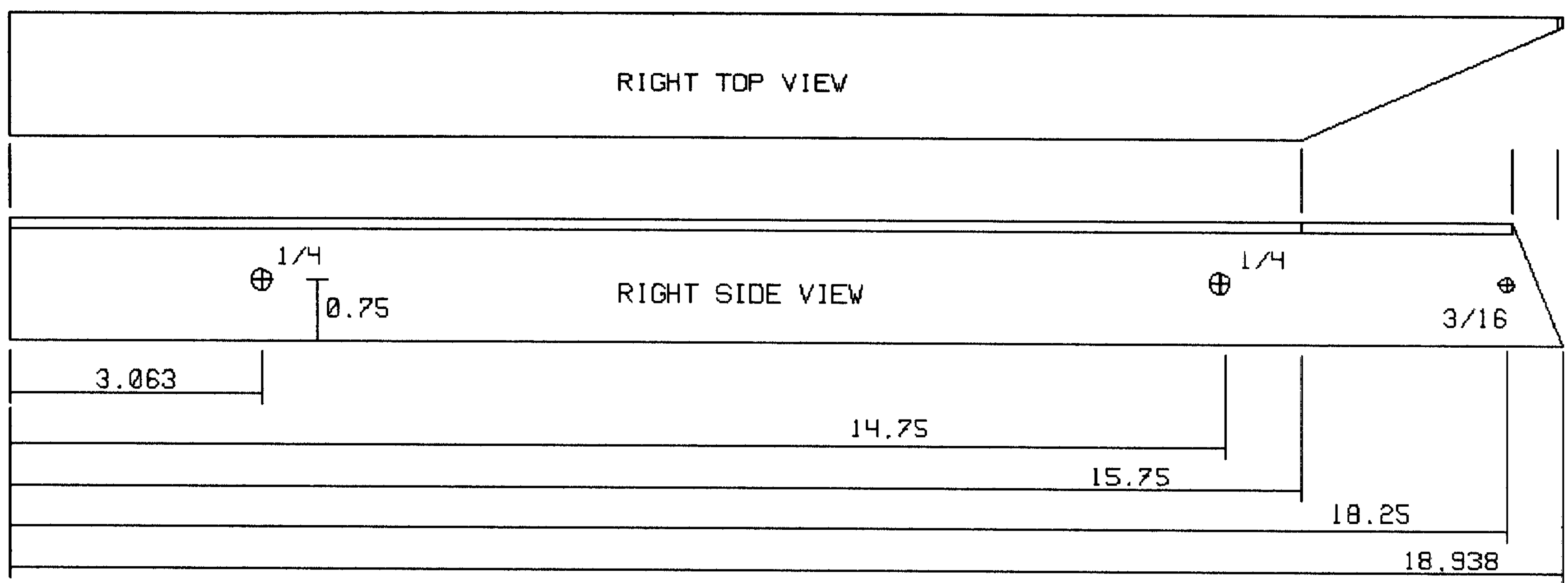
- Using Detail B of G6-3 as a guide, mount the two horizontal engine bearers, including the use of two AN970-4 washers between each bearer and the mast. Although not labe;ed in the detail, the usual AN960 washers are used under the head and nut. Tighten the nut enough to hold the bearers but loose enough that they can be rotated slightly. The top of the temporary shock plate should just reach the bottom edge of the two bearer struts.

- Using Detail A of G6-3 as a guide, secure the bottom end of each diagonal strut. Note that four AN970-4 washers are used as spacers on each side and that AN970-4 washers replace the normal AN960 washers at the outboard enf of each spacer. Tighten the nut but allow for movement of the strut at this point.

- Attach the upper end of each diagonal strut to the outside of the horizontal strut using the hardware indicated.

- With the ends of the horizontal strut overlapping the outside of the two seat braces, match drill 3/16 holes in the seat braces, securing with the AN-3 hardware indicated. Note that the AN960 washer is mistakenly labeled as AN960-10 - it should be AN960-316.

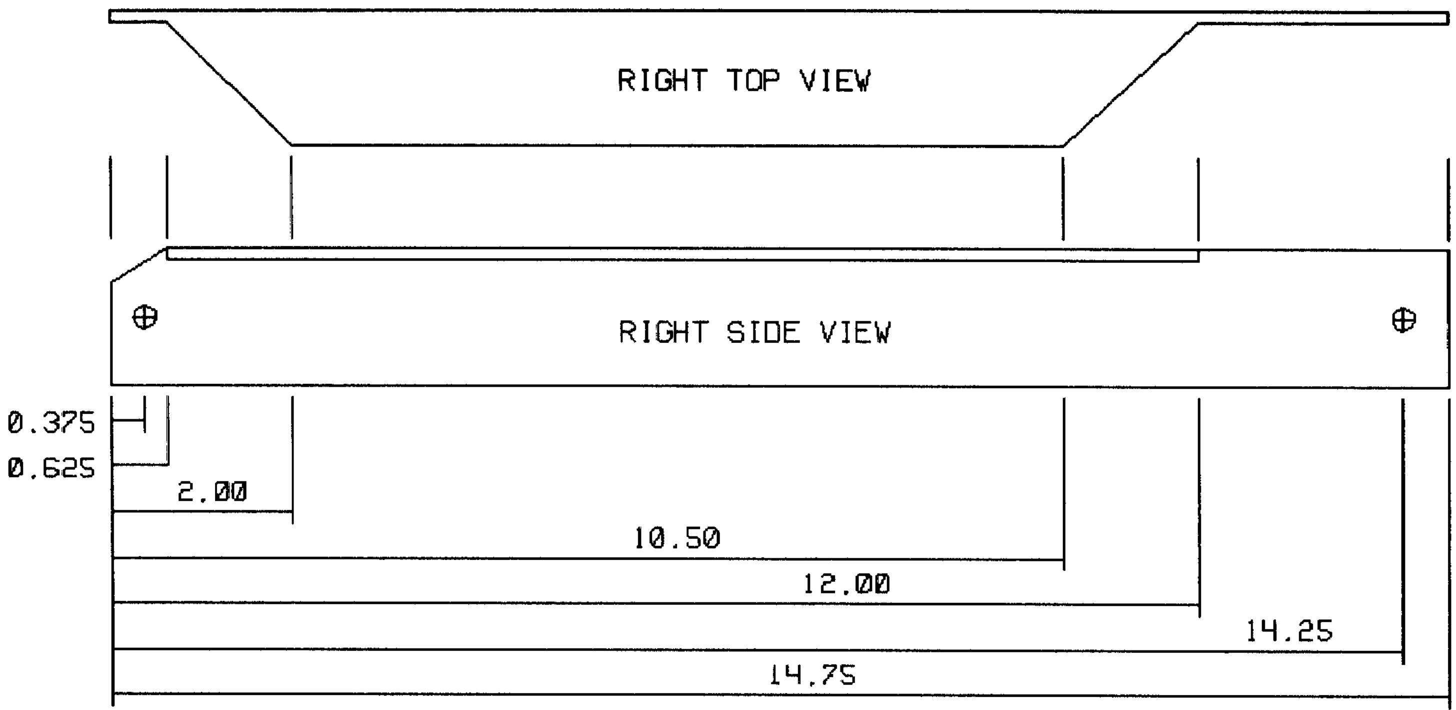
- Tighten all remaining nutes.



RIGHT STRUT SHOWN - LEFT IS OPPOSITE

MATERIAL: 1.5 x 1.5 x 1/8 6061-T6 EXTRUDED ANGLE

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: HORIZONTAL ENGINE STRUT G6-1 2 REQUIRED	SCALE: PAGE OF

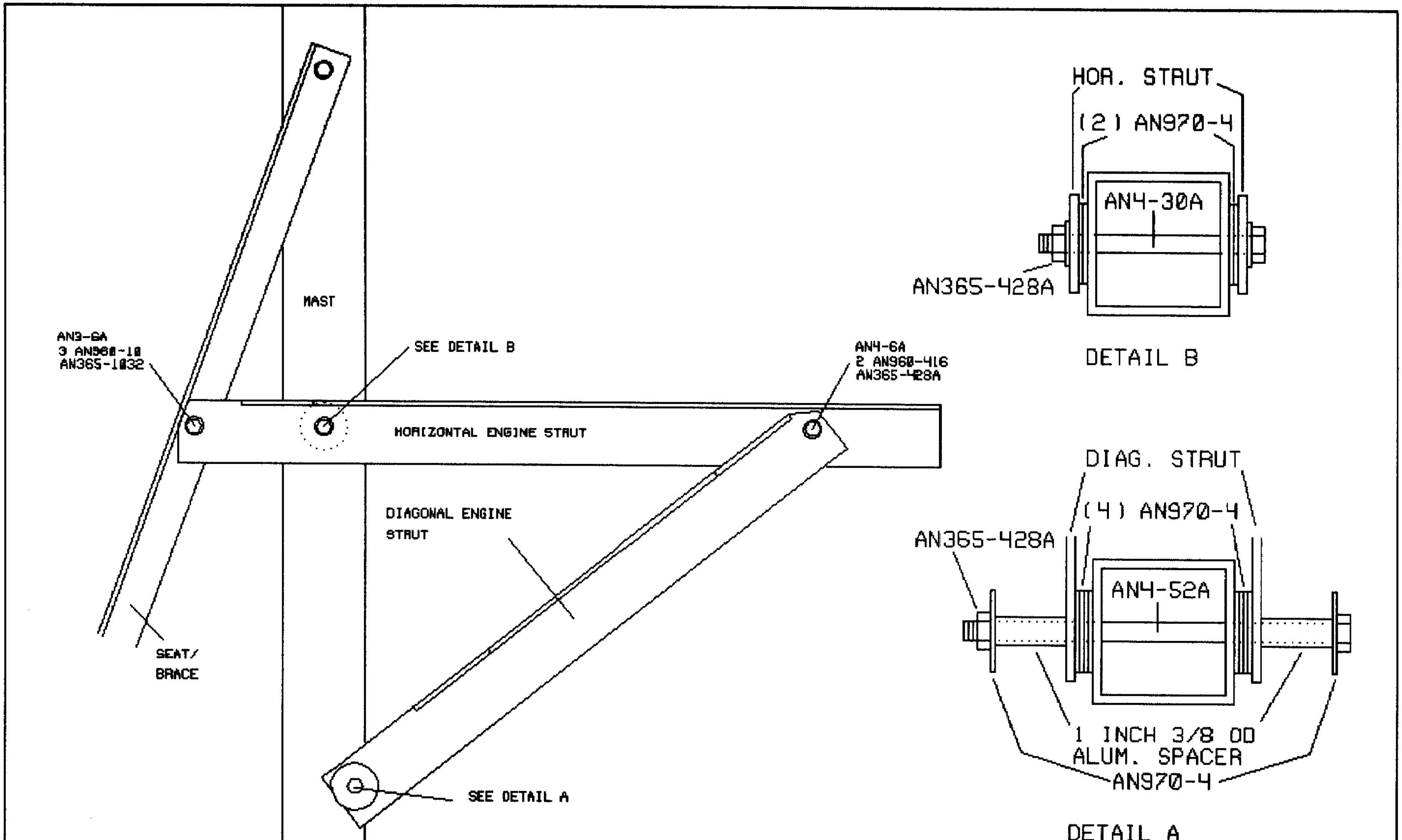


ALL HOLES 1/4 INCH

RIGHT SIDE SHOWN - LEFT IS OPPOSITE

MATERIAL: 1.5 X 1.5 X 1/8 6061-T6 EXTRUDED ANGLE

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: DIAGONAL ENGINE STRUT G6-2 (2 REQUIRED)	SCALE: PAGE OF



LEFT SIDE VIEW

The GYROBEE	DATE: SEP 97 REV: 3.0
DRAWING: ENGINE MOUNT ASSEMBLY G6-3	SCALE: NA PAGE OF

PHASE 7 - FUEL TANK MOUNT

Prints:

- **G7-1** - Horizontal Strut/Beam
- **G7-2** - Diagonal Strut
- **G7-3** - Cross and Side Pieces
- **G7-4** - Top View
- **G7-5** - Side View

Fabrication Notes:

- There are no particular difficulties here - just remember to trim the cross-pieces as indicated (G7-3) after drilling.

Hardware:

- **AN3-6A** bolts (6)
- **AN3-30A** bolt (1)
- **AN960-316** washers (14)
- **AN365-1032** nylock nuts (6)
- **3/16 pop-rivets** - aluminum

Assembly:

- Take a 6 inch length of 2 X 2 x 1/8 wall square tube and drill a 3/16 hole displaced 0.25 inch from one wall. Temporarily bolt the horizontal beams/struts to this piece as if it were the mast in G7-5. Hardware-store 3/16 bolt, nut, and washers will do as they will be removed later.

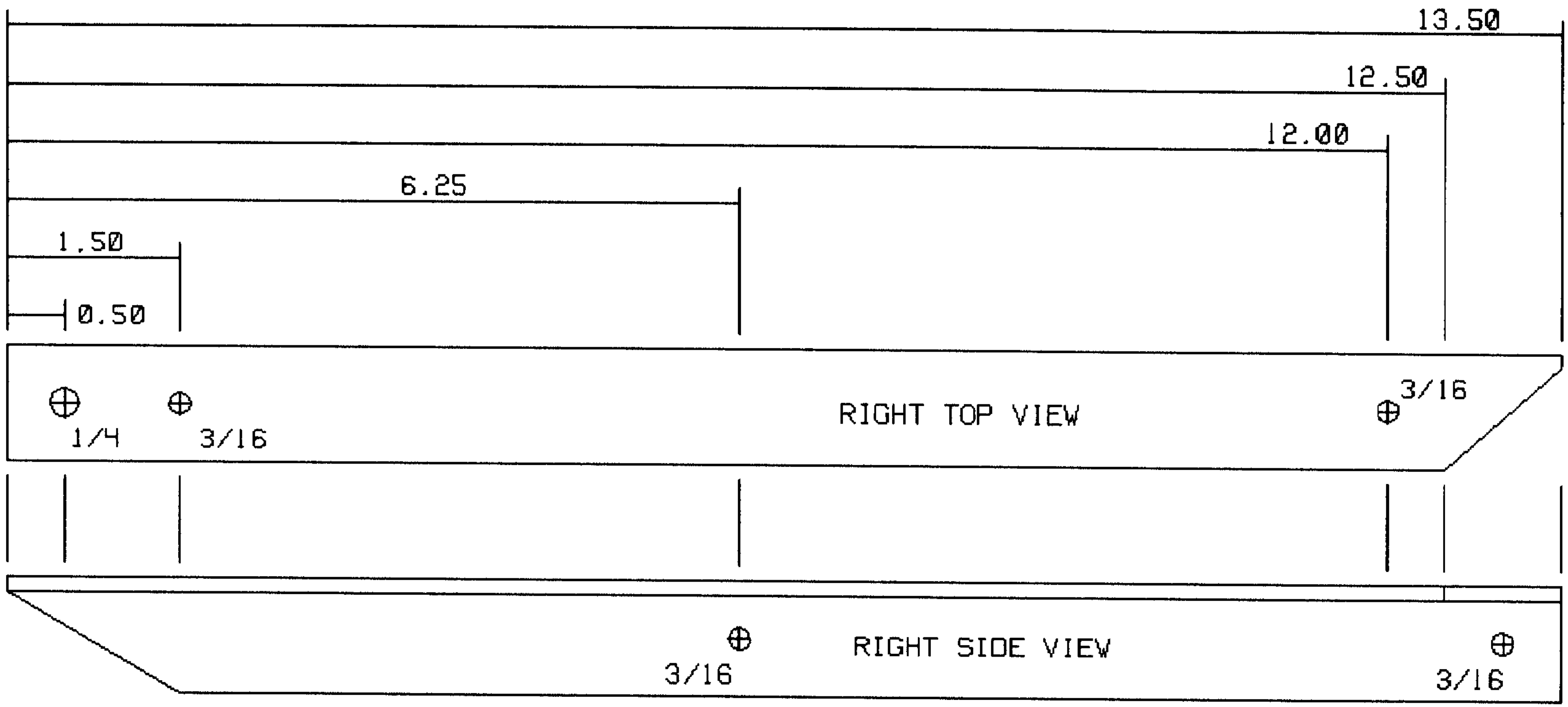
- Bolt on the cross-pieces with the indicated AN3 hardware per G7-4.

- Pop-rivet the side beams into place per G7-4.

- Take the assembly to a welding shop and have the horizontal, cross, and side pieces heliarc welded. **Do not weld the horizontal beams to the dummy mast piece**!

- Remove the dummy mast section and bolt the assembly to the mast using the AN3 hardware indicated in G7-5. Tighten the nut just enough to permit some movement of the assembly.

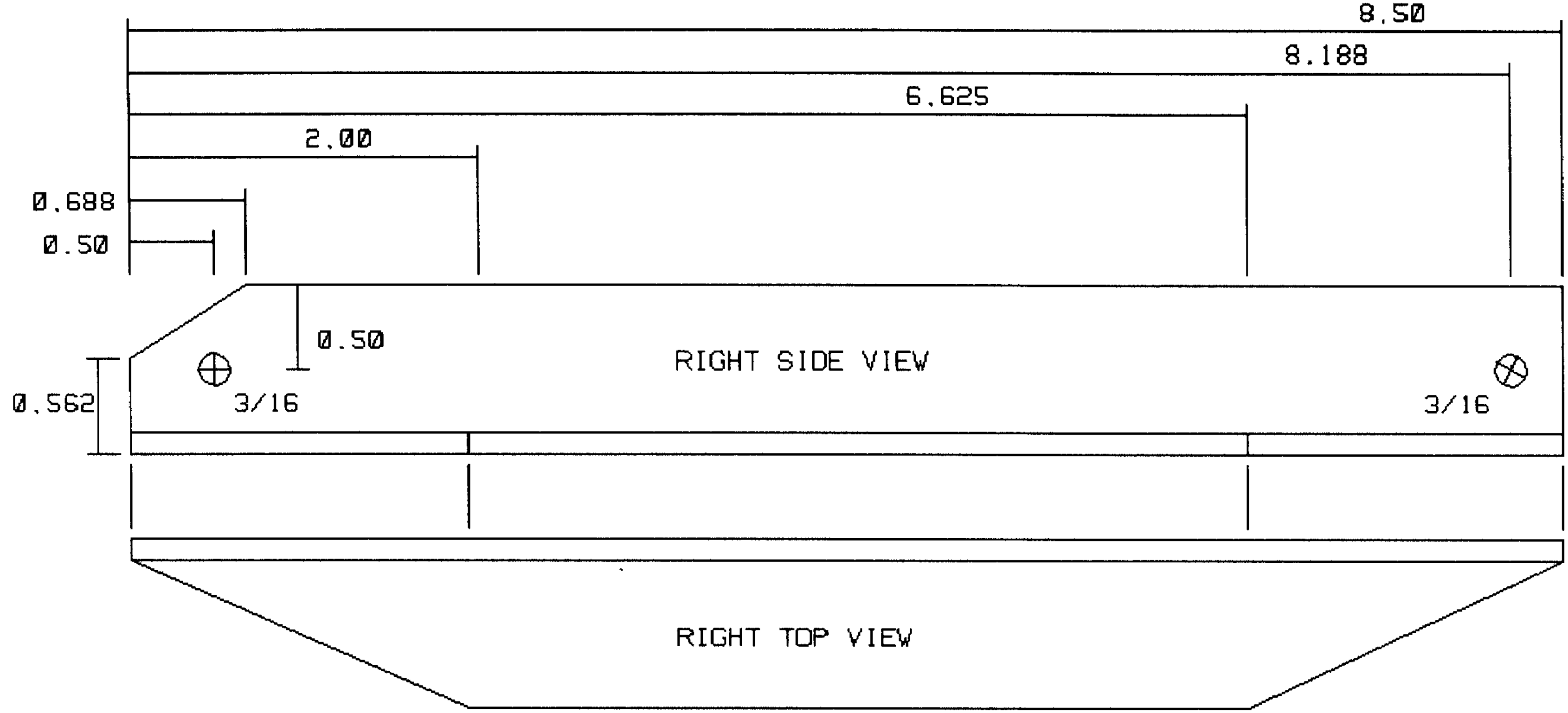
Install the diagonal struts per G7-5 and tighten all nuts.



MATERIAL: 1 × 1 × 1/8 6061-T6 EXTRUDED ANGLE STOCK

RIGHT MOUNT SHOWN - LEFT IS OPPOSITE

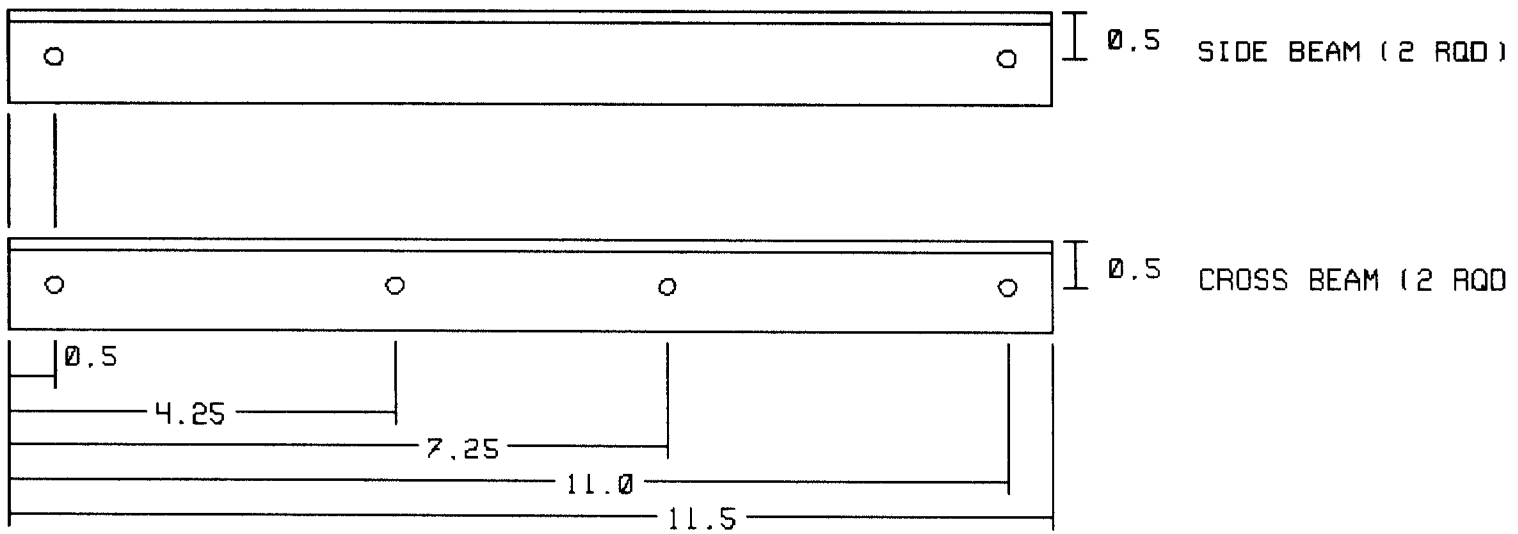
The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: FUEL TANK MOUNT (EIPPER) G7-1 HORIZONTAL BEAM (2 ROD)	SCALE: PAGE OF



MATERIAL: 1 x 1 x 1/8 6061-T6 EXTRUDED ANGLE

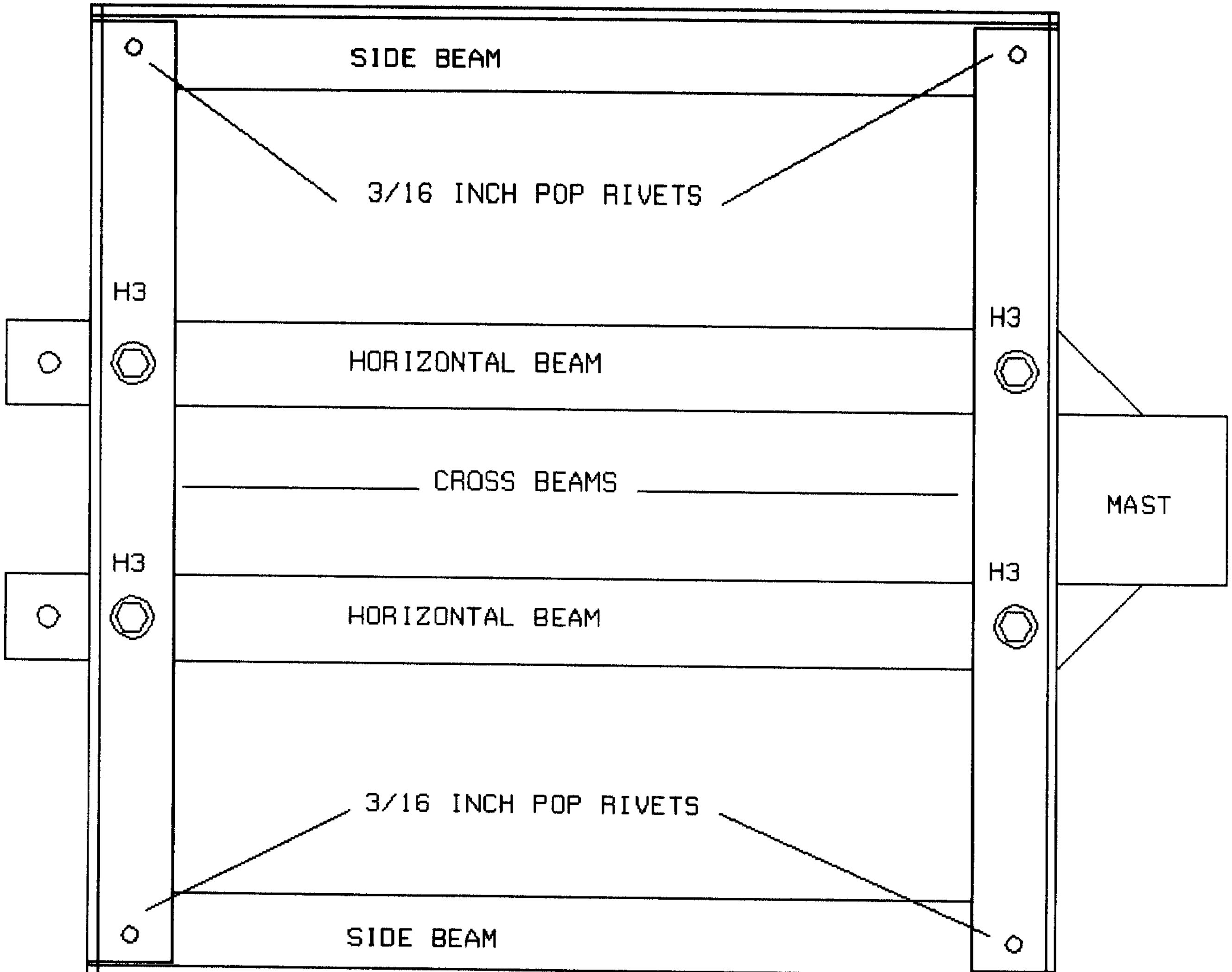
RIGHT PIECE SHOWN - LEFT IS OPPOSITE

The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: FUEL TANK MOUNT DIAGONAL STRUT (2 RQD) G7-2	SCALE: PAGE OF



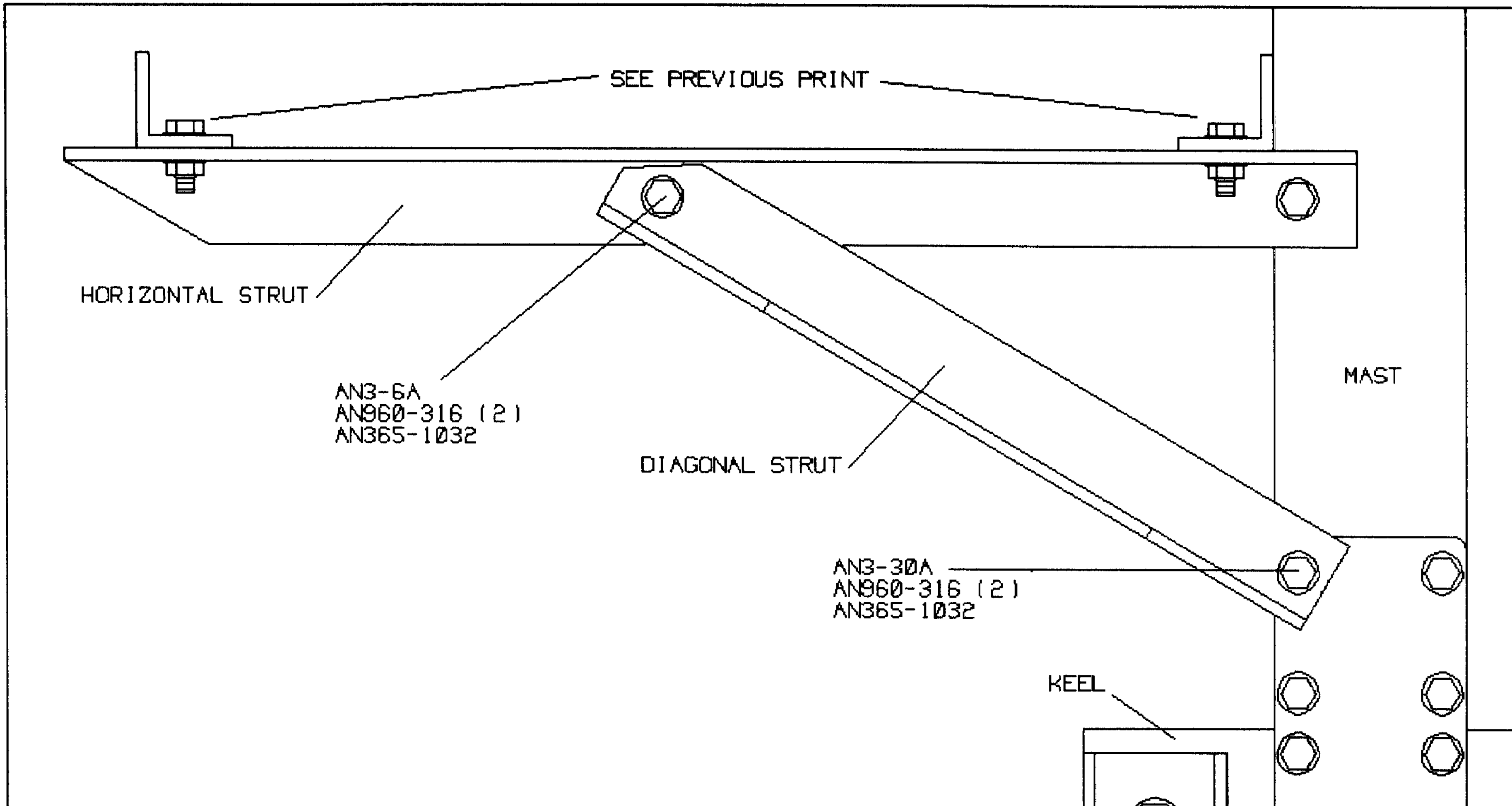
MATERIAL: 1 X 1 X 1/8 6061-T6 EXTRUDED ANGLE
ALL HOLES 3/16
CUT 3/16 OFF EACH END OF EACH CROSS BEAM AFTER
DRILLING PIECE

The GYROBEE	DATE: MAY 88 REV: 1.0
DRAWING: FUEL TANK MOUNT CROSS AND SIDE PIECES G7-3	SCALE: INCHES PAGE 2 OF 5



H3: AN3-6A BOLT, 3 AN960-10 WASHERS, AN365-1032 NUT (4 SETS RQD). SEE ASSEMBLY NOTES FOR ALTERNATE SIZING AND FRAME WELDING OPTIONS

The GYROBEE	DATE: MAY 88 REV: 1.0
DRAWING: FUEL TANK MOUNT (EIPPER GT) G7-4 TOP VIEW	SCALE: NONE PAGE OF



The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: FUEL TANK MOUNT - RIGHT SIDE VIEW G7-5	SCALE: PAGE OF

PHASE 8 - RUDDER PEDALS AND LINKAGES

Prints:

- **G8-1** - Rudder Pedal Bracket
- **G8-2** - Rudder Pivot Brackets
- **G8-3** - Rudder Pedals
- **G8-4** - Rudder Control Horn
- **G8-5** - Rudder Control Horn Brace
- **G8-6** - Spring and Heim Rod Attach Points
- **G8-7** - Assembly Top View
- **G8-8** - Assembly Side View
- **G8-9** - Rudder Pedal-Control Horn Connections

Fabrication:

The prints contain all the essential fabrication details.

Hardware:

- **AN3-6A** bolt (6)
- **AN3-7A** bolt (6)
- **AN960-316** washer (24)
- **AN365-1032** nylock nuts (12)
- **AN4-7A** bolt (4)
- AN4-11A bolt (2)
- **AN4-22A** bolt (2)
- **AN960-416** washer (38)
- **AN8-27** bolt (1)
- **AN960-816** washer (2)
- **AN310-8** castle nut and matching cotter pin (1)
- **AN115-21** shackle (2)
- **AN316-4** check nut (2)
- **HM4** Heim rod end (2)
- **HF4** Heim rod end (2)

Assembly:

- Fabricate both the rudder pedal bracket (**G8-1**) and rudder pivot brackets (**G8-2**) and attach the pivot brackets to the pedal bracket using the hardware indicated in **G8-1**.

- Attach the rudder pedal bracket to the nose block (see **G8-7**) using the hardware indicated in **G8-1.**

- Fabricate the rudder pedals per **G8-3**.

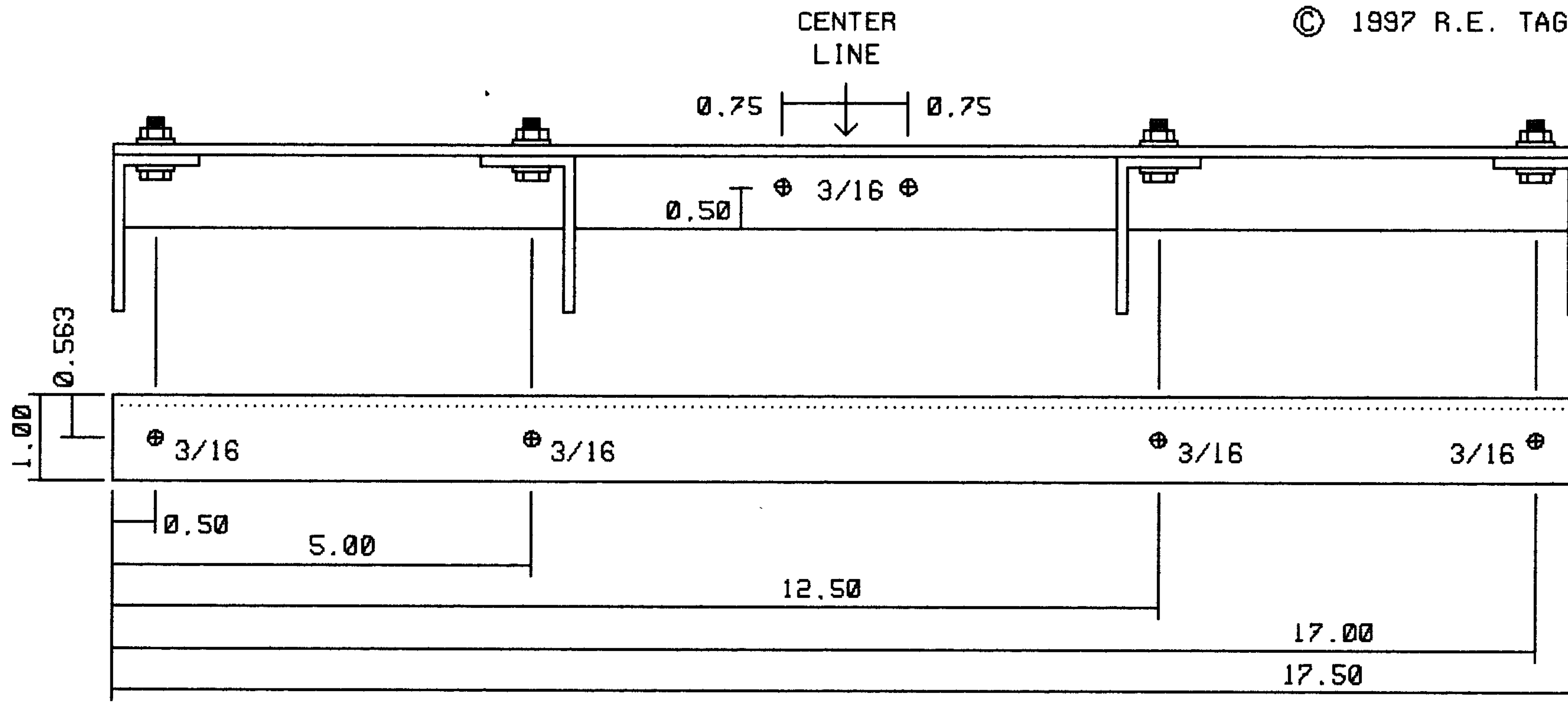
- Fabricate both the rudder control horn (**G8-4**) and brace (**G8-5**).

- Following the detail view on the **left** side of **G8-6**, attach the bracket to the lower side of the front of the control horn at the two end-holes. As you assemble these pieces on the AN4-22A bolt, install an HM4 Heim rod end in the space indicated.

- Following the detail view on the **right** side of **G8-6**, install the wheel-spring attach points in the holes on either side of the nose-wheel fork.

- Using **G8-9** as a guide, thread a check nut on each HM4 threaded extension followed by an HF4 fitting.

- The HF4 fittings connect to the lower extension of the rudder pedals using an AN4-11A bolt as indicated. Adjust the position of each HF4 fitting so that, when they are attached to the pedals, the control horn is centered and both pedals show equal deflection. Once this is achieved, tighten the check nuts. Install the nut on the AN4-11 bolts only hand-tight at this point, since they will have to be removed for final rudder cable installation.



MATERIAL: 1 X 1 X 1/8 INCH EXTRUDED 6061-T6 ALUM. ANGLE STOCK

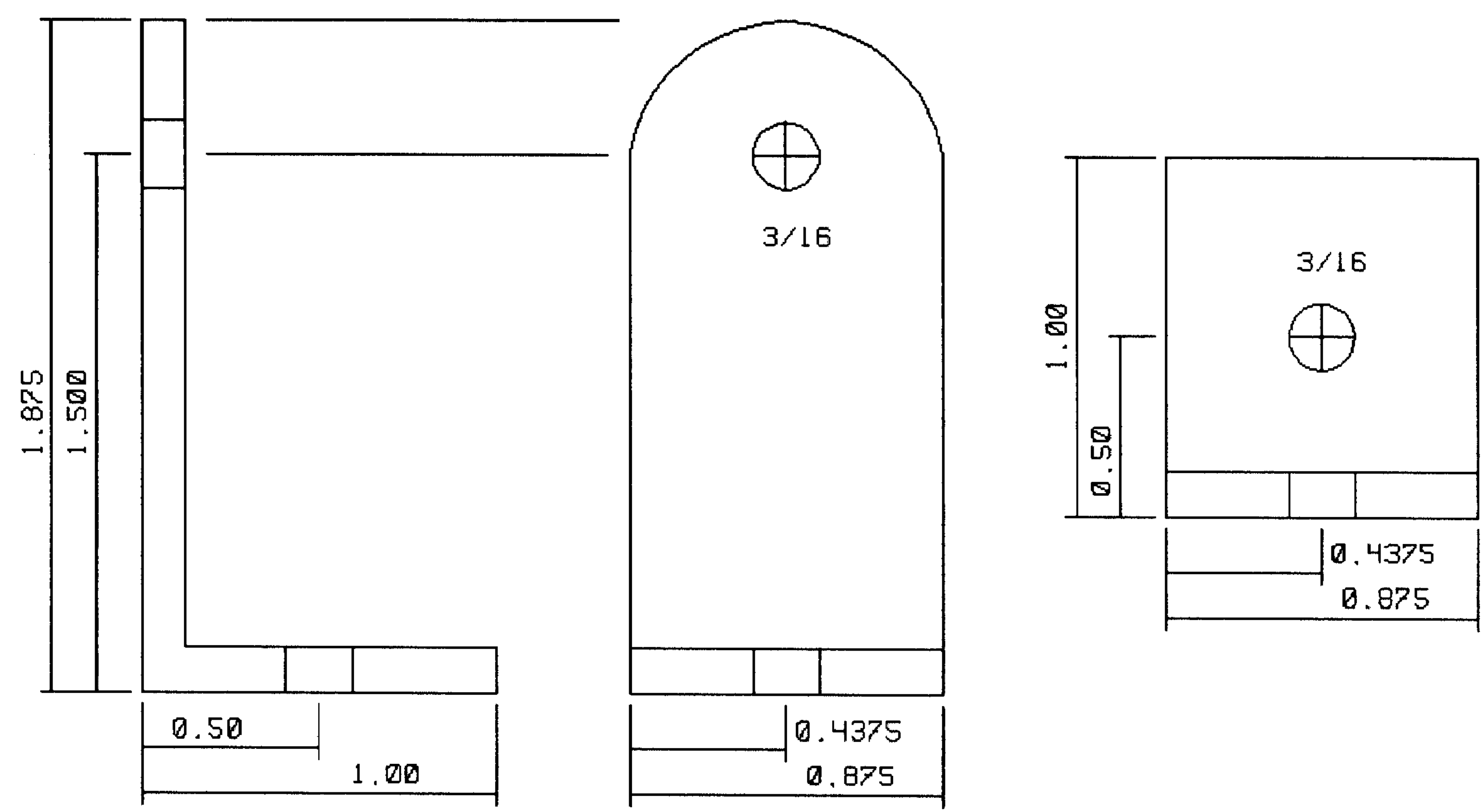
RUDDER PEDAL PIVOT BRACKETS SHOWN MOUNTED - SEE GB-31 FOR BRACKET

PEDAL BRACKET IS ATTACHED TO THE NOSE BLOCK WITH AN AN3-7A BOLT, TWO AN960-316 WASHERS AND AN AN365-1032 NUT AT EACH OF THE TWO 3/16 HOLES ADJACENT THE CENTER LINE.

INDIVIDUAL HINGE BRACKETS (4 TOTAL) ATTACH TO THIS BRACKET USING AN AN3-6A BOLT, 3 AN960-10 WASHERS, AND AN AN365-1032 NUT.

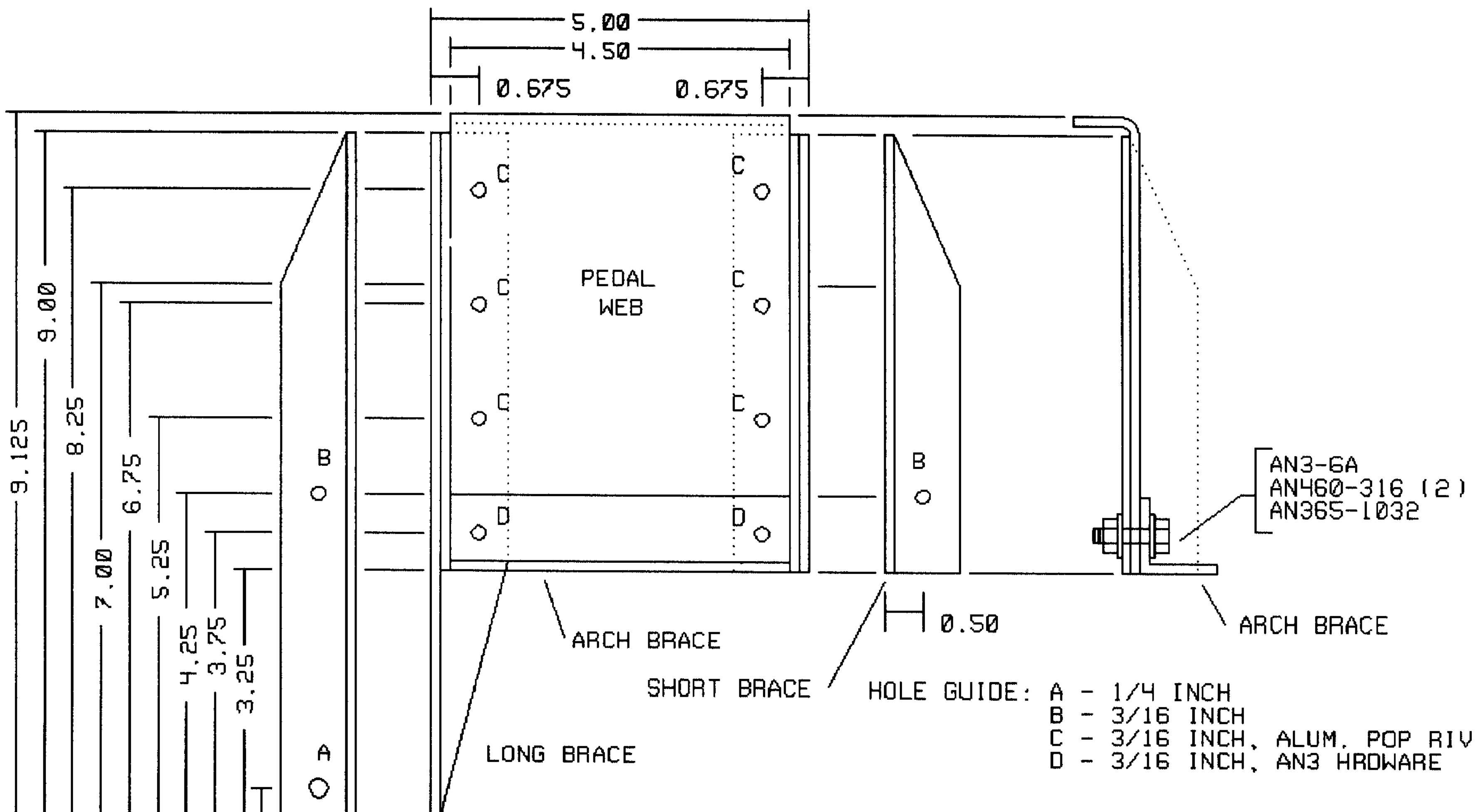
PEDALS ATTACH TO THE BRACKETS WITH AN AN3-7A BOLT, 3 AN960-10 WASHERS, AND AN AN365-1032 NUT AT EACH PIVOT HOLE. AN ADDITIONAL WASHER IS USED BETWEEN EACH PEDAL SIDE AND BRACKET TO REDUCE SIDE PLAY.

The GYROBEE	DATE: MAY 98 REV: 3.10
DRAWING: RUDDER PEDAL BRACKET GB-1	SCALE: INCHES PAGE OF



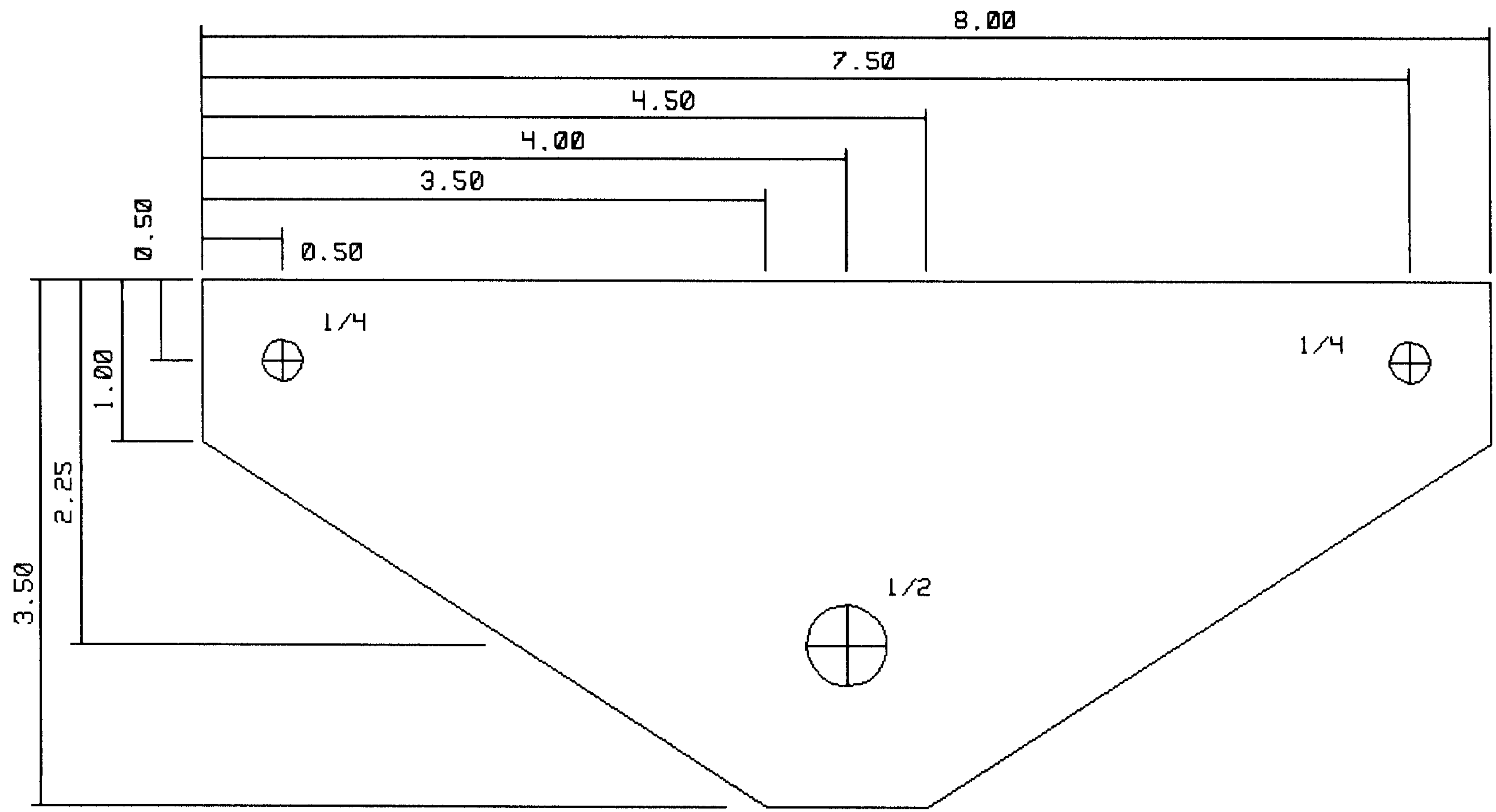
FABRICATE BRACKETS FROM PIECES CUT FROM 2 X 2 X 1/8 INCH SQUARE EXTRUDED ALUM. TUBE STOCK
SEE TEXT FOR HARDWARE REQUIREMENTS

The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: RUDDER PIVOT BRACKETS G8-2 (4 RQD)	SCALE: INCHES PAGE OF



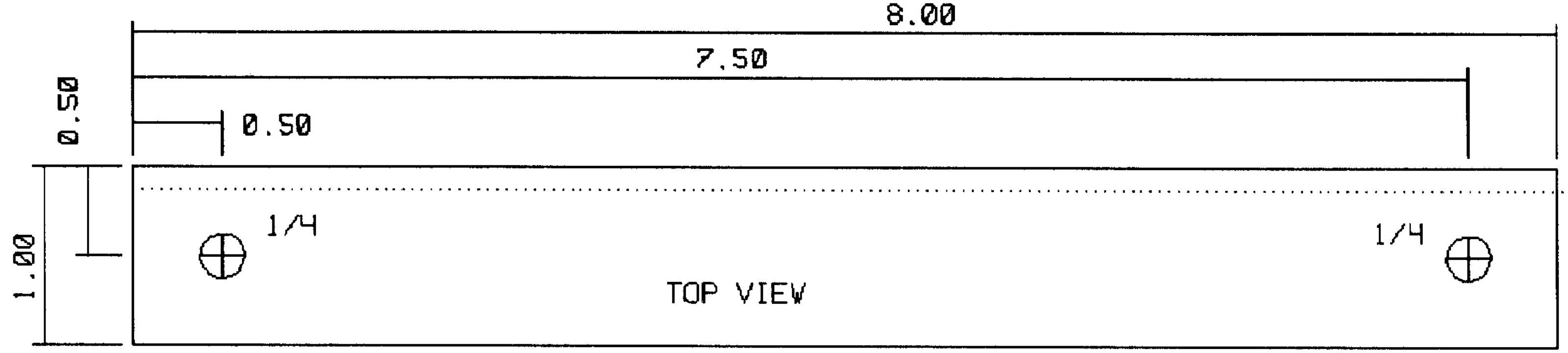
MATERIAL: PEDAL WEB - 0.0625 6061-T6 SHT
BRACES - 1 X 1 X 1/8 6061-T6 EXTRUDED ANGLE

The GYROBEE	DATE: JUNE 88 REV: 2.0
DRAWING: RUDDER PEDALS (2 RQD) G8-3 RIGHT SHOWN, LEFT IS OPP.	SCALE: INCHES PAGE 1 OF 2

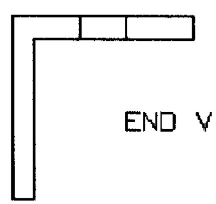


MATERIAL: 1/8 THK 6061-T6 ALUM. SHT STOCK

The GYROBEE	DATE: APR 90 REV: 1.0
DRAWING: RUDDER CONTROL HORN GB-4	SCALE: INCHES

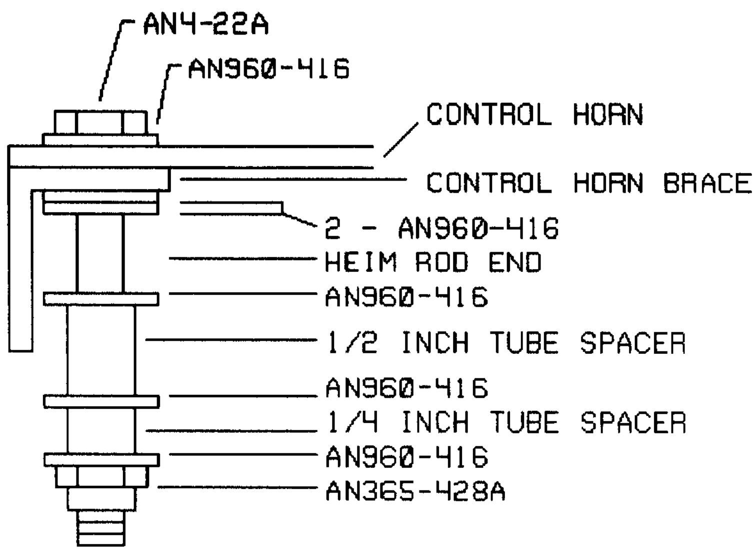


MATERIAL: 1 X 1 X 1/8 EXTRUDED 6061-T6 ALUM. ANGLE STOCK

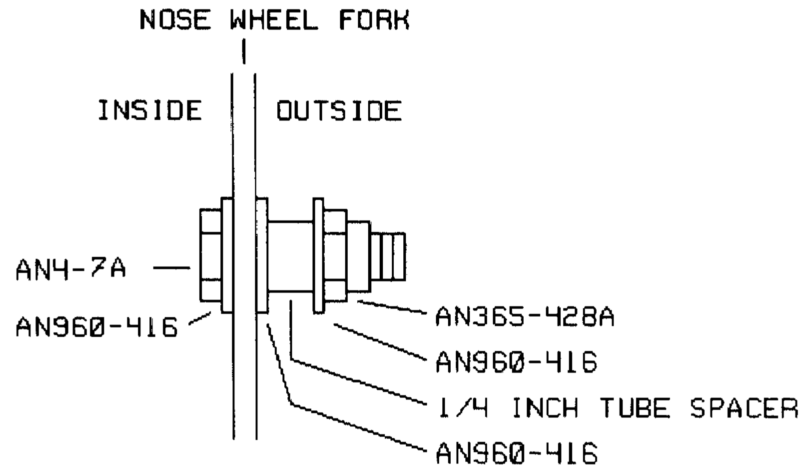


END VIEW

The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: RUDDER CONTROL HORN BRACE G8-5	SCALE: INCHES PAGE OF



CONTROL HORN HEIM AND SPRING ATTACH POINTS (2 RQD)



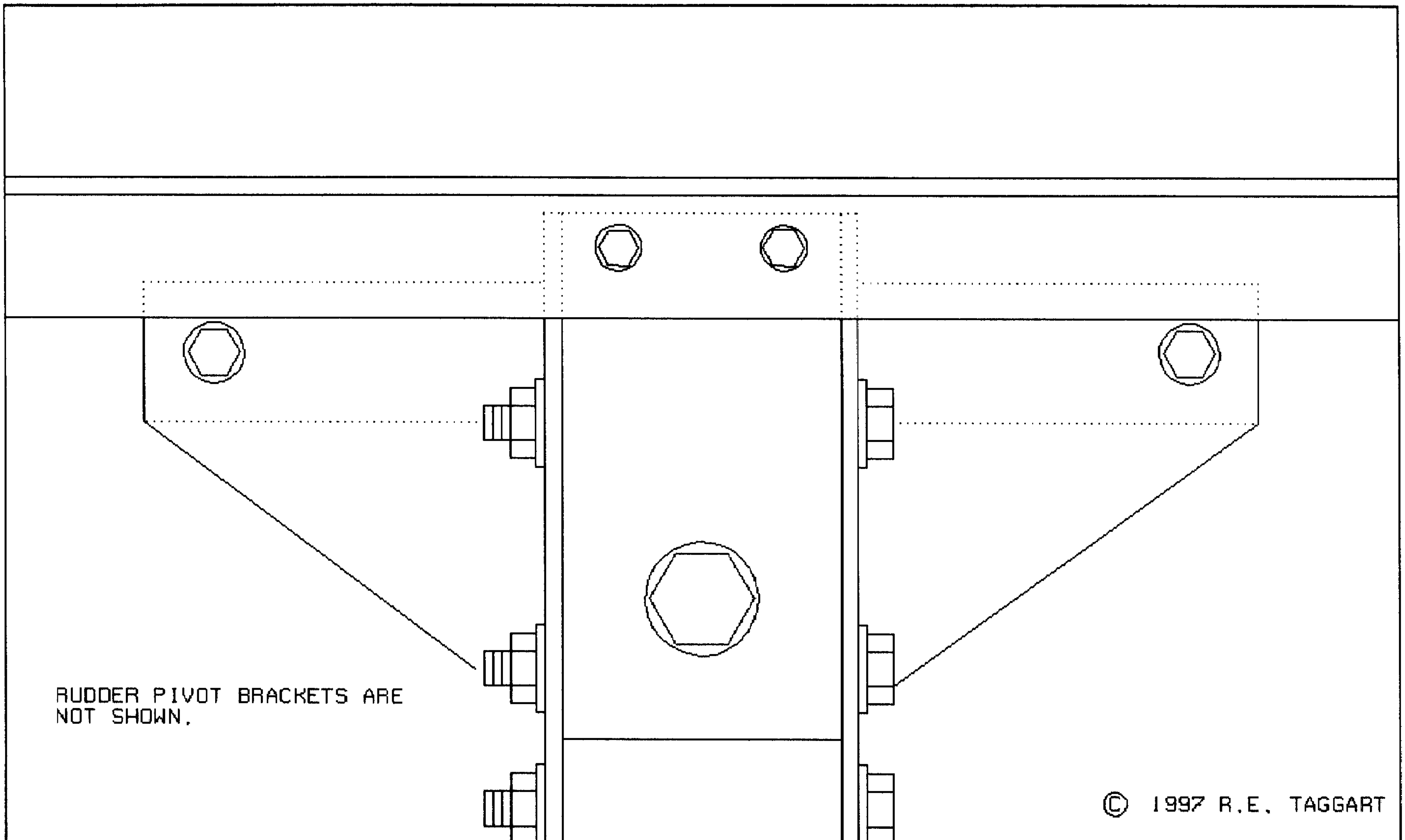
WHEEL FORK SPRING ATTACH POINT (2 RQD)

(1) SEE PHOTOGRAPHS FOR DETAILS OF SPRING AND HEIM ROD LINKAGES

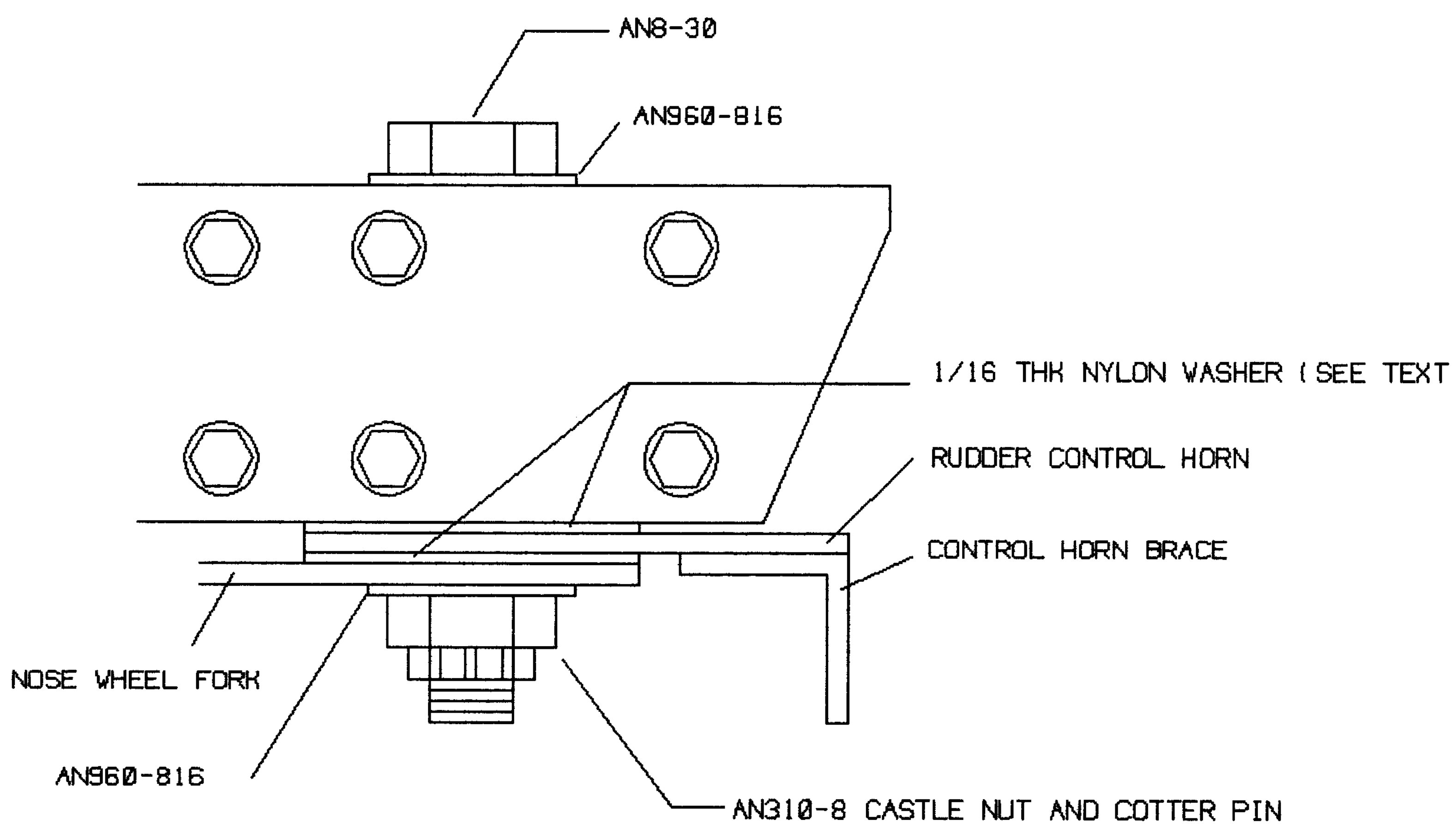
(2) SEE PARTS LIST FOR SPRING OPTIONS

(3) ALL TUBE SPACERS FABRICATED FROM 3/8 INCH O.D. (1/4 INCH I.D.) 6061T-6 ALUM. TUBE STOCK

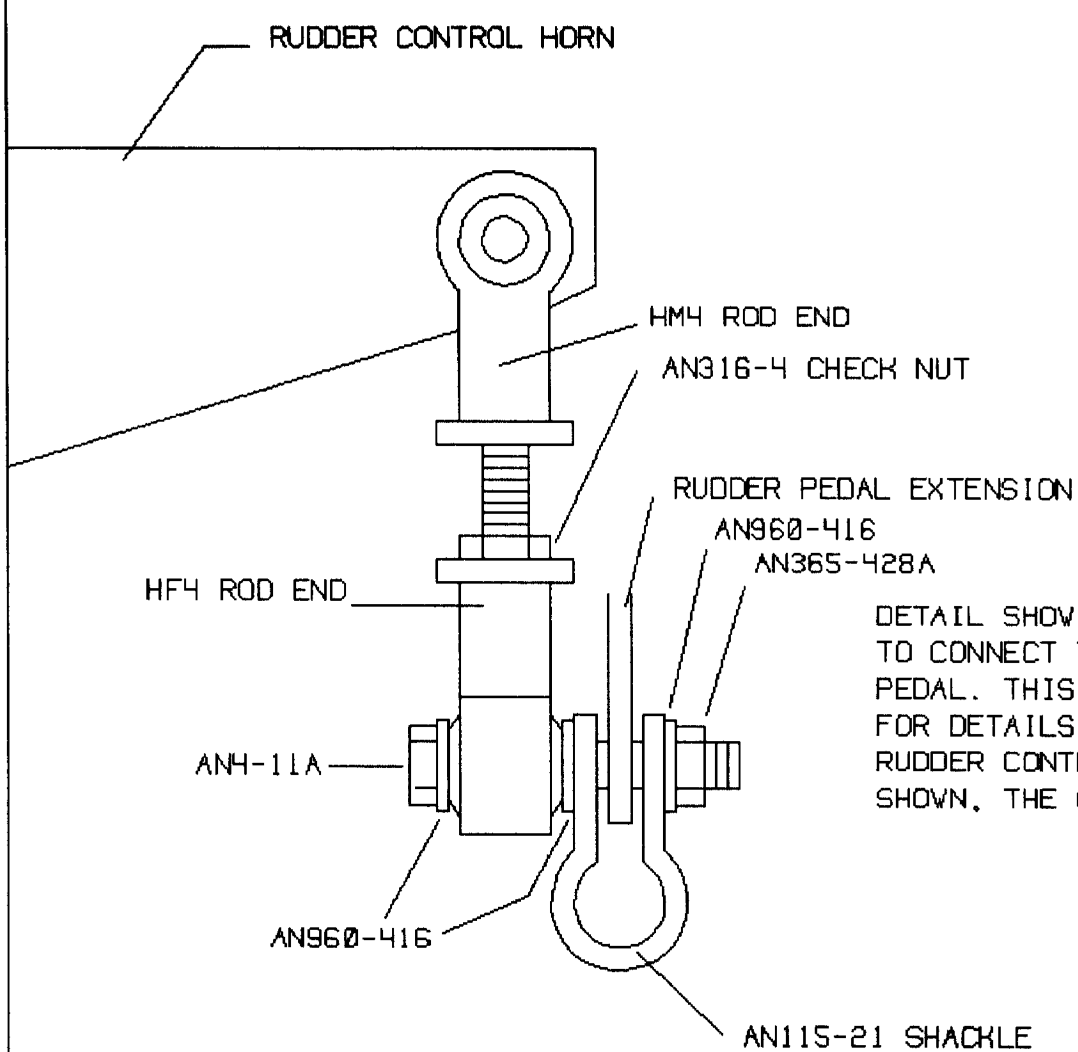
The GYROBEE	DATE: MAY 90 REV: 2
DRAWING: G8-6 SPRING AND HEIM ROD ATTACH POINTS	SCALE: PAGE OF



The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: RUDDER CONTROL HORN GB-7 ASSEMBLY (TOP VIEW)	SCALE: NA PAGE OF



The GYROBEE	DATE: MAY 98 REV: 1.10
DRAWING: RUDDER CONTROL HORN ASSY. G8-8 SIDE VIEW	SCALE: NA PAGE OF



DETAIL SHOWING THE USE OF HEIM ROD END FITTINGS TO CONNECT THE RUDDER CONTROL HORM AND RUDDER PEDAL. THIS VIEW IS DIAGRAMATIC. SEE ALSO G8-6 FOR DETAILS OF THE ROD END ATTACHMENT TO THE HORN. RUDDER CONTROL CABLE ATTACHES TO SHACKLE. ONE SIDE SHOWN. THE OTHER IS OPPOSITE.

The GYROBEE	DATE: APR 90 REV: 1.5
DRAWING: G8-9 RUDDER PEDAL/CONTROL HORN CONNECTION	SCALE: NA PAGE OF

PHASE 9 - MOUNTING THE SEAT

Prints:

- **G9-1** - Rear Seat Plates
- **G9-2** - Bottom Seat Plates
- **G9-3** - Seat Bottom Angles
- **G9-4** - Seat Support Struts

Fabrication:

G9-1, **2**, **3** describe the fabrication of the rear and bottom seat plates and the seat bottom angles. You will have to delay making the seat support struts (**G9-4**) until the seat is in place, since the precise seat position determines the length of these parts.

Hardware:

- **AN3-7A** bolt (20)
- **AN960-316** washer (40)
- **AN365-1032** nylock nut (20)
- **AN4-6A** bolt (2)
- **AN4-26A** bolt (1)
- **AN960-416** washer (6)
- **AN365-428** nylock nut (3)
- **3/16 pop-rivets** - aluminum

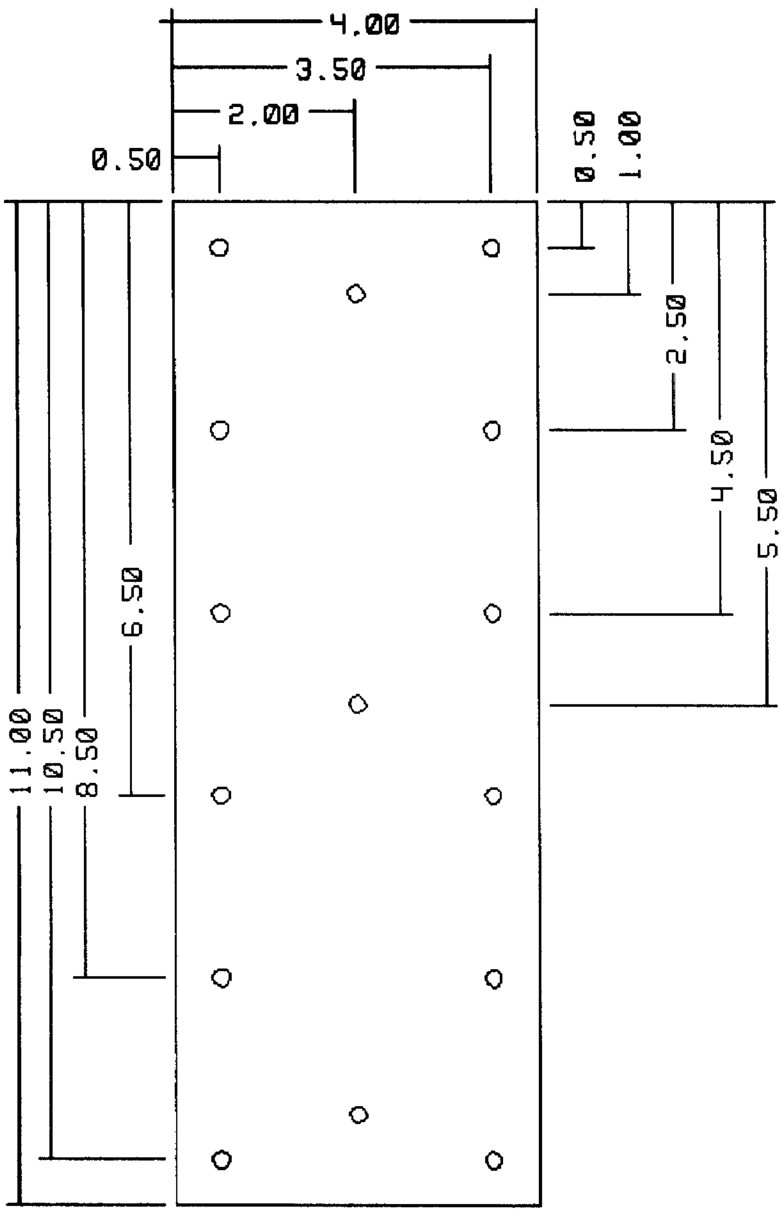
Assembly:

- Draw a reference center line down the back of the seat and along the bottom.
- Position the back rear seat against the rear of the seat so the center-line is centered in the three 3/16 holes down the middle of the plate. Maintaining the centered orientation, slide the plate up and down the seat back to locate the flattest portion of the seat back. When located, use a 3/16 bit to drill the three holes through the seat back using the plate as a drilling guide.
- Align the front rear plate (1/16 inch) with the three centered holes and pop-rivet the two plates together, through the seat back, from the inside of the seat.
- Repeat the previous two steps with the lower (1/8) and upper (1/16) seat bottom plates.
- Using the 1/8 seat plates as drilling guides, drill the 12 - 3/16 holes through the seat back and the 8 - 3/16 holes through the seat bottom.
- Align each seat bottom angle with the four 3/16 holes along each edge. The edge of the angle should align with the edge of the plate with the down-ward directed side facing toward the center of the seat bottom (see top of **G9-4**). The single 1/4 inch hole of each brace should face the **front** of the seat. Secure each bottom angle brace at four points using the AN3 hardware indicated in **GB9-2**.
- Lay a strip of masking tape down the forward flange of the two seat braces and mark the center-line with a pencil.
- Position the rear of the seat against the seat braces so the lines you have drawn are visible in the center of the 6 holes along each edge of the rear seat plates. Slide the

seat up or down, keeping it centered, until the bottom of the seat is positioned 9 inches above the top of the keel and clamp or firmly hold the seat in place against the seat braces.

- Using the rear seat plate as a drilling guide, drill through the seat braces at the upper and lower holes on the plate using a 3/16 bit. Temporarily secure the seat to the mast braces at these four holes using 3/16 hardware.
- Now drill the remaining holes through the braces using the rear seat plates as a drilling guide.
- Remove the seat from the braces, strip the masking tape from the seat braces, and de-burr the holes you have drilled.
- Attach the rear of the seat to the seat braces at all 12 holes using the AN3 hardware noted in GB-1.
- With the seat in place, measure the distance from the 1/4 inch holes in the lower seat braces straight down to the center of the keel side-wall. Add 1 inch to this measurement. This is distance **A** in **G9-4**. Fabricate the two seat support struts at this time.
- Loosely attach the upper end of each support strut to the lower seat brace using the hardware and orientation shown in **G9-4**.
- Using a wooden block against the forward flanges of the seat support struts, to assure they stay parallel, align them straight up and down and clamp them to the sides of the keel.
- The lower 1/4 inch holes in each seat support strut should be located at the center of each keel side-wall.. Use the holes as a drill guide to match-drill 1/4 inch holes in the keel side-walls. Move the struts out of the way, de-burr the two new holes, and attach the struts to the keel with the AN4 hardware indicated in **G9-4**. Tighten all the AN4 hardware at this time.

The seat should now be firmly anchored in place. Put the inner foam pad in place and secure the vinyl seat cover. You are now free to sit in the seat and make engine sounds whenever you need encouragement!

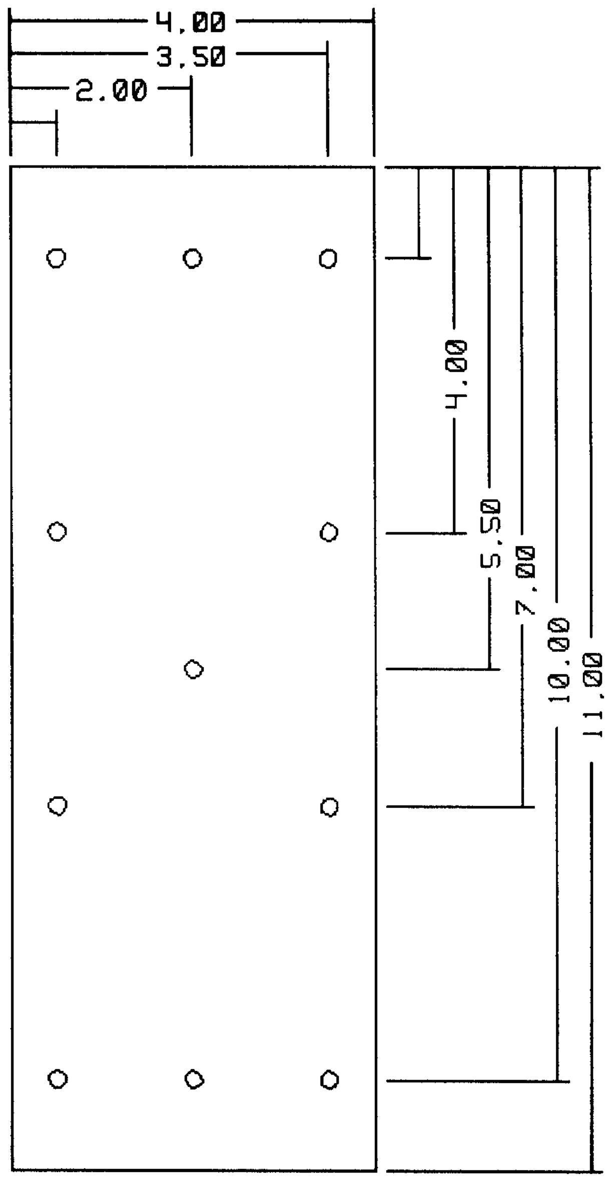


ALL HOLES 3/16 INCH. BACK SEAT PLATE IS 1/8 THK 6061-T6 ALUM. SHEET, FRONT PLATE IS 1/16 THK. 6061-T6 ALUM. SHEET. PREPARE BACK PLATE AS SHOWN AND THEN USE AS A TEMPLATE TO MATCH DRILL THE FRONT PLATE

ON ASSEMBLY, USE BACK PLATE TO MATCH DRILL THE THREE CENTER LINE HOLES ON THE SEAT BACK. USE 3/16 INCH POP RIVETS, INSERTED FROM THE FRONT, TO SECURE FRONT AND BACK PLATES TO THE REAR OF THE SEAT. ONCE SECURE, MATCH DRILL ALL HOLES THROUGH THE FIBERGLASS SEAT BACK.

THE SEAT MOUNTS TO THE MAST/SEAT BRACE RAILS AS DESCRIBED IN THE TEXT. AT EACH OF THE 12 MOUNTING HOLES, AN AN3-7A BOLT, 2 AN960-10 WASHERS, AND AN AN365-1032 NUT ARE USED.

The GYROBEE	DATE: JUNE 1988 REV: 1.0
DRAWING: REAR SEAT PLATES (2 RQD) G9-1	SCALE: INCHES PAGE OF

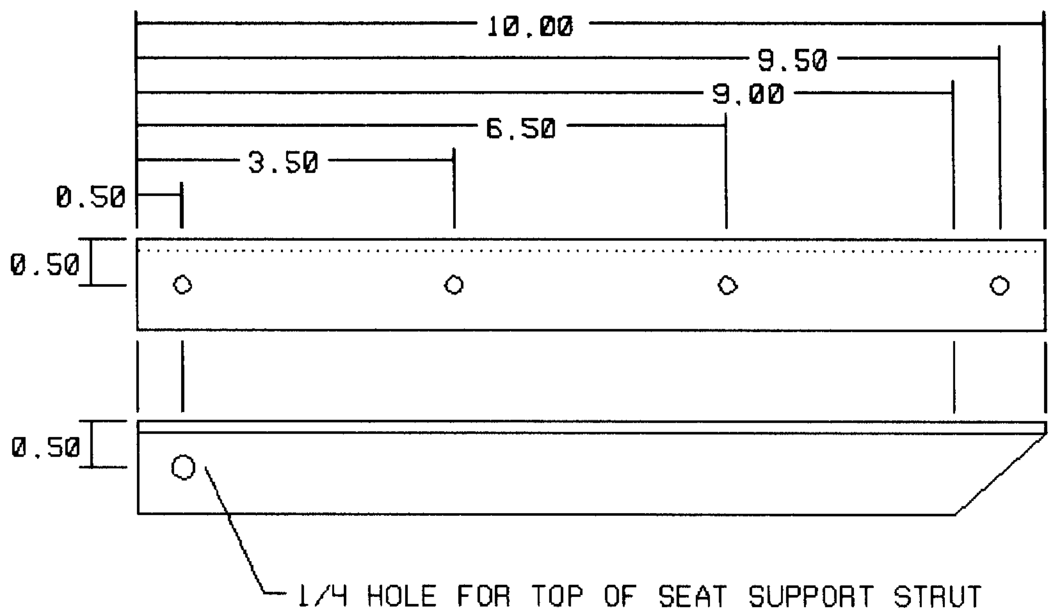


BOTTOM PLATE IS 1/8 INCH 6061-T6 ALUM. SHT. TOP PLATE IS 1/16 INCH 6061-T6 ALUM. SHT. PREPARE BOTTOM PLATE AS SHOWN AND USE AS A TEMPLATE TO MATCH DRILL THE TOP PLATE. ALL HOLES ARE 3/16 INCH.

ON ASSEMBLY, USE BOTTOM PLATE AS A TEMPLATE TO MATCH DRILL THE THREE CENTER-LINE HOLES ON THE SEAT BOTTOM. USE 3/16 POP RIVETS TO SECURE TOP AND BOTTOM PLATES TO THE SEAT BOTTOM AND THEN MATCH DRILL THE REMAINING HOLES THROUGH THE FIBERGLASS.

AT EACH OF THE 8 HOLES THE SEAT IS SECURED TO THE LOWER SEAT BRACES USING AN AN3-7A BOLT, 2 AN960-10 WASHERS, AND AN AN365-1032 NUT.

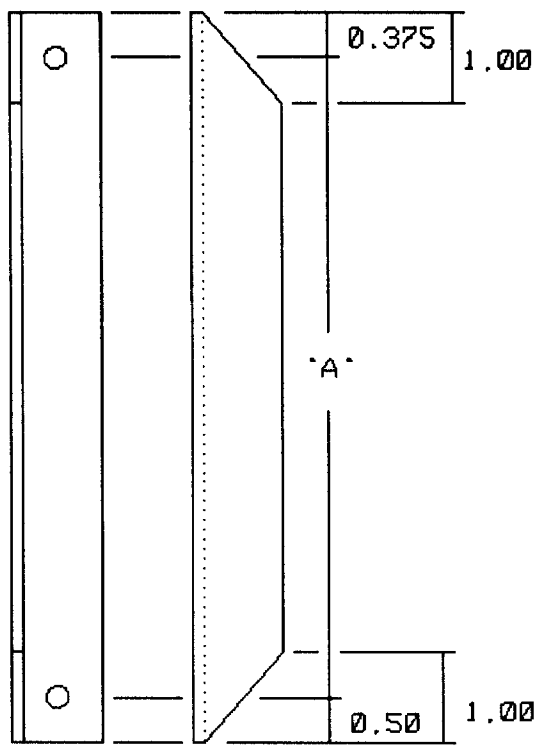
The GYROBEE	DATE: JUNE 88 REV: 1.0
DRAWING: BOTTOM SEAT PLATES (2 RQD) G9-2	SCALE: INCHES PAGE OF

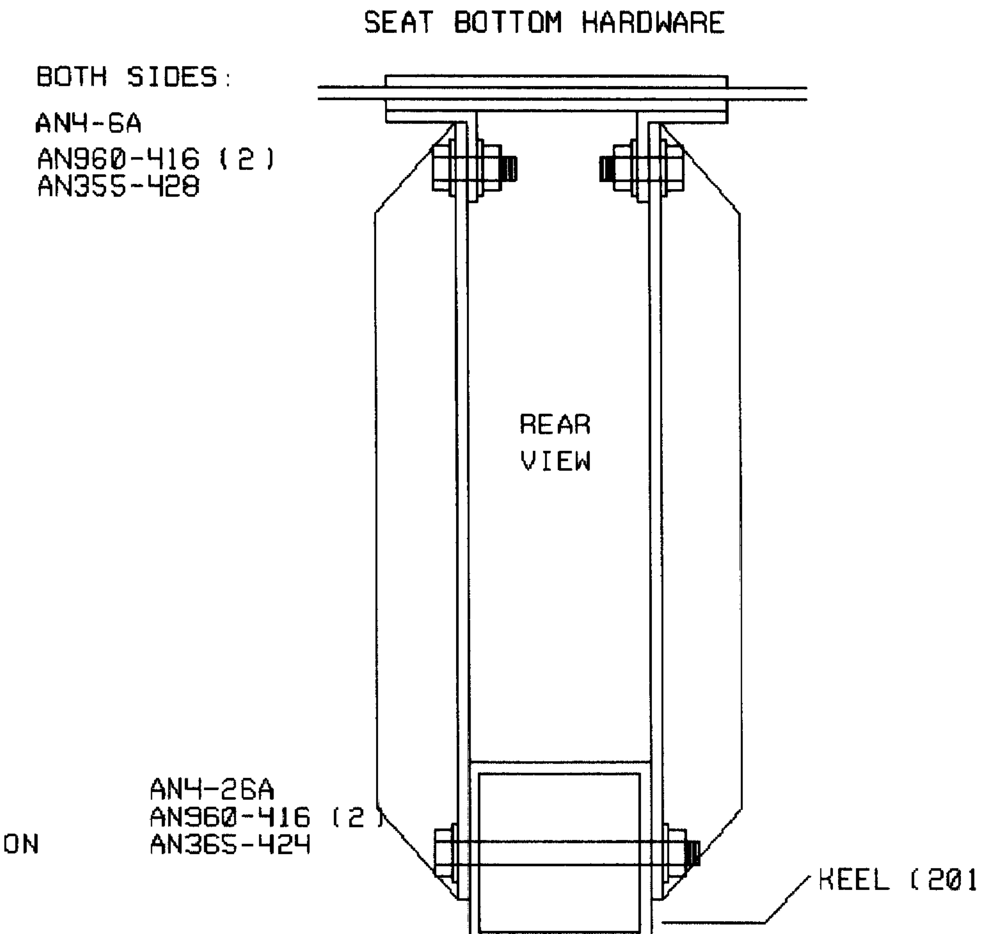


MATERIAL: 1 X 1 X 1/8 EXTRUDED 6061-T6 ALUM. ANGLE

ONE PIECE SHOWN, SECOND IS OPPOSITE

The GYROBEE	DATE: JUNE 88 REV: 1.0
DRAWING: SEAT BOTTOM ANGLES (2 RQD) G9-3	SCALE: INCHES PAGE OF





MATERIAL: 1 X 1 X 1/8 6061-T6 ALUM. EXTRUSION

LEFT STRUT SHOWN, RIGHT IS OPPOSITE

SEE TEXT FOR DETERMINATION OF DIMENSION 'A'

The GYROBEE	DATE: JUNE 88 REV: 1.0
DRAWING: SEAT SUPPORT STRUTS (2 RQD) G9-4	SCALE: INCHES PAGE OF

PHASE 10 - CONTROL STICK, TAIL BOOM, AND TAIL GROUP

Prints:

- **G10-1** - Tail boom
- **G10-2** - Tail wheel plates
- **G10-3** - Tail wheel mounting

Fabrication:

- **G10-1** (Tail boom). Drill the single 1/4 inch hole indicated. The slot on the top of the boom must be milled or cut - be sure to finish all cut edges. This slot is designed to clear the rear mounting hardware for the control stick. If you are not using the KB-2 control stick, the slot will have to be relocated to center on the location of the rear stick attachment bolts.
- The plates in **G10-2** have some odd dimensions. You should probably make a full-sized layout on paper and then transfer to the sheet stock.

Hardware:

- **AN3-26A** bolt (4)
- **AN4-26A** bolt (2)
- **AN4-27A** bolt (4)
- **AN960-316** washers (8)
- **AN960-416** washer (12)
- **AN970-5** washer (10)
- **AN365-1032** nylock nuts (4)
- **AN365-428** nylock nut (6)
- **KB2** tail group hardware

Assembly:

- Slide the front of the tail boom between the mast/keel cluster plates and temporarily pin in place with an **AN4** bolt using the upper of the two holes on the cluster plate.

- Clamp the forward section of the tail boom up against the lower side of the keel so the front of the boom is located between the two seat brace extensions. Match-drill 1/4 inch holes from either side, using the holes in the seat brace as a drilling guide. Remove the tail boom.

- Using heavy paper as a pattern, transfer the bolt pattern from the KB-2 rudder assembly to the top of the rear of the tail boom. The pattern template should be carefully centered side to side and the location of the rudder/fin hinge line should correspond to the rear end of the tail boom. Drill these 1/4 inch holes through the tail boom from top to bottom.

- Repeat this process with the bolt pattern from the horizontal stabilizer. When aligning this pattern on the top of the tail boom, measure to assure that the stab will be located just forward of the vertical fin. If you are not sure, loosely bolt the fin/rudder at three points to verify the positioning of the stabilizer template.

- Mount the control stick supports to the upper keel using four **AN4-27A** bolts and matching hardware. The stick assembly can then be mounted. The position of the threaded pivot inserts in the mounting blocks should firmly secure the stick but still permit free movement of the stick assembly. lightly grease the pivot points.

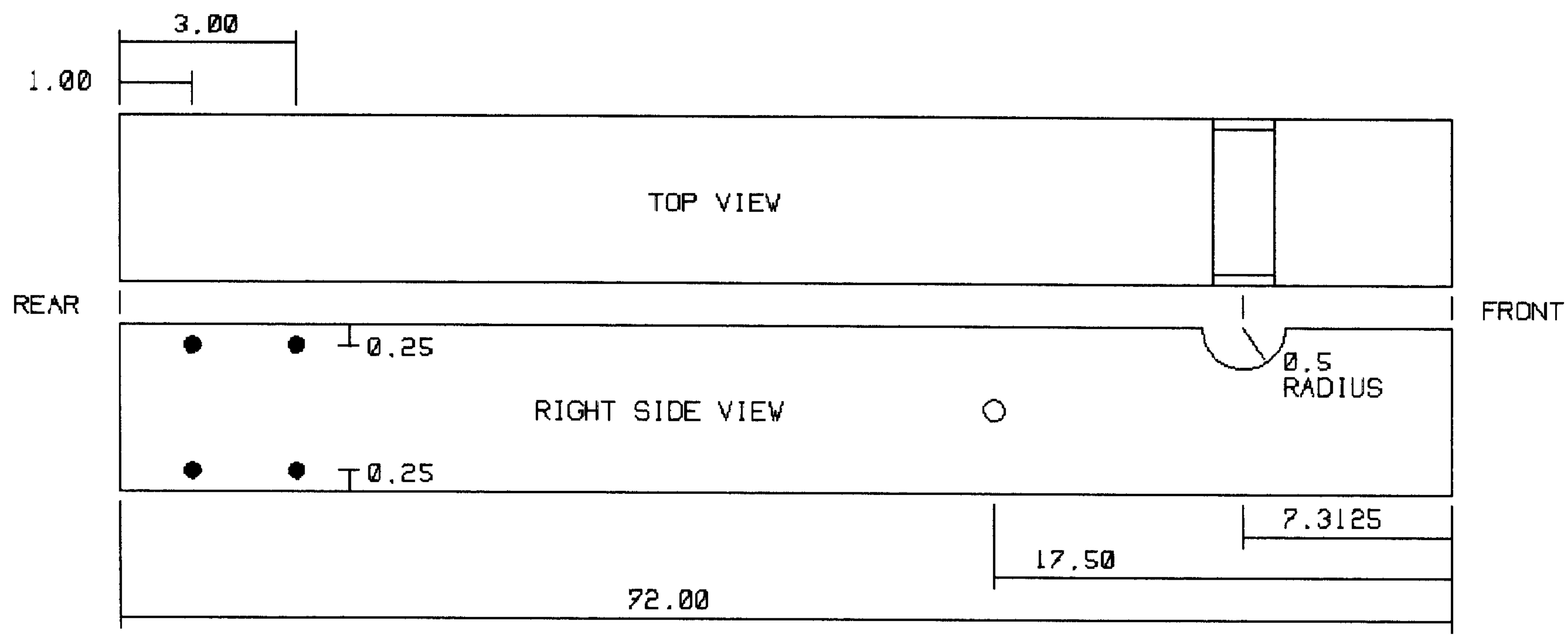
- Slide the tail boom back into place between the cluster plates and seat brace extensions and secure with the **AN4-26A** hardware.

- Use the hardware supplied to mount the vertical fin/rudder at the back of the tail boom. The bolts insert from the bottom of the boom (make sure there is a washer under each bolt head) and capture the threaded holes at the base of the fin/rudder above the tail boom.

- Cut a piece of thick rubber from a tire/truck inner-tube and use it as a gasket between the top of the tail boom and the bottom of the horizontal stabilizer, punching or cutting holes as required to pass the 3/16 mounting bolts. The gasket should be two inches wide and its length should match the center chord of the stabilizer.

- Secure the horizontal stab to the top of the tail boom using the **AN3** hardware supplied with the KB-2 tail group components.

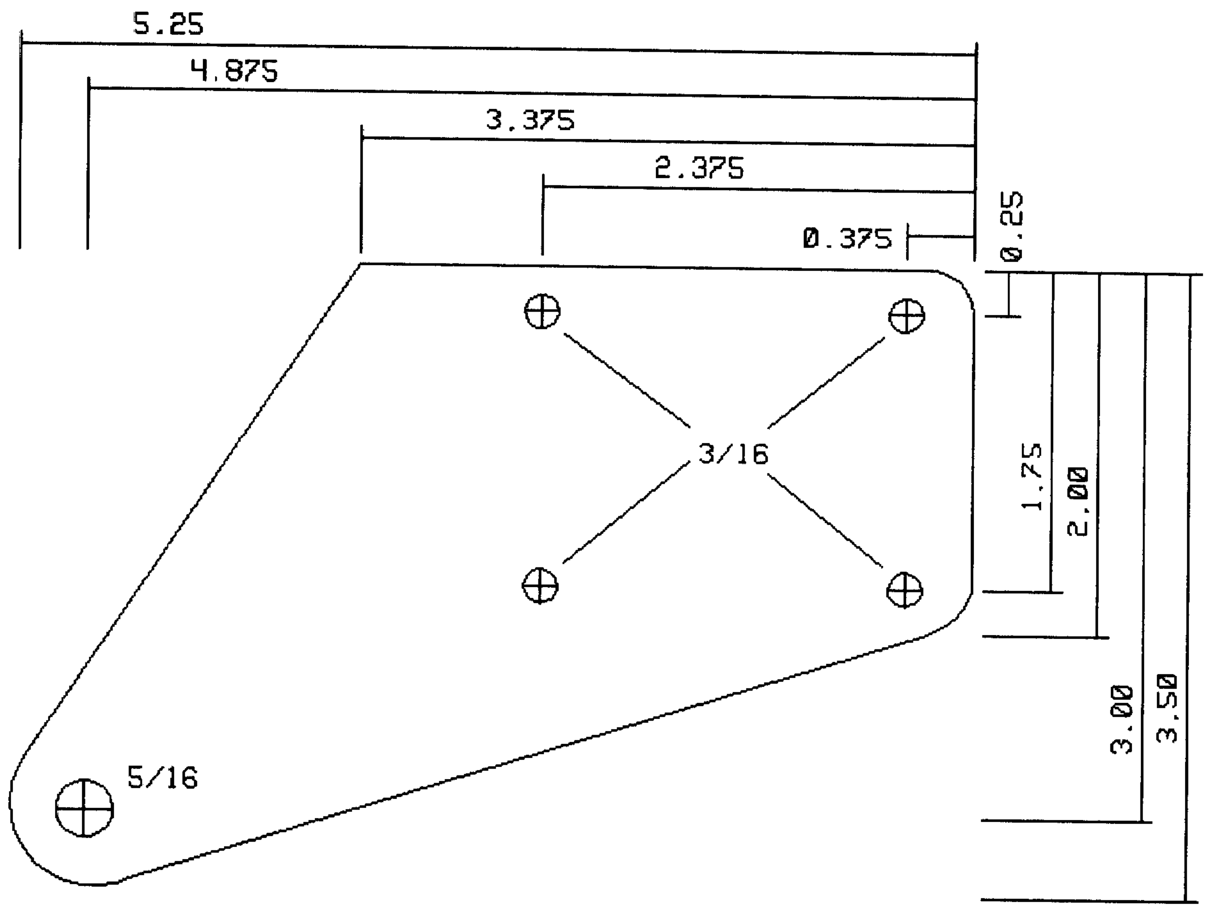
Mount the tail wheel plates on either side of the rear end of the tail boom using the hardware indicated in **G10-3**. Mount the tail wheel to the plates. Use AN970-5 washers between the inside of the plates and the wheel as needed to eliminate excess side-play.



MATERIAL: 2 x 2 x 1/8 WALL 6061-T6 EXTRUDED
TUBE STOCK

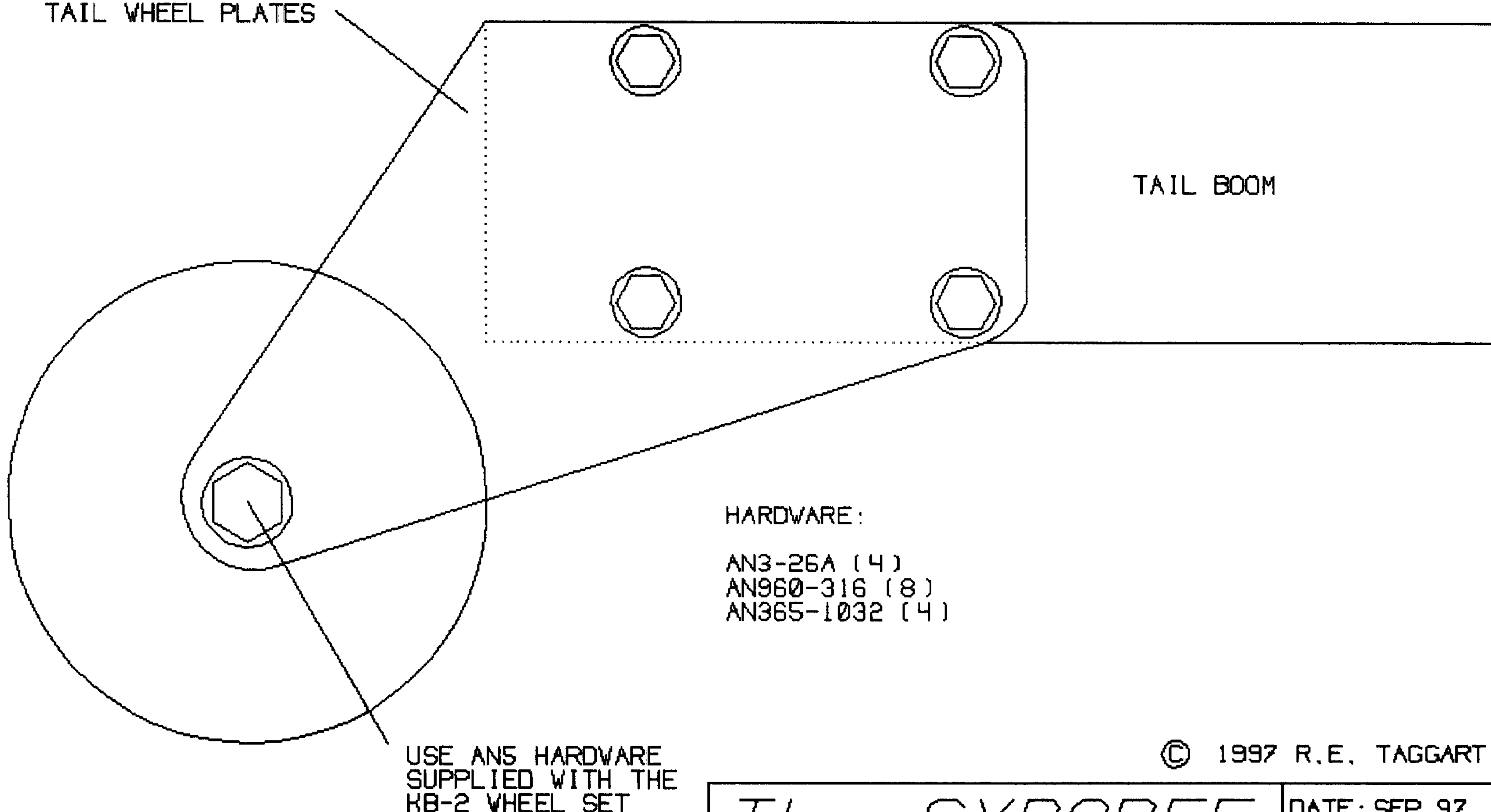
HOLE KEY
○ - 0.25
● - 3/16

The GYROBEE	DATE: SEP 97 REV: 1.0
DRAWING: TAIL BOOM G10-1	SCALE: PAGE OF



MATERIAL: 1/8 THK 6061-T6 SHEET STOCK

The GYROBEE	DATE: SEP 97 REV: 3.0
DRAWING: TAIL WHEEL PLATES (2 RQD) G10-2	SCALE: PAGE OF



The GYROBEE	DATE: SEP 97 REV: 3.0
DRAWING: TAIL WHEEL MOUNTING G10-3	SCALE: PAGE OF

PHASE 11 - ROTOR HEAD CHEEK PLATES

Prints:

- **G11-1** - Head cheek plate layout

Fabrication:

There is no way to provide a single universal layout for the rotor head cheek plates since the various rotor heads differ slightly in layout. **G11-1** provides some guidelines for laying out the cheek plates based on your particular head unit. The hole pattern on the **right** side (bottom) is based on the holes at the top of the mast and the layout can be transferred to a paper template using print **G1-2**. The layout diagram, drawn full-size, should include the outline of the upper part of the mast so you can be sure of adequate clearance between the top of the mast and the bottom of the head assembly.

The hole pattern at the left represents the hole pattern for the rotor head base and can usually be taken from the cheek plates that are typically supplied with the head. If no cheek plates were supplied, measure the vertical and horizontal distance between the mounting holes and make a full-sized paper template for the head pattern. Draw a line parallel to the lower two holes that represents the dimension of the downward extension of the two head end blocks below the lower holes. This line will indicate the downward extension of the blocks for determining clearance. Use intersecting lines from the holes, as shown in **G11-1**, to determine the center of the hole pattern.

To determine the relationship of the upper (head) and lower (mast) holes:

- Rotate the upper hole pattern (head) **10 degrees (see note at end of this section) backward** with reference to the mast and

- Position the center of the head pattern (the intersection point for the diagonal lines) directly above the forward edge of the mast, and

- Position the head pattern vertically so the lower line you drew (marking the lower extension of the head end blocks) **clears the rear of the mast by 1/4 inch**.

When all three conditions are met, mark the location of all holes. Now plot an outline around all the holes to mark the extent of the cheek plates.

Cut and finish the pair of plates and use a center-punch to transfer your hole pattern to one of the plates. Clamp the two plates together and match-drill the required holes. The mast holes are 1/4 inch, but the head mounting hole size is determined by the head you are using and you should use the head as a guide for the required size.

Hardware:

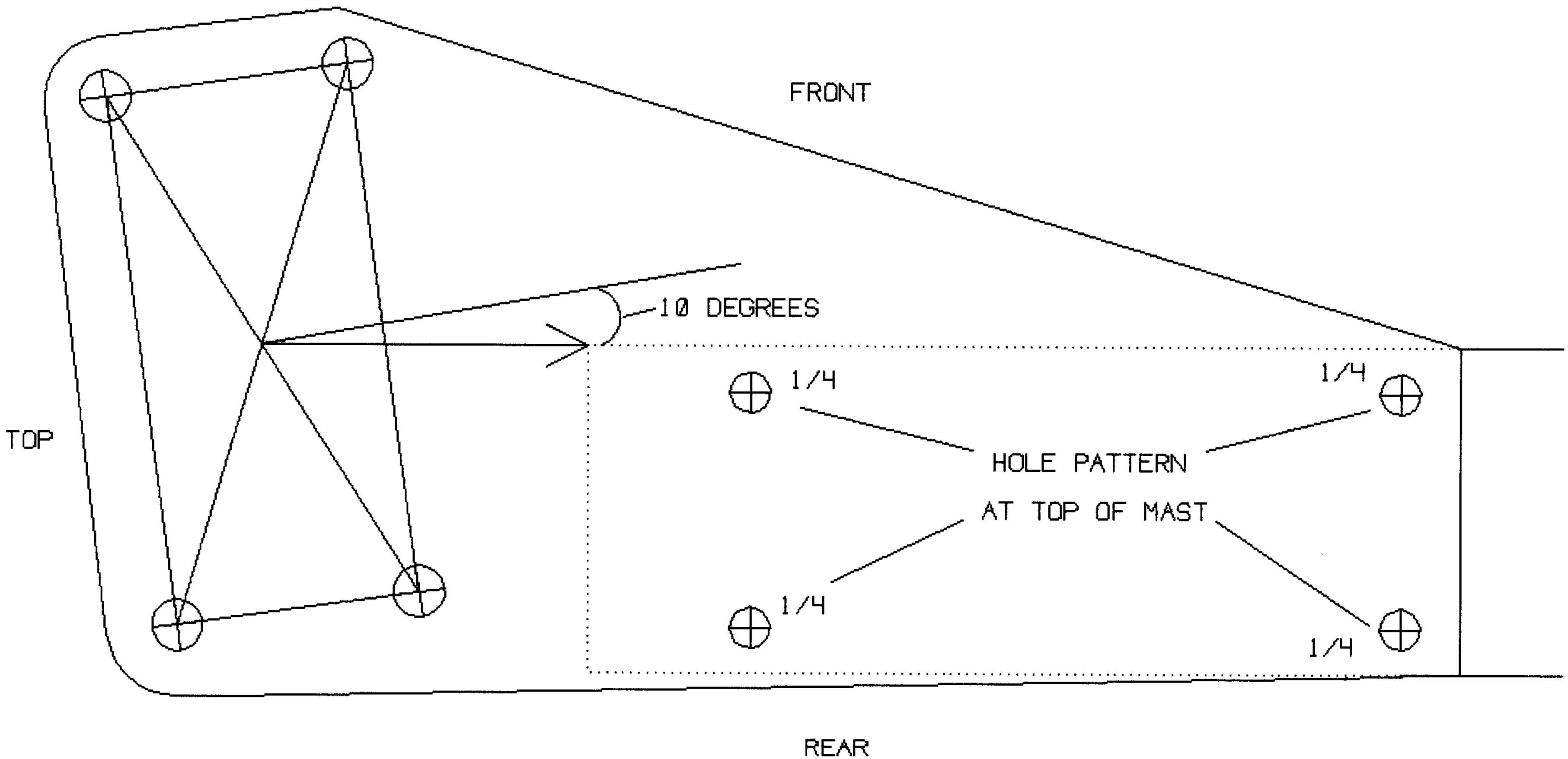
- **AN4-26A** bolt (4)
- **AN960-416** washer (8)
- **AN365-428** nylock nut (4)
- Head mounting hardware

Assembly:

Mount the plates at the top of the mast using the AN4 hardware and then mount the head between the upper end of the plates using the hardware supplied with your rotor head.

Note:

The 10 degree mounting angle shown in print **G11-1** is appropriate for the Rotordyne head used on the prototype. Other heads may require a slightly different angle, depending on the range of travel of the head in the pitch axis. See **Appendix 1** for information on the proper head angle and rotor system set-up.



MATERIAL: 1/8 THK 6061-T6 SHEET STOCK

The GYROBEE	DATE: APR 99 REV: 3.1
DRAWING: HEAD CHEEK PLATE LAYOUT G11-1 SEE TEXT FOR DETAILS	SCALE: INCHES PAGE OF

PHASE 12 - RUDDER CABLE INSTALLATION

Print:

- **G12-1** - Fairlead block

Fabrication:

The rudder cables are routed through a fairlead block consisting of an outer casing fabricated by cutting away one side of a 2 inch long piece of 2 x 2 square tube stock. Inside of the block is a solid or laminated block of hardwood, finished to provide a smooth slide-fit into the casing and sanded flush with the casing on the top side and the front and back faces. Two offset 1/8 inch wide/deep slots are cut in the block to pass the 3/32 rudder cables. When the block is complete, center the block in the space between the keel/mast cluster plate, flush against the lower tail boom, and match-drill 1/4 inch holes in the casing, using the cluster plate holes as a drill guide. Remove the fairlead assembly and finish drilling through the hardwood block, using the holes in the casing as a drill guide.

Hardware:

- **AN115-21** shackles (2)
- **AN100-4** stainless thimbles (4)
- **AN393-11** clevis pins (2)
- **3/32 oval nicopress sleeves** (8) (LEAF M1031)
- **3/4 inch cowling pins** (2) (LEAF F5110)
- **AN4-26A** bolt (1)
- **AN960-416** washer (2)
- **AN365-428** nylock nut (1)
- **3/32 inch (7x7)** stainless control cable (25 feet)

Assembly:

Assembling the rudder cables will require a tool for cleanly cutting the cable as well as a swaging tool for the nicopress sleeves. All of these are available in the LEAF catalog, but it makes little sense to buy these tools for just this project (although they are a good investment for a club). Many EAA chapters or individual members will have the necessary tools or, failing that, visit the maintenance hangar at the local airport.

- Install an **AN115** shackle at each of the two rudder control horns using an **AN393** clevis pin and a cowling pin for retention.

- Slip an **AN100-4** stainless thimble into each of the rudder shackles.

- Cut the length of rudder control cable in half and double-swage a stainless thimble at one end of each length. If you are not sure how to do this step, get some help!

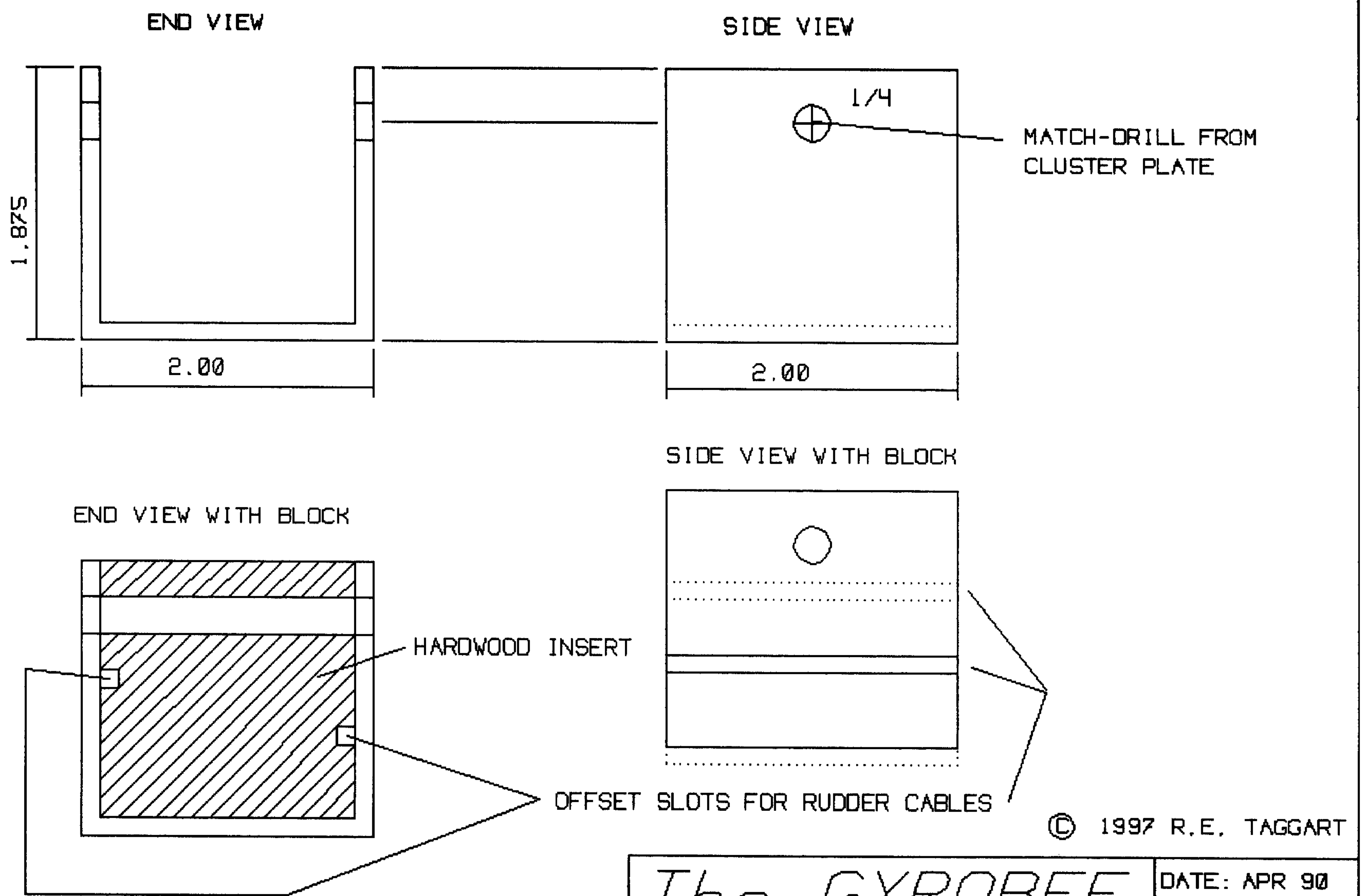
- Remove the shackles from the lower extensions of the rudder pedals, slip the thimble-end of the cables over each shackle, and re-install, tightening the nylock nuts at this time.

- Run the two cables parallel to the keep back past the mast/keel cluster plate. Slide each cable into the slot in the hardwood fairlead block and slide the casing over the block to retain the cables. Install the block under the tail boom at the mast/keel cluster plate using the **AN4-26A** hardware.

- Cross the cables under the tail boom and hold them taught at the rudder control horns. The cables should not rub where they cross-over. Center the rudder, blocking it if required. Place a wood block across the rudder pedals so both have the same angle and they are at about the half-way point in their range of movement.

- Run each cable around the thimble in the two shackles at the rudder control horns. The cables should have no slack, but they shouldn't be particularly tight either. Double swage the cable at each thimble and cut off the excess.

- Remove the rudder and pedal blocks. The rudder should be centered with equal pedal deflection. If the right pedal is deflected forward, the rudder should deflect to the right and vice versa with the left pedal. Total rudder deflection in either direction should be essentially equal.



The GYROBEE	DATE: APR 90 REV: 1.5
DRAWING: FAIRLEAD BLOCK G12-1	SCALE: NA PAGE OF

PHASE 13 - SEAT BELT AND SHOCK PLATE INSTALLATION

Prints:

- **G13-1** - Shock plate and harness plate mounting
- **G13-2** - Vertical strut/shock plate attachment

Fabrication:

- The harness plate in **Detail A** of **G13-1** should be made up from 1/8 inch 6061-T6 sheet stock.
- Prepare a 7/8 inch long spacer from 3/8 OD 6061-T6 tube
- Fabricate the 3/8 inch OD spacers detailed in **G13-2** (two sets)

Hardware:

- **AN3-32A** bolt (2)
- **AN960-316** washer (22)
- **AN365-1032** nylock nut (2)
- **AN4-6A** bolt (3)
- **AN4-26A** bolt (1)
- **AN4-34A** bolt (2)
- **AN960-416** washer (8)
- **AN365-428** nylock nut (6)
- **AN970-4** washer (4)
- **AN870-6** washer (4)

Assembly:

- Secure the mast so the airframe cannot tip over and remove the bolts holding the vertical strut fittings to the temporary shock plate. Remove the temporary shock plate from the mast.

- Mount the shock plate (G4-2) to the rear of the mast with a pair of AN3-32A bolts. Where the bolts emerge from the front of the mast, add 9 AN960-316 washers to each bolt and then slide on the harness plate and secure each bolt with another AN960-316 washer and an AB365-1032 nylock nut.

- Using Detail B of G13-1 as a guide, use an AN4-26A bolt to mount a 7/8 inch long 3/8 OD spacer between the seat braces at the hole above the attach point for the engine bearers. Use a total of four AN960-416 washers, one each for the bolt head and nut and one at each end of the spacer where it hears against the inside of the seat braces.

- Thread the common strap from the shoulder harness between the seat braces and over the spacer from the previous step. Secure the strap end-fitting to the 1/4 inch hole in the harness plate using an AN4-6A bolt and associated hardware.

- Secure each lap bent fitting to the belt plates on the keel using an AN4-6A bolt and associated hardware.

- Using G13-2 as a guide, attach each vertical strut fitting to the shock plate. The internal spacer (B) should be greased when slid into the bolt and grease should be applied to the internal area of the slot once the fittings are in place.

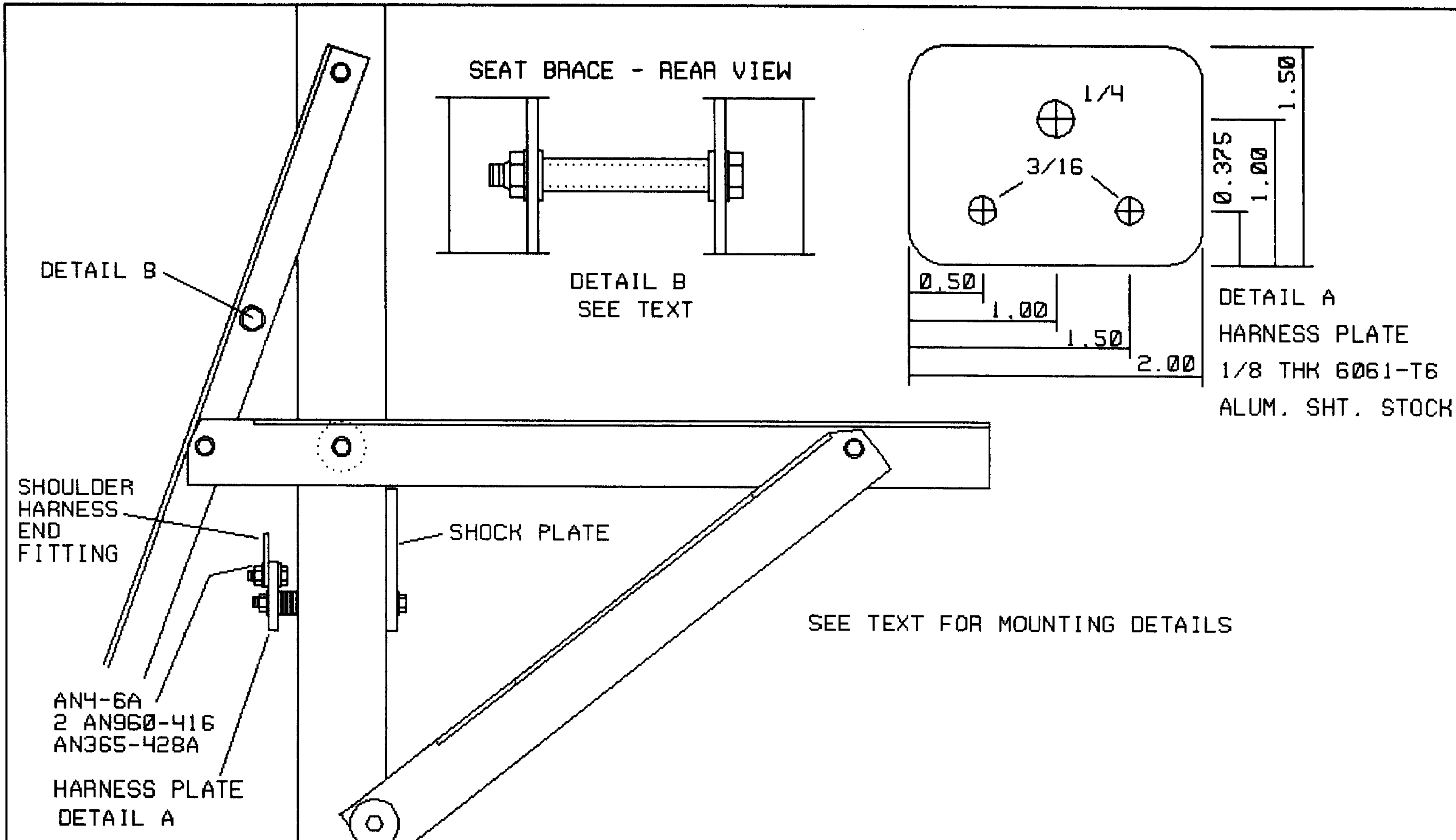
- Tie off, with double knots, two 6 inch loops of standard braided bungee chord.

- At each strut fitting, loop the bungee over one of the outer strut fitting spacers, stretch it down around the spacer where the diagonal engine bearer attaches to the mast, and back up to the spacer on the other side of the strut fitting. It should take a LOT OF EFFORT to stretch the bungees into place. If it is too easy, make each loop a bit shorter. If you can't do it, make the loops a bit longer.

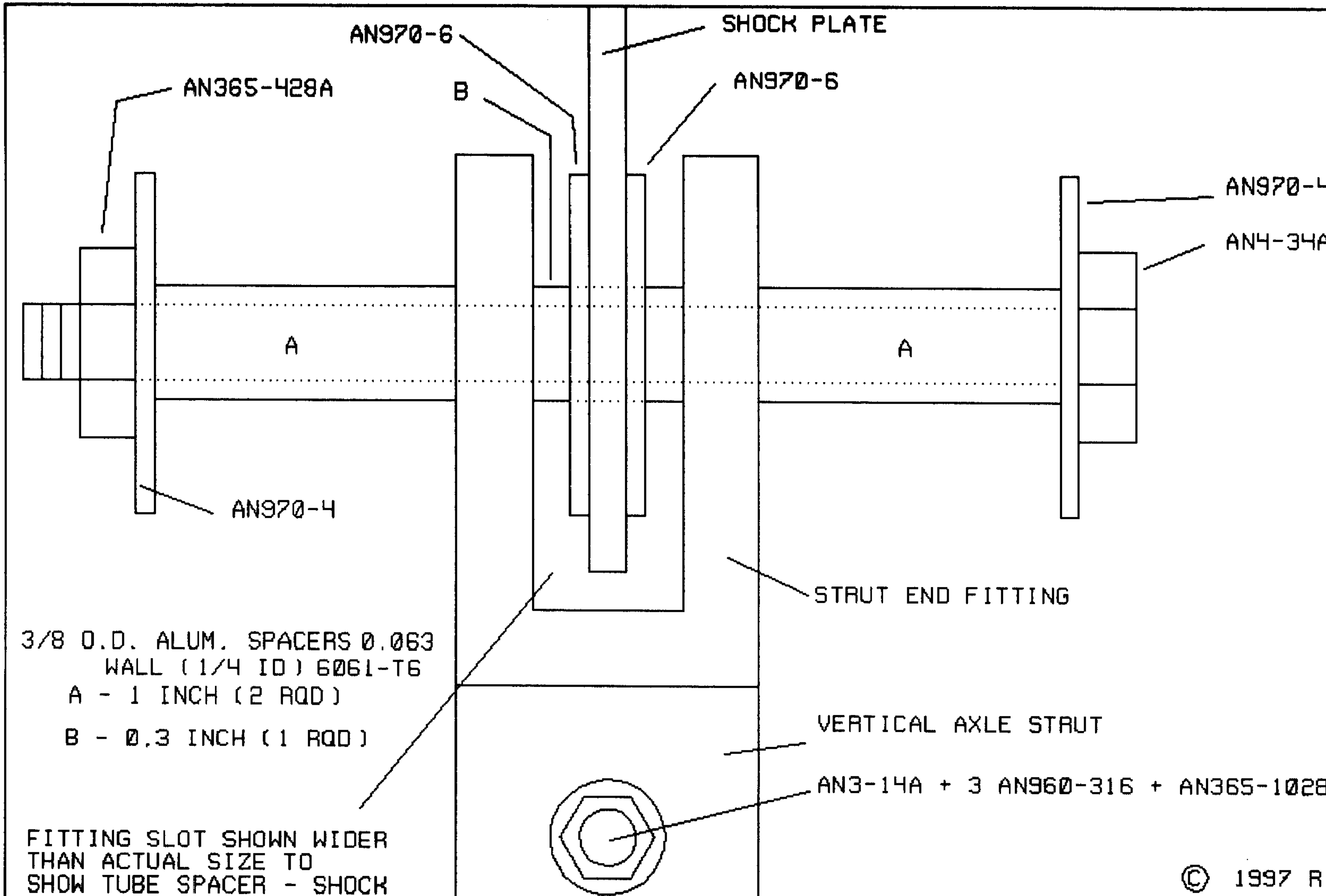
CRITICAL MAINTENANCE NOTE!

AT LEAST ONCE EACH FLYING SEASON, CRITICALLY INSPECT THE INNER SPACERS ON THE STRUT FITTINGS FOR EXCESSIVE WEAR AND REPLACE AS REQUIRED. IF THE SPACER HAS WORN THROUGH, YOU SHOULD REPLACE THE BOLT AS WELL.

FAILURE TO PERFORM THIS INSPECTION CAN ULTIMATELY LEAD TO ATTACHMENT FAILURE OF ONE OR BOTH VERTICAL GEAR STRUTS, RESULTING IN EXTENSIVE AIRFRAME DAMAGE AND POSSIBLE INJURY!!



The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: SHOCK PLATE AND HARNESS PLATE MOUNTING G13-1	SCALE: NA PAGE OF



3/8 O.D. ALUM. SPACERS 0.063 WALL (1/4 ID) 6061-T6
A - 1 INCH (2 RQD)
B - 0.3 INCH (1 RQD)

FITTING SLOT SHOWN WIDER THAN ACTUAL SIZE TO SHOW TUBE SPACER - SHOCK PLATE PLUS WASHERS FILL SLOT ON ACTUAL FITTINGS

The GYROBEE	DATE: SEP 91 REV: 2.0
DRAWING: VERTICAL STRUT/SHOCK PLATE ATTACHMENT G13-2	SCALE: INCHES PAGE OF

PHASE 14
ENGINE MOUNTING AND FUEL TANK INSTALLATION

Prints:

- **G14-1** - Eipper engine mount
- **G14-2** - Fuel tank
- **G14-3** - Muffler mounting plate

Hardware:

- See **G14-1**
- **AN848-40** fuel fitting
- **AN316-7** stop nut

Other Components:

- Small stainless hose clamps
- Fuel primer bulb
- Vinyl fuel line
- Nylon cable ties

Engine

Detailed notes are not practical here as you will need to apply some ingenuity. On the prototype we were able to use a custom dynafocal engine mount for the 447 that was available from LEAF. This mount is no longer available so an alternative is needed. Print **G14-1** shows a detail view from the LEAF catalog for the engine-mounting components used on the Eipper Sprint and Sport fixed-wing ultralights. Although this is an inverted mounting system, there is no reason why the same mount cannot be used to mount the engine upright on the engine mount rails. To provide maximum clearance, the cross-piece at the PTO/gearbox end of the engine should be flush with the end of the horizontal engine mounting beam.

Muffler Mount

To conserve space, we utilized the side-mount muffler option. A steel plate (G14-3) anchors to the two engine mount bolts on the muffler side of the engine (the size and spacing of these holes is dependent on the details of your engine mounting hardware. The muffler secures to the plate with two heavy-duty stainless hose clamps visible in several of the pictures in the Gyrobee Photo Gallery on the Rotorbyte Website. The plate should be well-finished to prevent corrosion. The muffler springs should be safety-wired and it is good practice to apply high-temperature silicone adhesive to the coils to inhibit vibration.

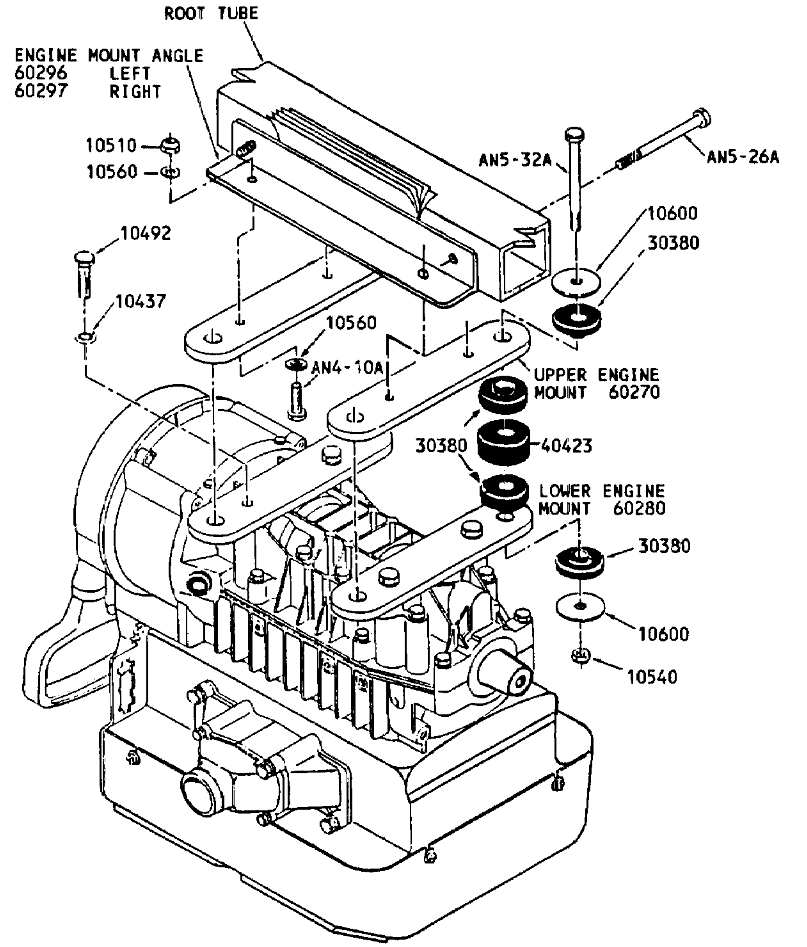
This plate should be inspected prior to each flying session. After a year or two, it will eventually fail due to the initiation of one or two small cracks originating at the ends of the slots for the stainless clamps. When this occurs, the plate should be replaced (we keep an extra on hand to encourage prompt replacement). The part does not fail in a

catastrophic fashion and should not present a safety hazard in you are diligent about your preflight inspections.

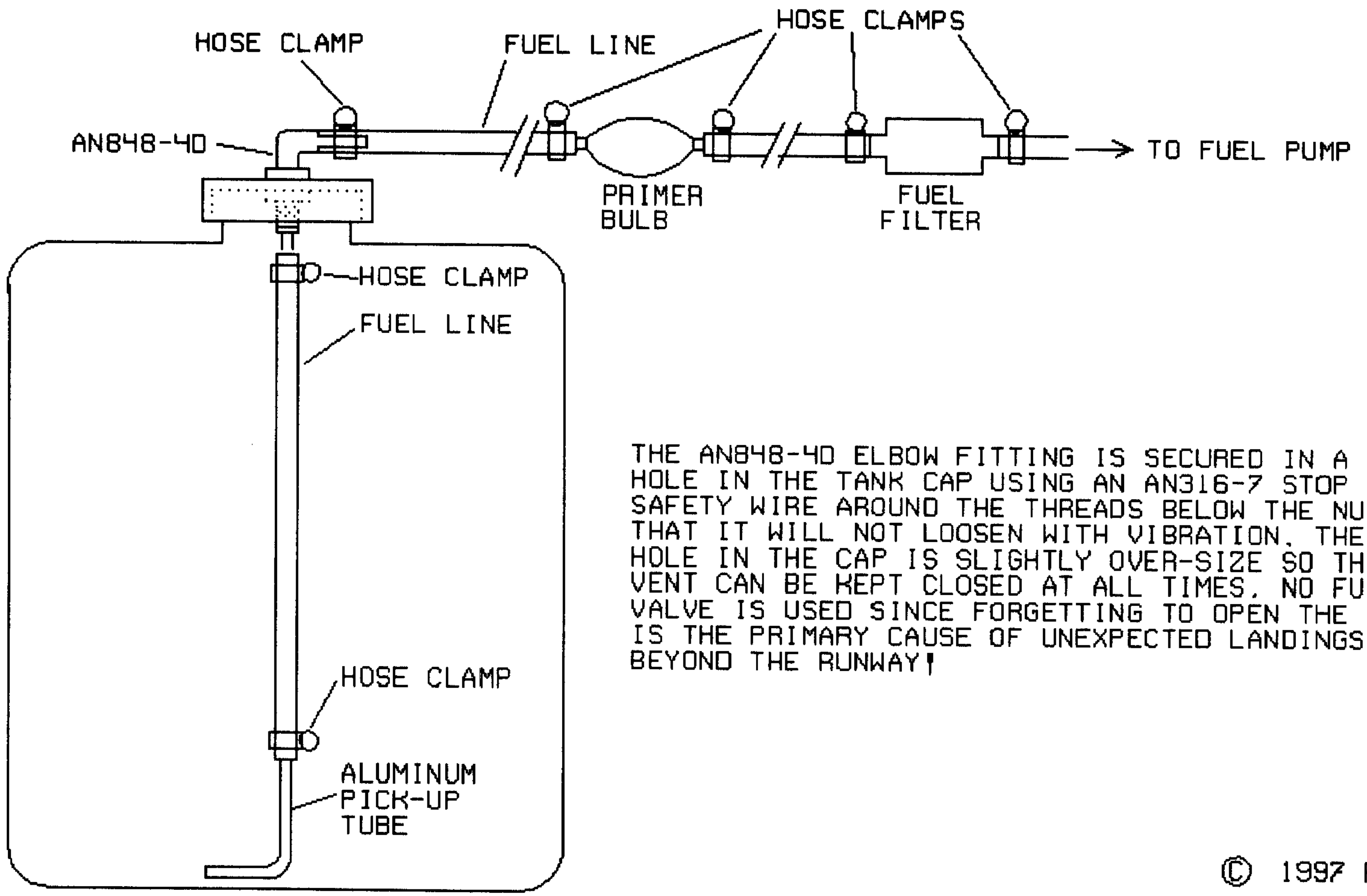
Fuel Tank

G14-2 contains all the information needed to plumb the fuel tank. Many of the photographs in the **Gyrobee Photo Gallery** on the **Rotorbyte Website** contain details on the placement of the fuel system components. Note that the fuel pick-up tube should be flush with the tank bottom and directed toward the rear, since the aircraft flies in a nose-up attitude.

ENGINE MOUNT - SPRINT, SPORT
ROTAX 447

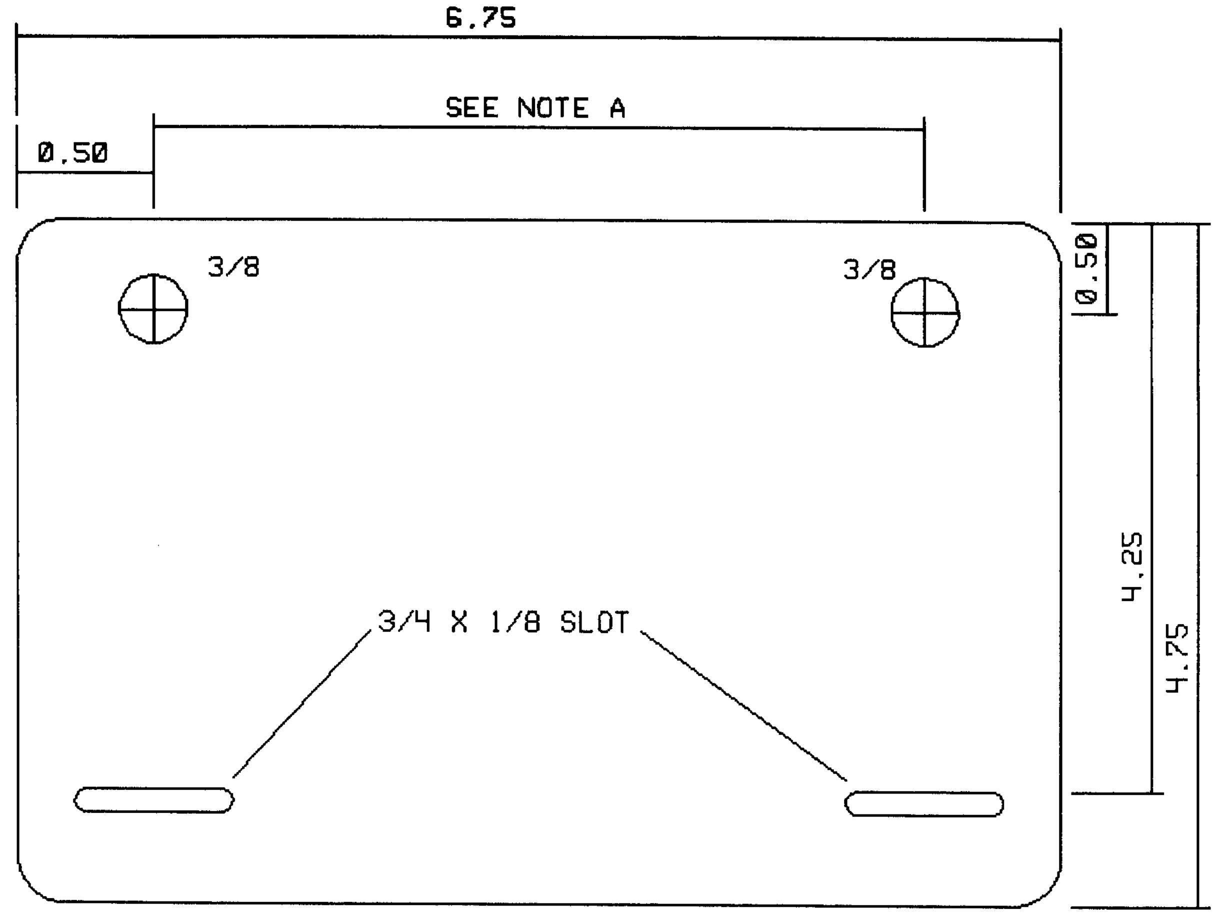


The GYROBEE	DATE: SEP 97 REV: 2.0
DRAWING: EIPPER ENGINE MOUNT G14-1	SCALE: NA PAGE OF



THE AN848-4D ELBOW FITTING IS SECURED IN A 1/2 INCH HOLE IN THE TANK CAP USING AN AN316-7 STOP NUT. WRAP SAFETY WIRE AROUND THE THREADS BELOW THE NUT TO ASSURE THAT IT WILL NOT LOOSEN WITH VIBRATION. THE 1/2 INCH HOLE IN THE CAP IS SLIGHTLY OVER-SIZE SO THE TANK VENT CAN BE KEPT CLOSED AT ALL TIMES. NO FUEL SHUT-OFF VALVE IS USED SINCE FORGETTING TO OPEN THE FUEL VALVE IS THE PRIMARY CAUSE OF UNEXPECTED LANDINGS JUST BEYOND THE RUNWAY!

The GYROBEE	DATE: MAY 90 REV: 1.0
DRAWING: FUEL TANK G14-2	SCALE: NA PAGE OF



MATERIAL: 0.063 THK STEEL SHT STOCK

NOTE: SLOTS ARE SHOWN WITH SQUARE CORNERS BUT CORNERS SHOULD BE RADIUSED WITH A FILE OR GRINDER TO INHIBIT STRESS CRACKS.

NOTE A: THE DISTANCE BETWEEN THESE TWO HOLES IS BASED ON THE DISTANCE BETWEEN THE LEFT-HAND ENGINE MOUNT BOLTS. THIS WILL BE ABOUT 5 11/16 BUT NEEDS TO BE MEASURES PRIOR TO DRILLING.

The GYROBEE	DATE: APR 90 REV: 1.0
DRAWING: MUFFLER MOUNTING PLATE G14-3	SCALE: INCHES PAGE OF

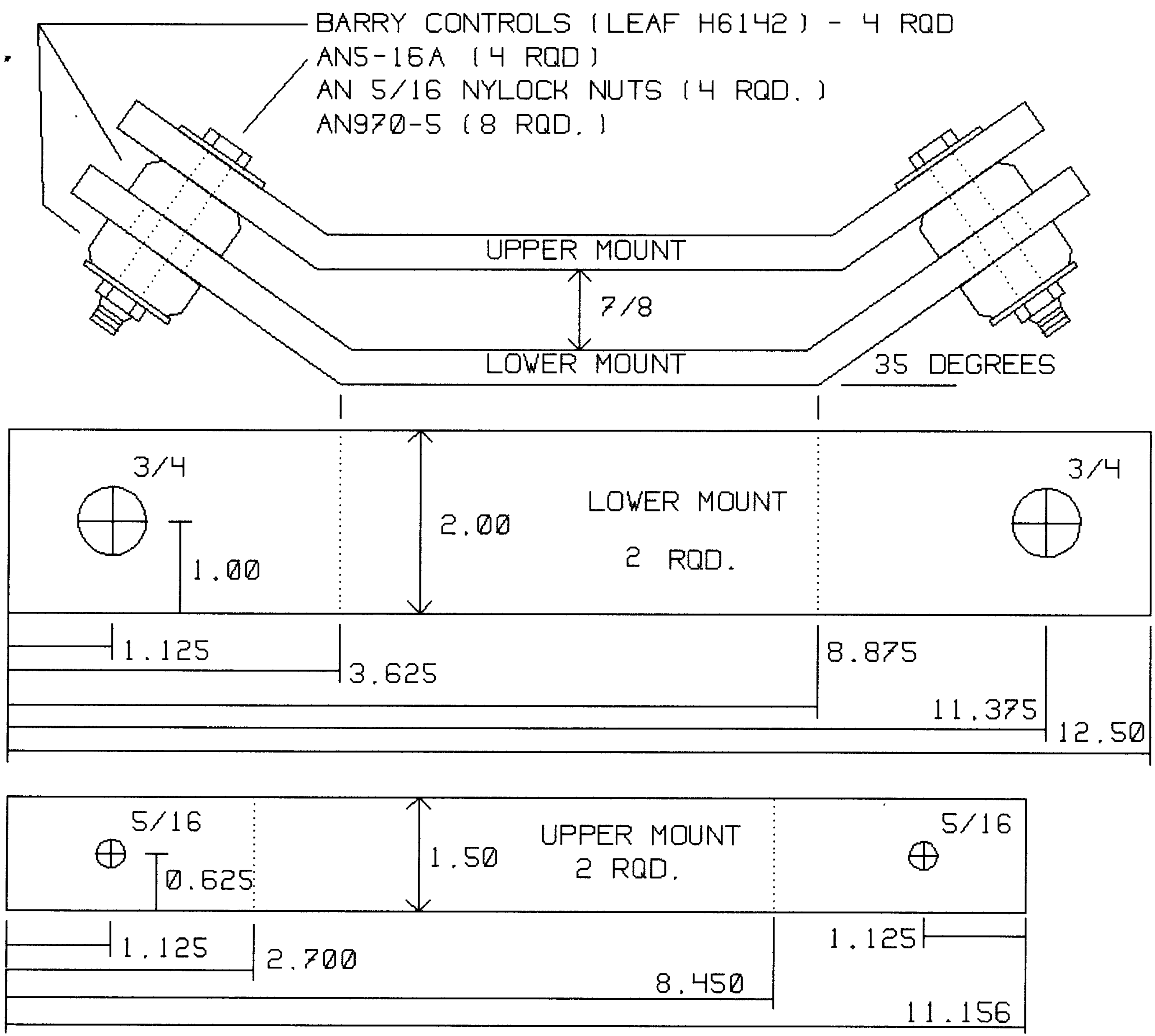
LEAF DYNAFOCAL ENGINE MOUNT

The LEAF dynafocal engine mount for the Rotax 447 is no longer available. Print G14-4 represents a replication of this unit, based on the best measurements I could make of the original on the aircraft, with adjustments made in the CADD program to be sure everything fits.

The mount consists of two lower mount bearers and two upper mount bearers. The bearers are fabricated from 3/8 inch 6061-T6 bar stock. The lower bearers are 2 inches wide while the upper ones are 1.5 inches wide. The really difficult part is to get the 35 degree bends at each end. If this is not the proper angle, and if the angles are not equal, the pieces probably won't fit very well. The 3/4 inch holes in the lower bearers should be chamfered slightly on both sides to avoid cutting into the rubber bushings.

The lower mounts bolt to the engine bearers (per the documentation) while the upper bearers bolt to the engine. The two seats of bearers are tied together at each end using Barry Controls vibration isolators available from LEAF (about $9.00 each). The upper mounts should end up about 7/8 inch above the lower bearers, providing ample clearance for the bolt heads. Although not shown on the drawings, the corners of all four bearers were radiused slightly

It was very hard to get delivery of these mounts when they were available and I suspect that their source had problems getting them out in any quantity. Perhaps Doug at **Aerotec** or some other supplier would be willing to gear up and make them. If not, it would be a tough job in the home shop. As an alternative, you may wish to look at the mounting hardware from **GyroTech**, as the ***HoneyBee*** engine mount is well done and seems to do a good job of isolating vibration.



BARRY CONTROLS (LEAF H6142) - 4 RQD
AN5-16A (4 RQD)
AN 5/16 NYLOCK NUTS (4 RQD.)
AN970-5 (8 RQD.)
UPPER MOUNT
7/8
LOWER MOUNT
35 DEGREES
3/4
3/4
1.00
2.00
LOWER MOUNT
2 RQD.
1.125
3.625
8.875
11.375
12.50
5/16
5/16
0.625
1.50
UPPER MOUNT
2 RQD.
1.125
2.700
8.450
1.125
11.156

PHASE 15
HANG TEST, ROTOR CONTROL RODS, AND PITCH TRIM SPRING

Hang Test:

Prior to installing the rotor control rods you will need to perform a hang test to verify that the head is properly positioned for the weight distribution of your aircraft. **Securely** the aircraft from the rotor head teeter bolt (or a grade 8 substitute) **so that the gear** wheels **are** about 2 feet off the und. With **half a tank of fuel** (or water, if you take care to completely empty and dry the tank when you are done) and you, sitting **normally** in the **seat, the** aircraft should hang **nose-down 10 degrees as measured on the keel! Variance** of +/- 1 **degree** is acceptable. If it is out of spec, see how much weight, **at the nose** of **tail,** is required to get it into trim. If only 1-2 pounds is required, you **can secure the** required amount of lead inside the front of the keel tube or **rear of the tail boom. If more** weight is required, it is **far better** to relocate the rotor head. If this is required, **make** dummy cheek plates from plywood until you get the proper position for **the head, and** then **use** your final plywood plates as a guide to making new **cheek plates (see Phan 1 1).**

Prints:

- **G15-1** - Rotor control rods
- **G15-2 -** Pitch-spring tension brace
- **G15-3 -** Tension spring brace assembly
- **G15-4** - Pitch trim spring installation

Fabrication:

G15-1. See assembly steps for determining the length of the chromoly control **rods**
G15-2. Prepare a pair of braces as indicated

G15-3. Prepare the two 2.25 and two 15/16 spacers as indicated, using 3/8 inch OD 6061 -T6 tube stock

G154. Prepare the tang fitting as indicated in the tang detail drawing and the **1/4** inch **spacer** from 3/8 inch OD 6061 -T6 tube stock.

Hardware:

- **AN3.1 1A** bolt (4)
- **AN960-316** washer (I 1)
- **AN365-1032** nylock nuts (5)
- **AN4-30A bolt** (3)
- **AN960-416** washer (I 0)
- **AN428-20 eye** bolt (1) see text
- **AN393-11** clevis pin (2)
- **AN 1 15-21** shackle (2)
- **AN490HIMP** control rod inserts (4)
- **AN3164** stop nuts (4)
- **HF4** Heim rod ends (4)

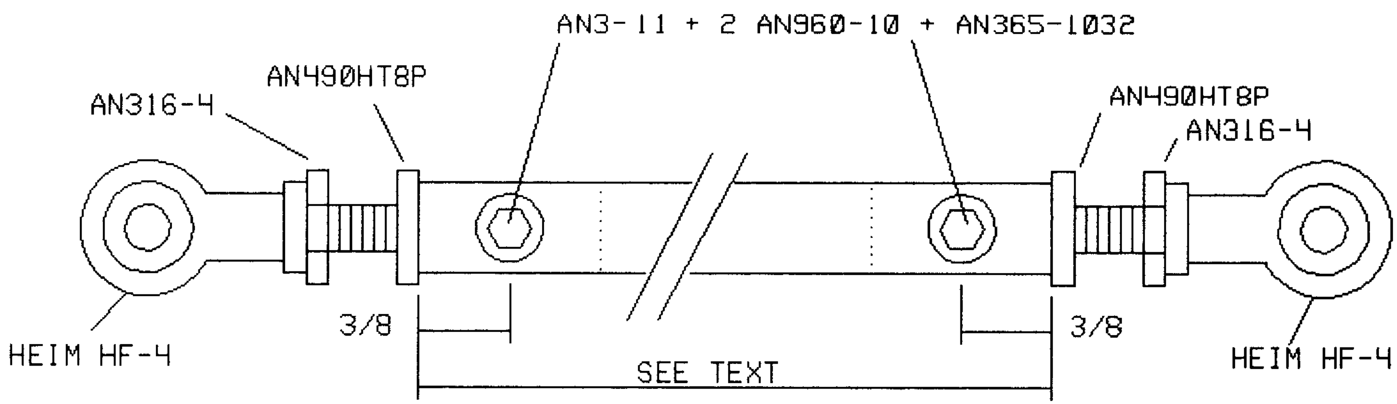
Assembly:

- Prior to assembly of the rotor control rods, you need to determine the length of each of the chromoly tubing pieces that make up the control rods. Proceed as follows:
  - Block the pitch bar of the rotor head assembly so that it is horizontal with the aircraft sitting on its landing gear.
  - Center the stick and block in at its forward limit of travel.
  - Measure the distance between the center of the hole on the control stick yoke and the co nding hole on the rear yoke on the rotor head. Do this for both sides and take the average length. Let this measurement be A,
  - Temporarily thread an HF4 Heim fitting half-way on the extension of one of the AN49O fittings. Measure the distance between the center of the hole on the Heim fitting and the lower edge of the retaining shoulder of the AN490 insert. Multiply by 2 and let this measurement be B.
  - The chromoly tubes should each be cut to a length equal to measurement A minus measurement B.

- Fabricate the control rods per G15-1 and install using the hardware provided with the rotor head and control stick. If castle nuts are supplied, be sure to install the cotter pins or clips. Release the control head and stick and the head should now track stick movements, side to side and fore and aft, without any slop, binding, or interference with other structural components.

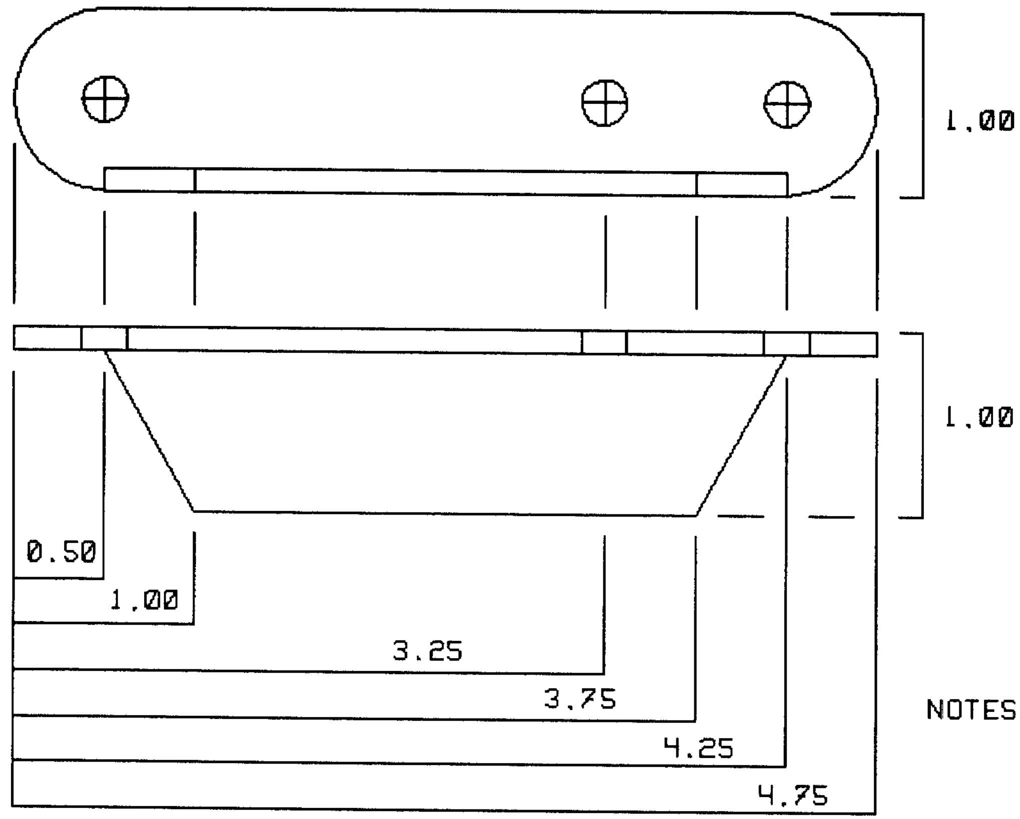
- Fabricate the pitch spring tension brace per G15-3, being sure to install the tang at the rear bolt during assembly. Since this fitting goes on the mast, you will have to assemble the fitting around the mast.

- Use G15-4 as a guide for installation of the remaining pitch trim spring components. Note that the length of the AN428 eye bolt is based on the thickness of the pitch bar on the Rotordyne head used on the prototype. Re-sizing of the eye bolt or changing the length of the aluminum spacer may be required for other head models. The spring is a heavy-duty one available from most hardware stores if you select from the dimensions indicated.



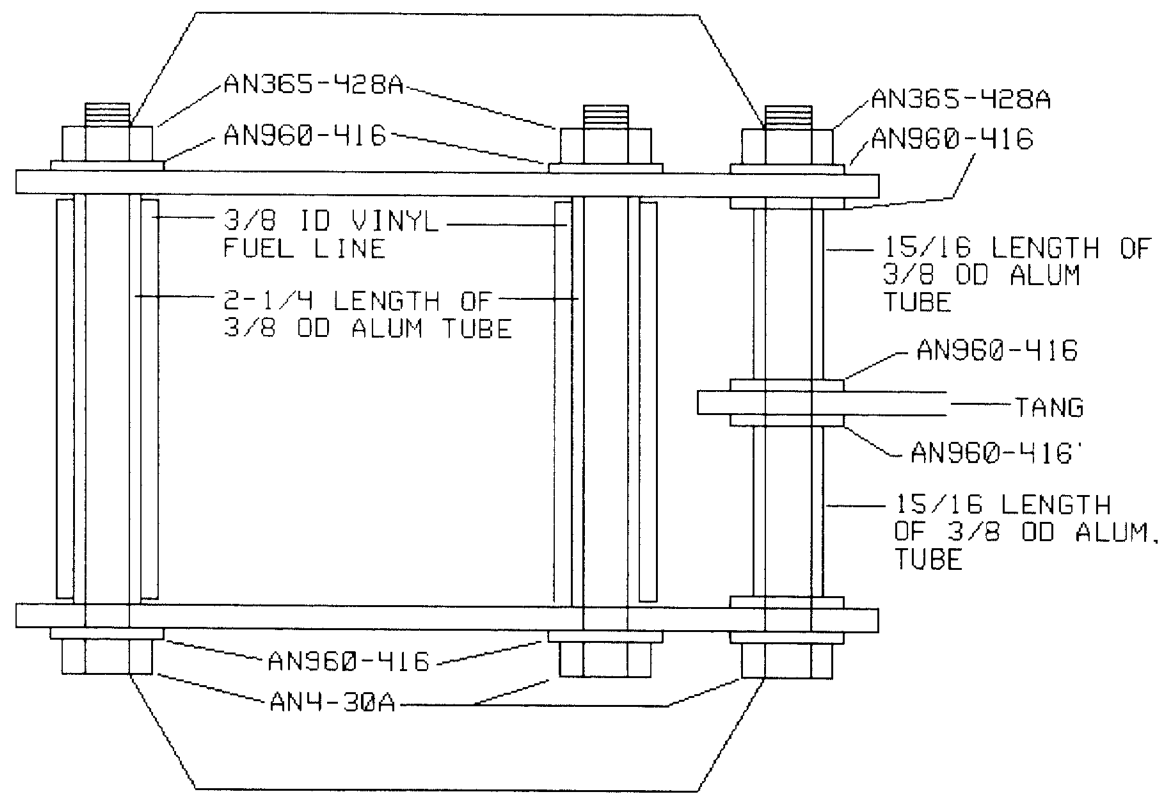
MATERIAL: 9/16 DIA. .065 WALL 4130 CHROMOLY TUBE STOCK

The GYROBEE	DATE: MAY 98 REV: 2.10
DRAWING: ROTOR CONTROL RODS (2 RQD) G15-1	SCALE: INCHES PAGE OF



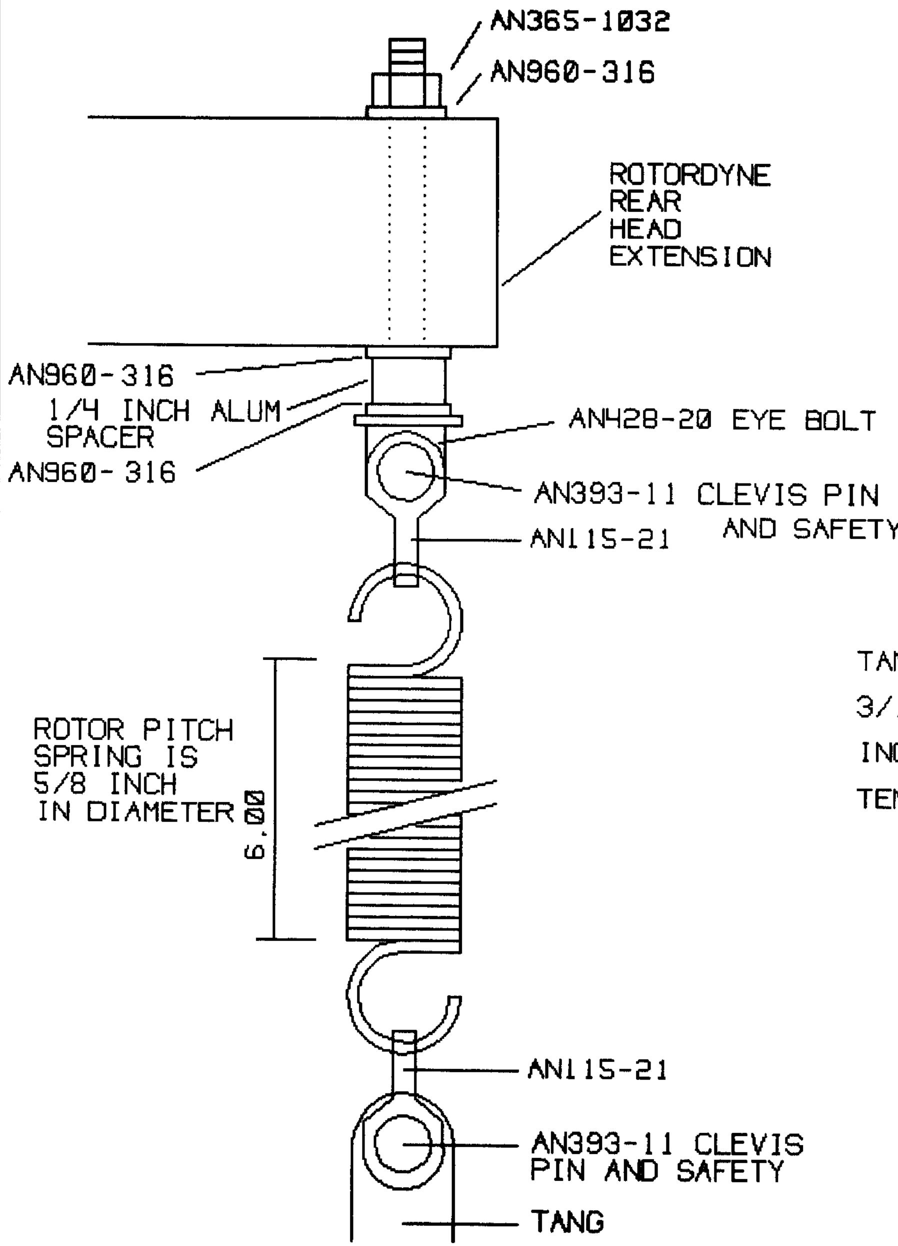
NOTES: ALL DIMENSIONS INCHES
ALL HOLES Ø.25 INCH

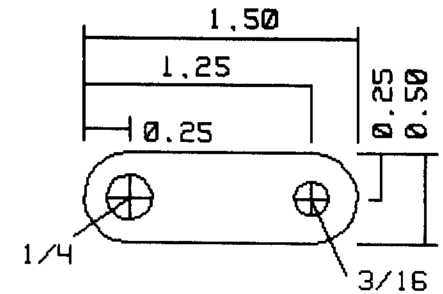
The GYROBEE	DATE: Ø59Ø REV: 1.Ø
DRAWING: PITCH SPRING TENSION BRACE G15-2 (2 RQD), SECOND IS OPP.	SCALE: NA PAGE 1 OF 2



LENGTH OF SHORT TUBES SHOULD BE FILED IF RQD SO THAT THE TANG WILL ROTATE FREELY BUT WITH MINIMAL SIDE-PLAY WHEN ALL NUTS ARE SECURED. RUBBER TUBING MAY BE SUBSTITUTED FOR THE VINYL SPECIFIED BUT TUBING MUST BE USED TO PROVIDE FRICTION ON THE MAST WITHOUT THE CHANCE OF SCRATCHING THE MAST.

The GYROBEE	DATE: MAY 90 REV:
DRAWING: TENSION SPRING BRACE ASSEMBLY G15-3	SCALE: NA PAGE 2 OF 2





TANG DETAIL

TANG MATERIAL: 1/8 THK STAINLESS STEEL SHT STOCK
3/16 HOLE LINKS WITH SPRING AS NOTED HERE. 1/4
INCH HOLE ENGAGES THE REAR BOLT ON THE HEAD
TENSION BRACKET.

The GYROBEE	DATE: APR 90 REV: 1.0
DRAWING: PITCH SPRING MOUNTING G15-4	SCALE; INCHES PAGE OF

PHASE 16
THROTTLE ASSEMBLY AND MISCELLANEOUS (BUT IMPORTANT) DETAILS

Prints:
- **G16-1** - Throttle components
- **G16-2** - Throttle assembly

Fabrication:

The prints referenced above show the original twist-grip throttle, using a Harley-Davidson motorcycle throttle with integral throttle lock. You can also use a conventional single arm pusher-type throttle quadrant, such as the **H7101** unit available from LEAF. If you use this option, you can mount the throttle quadrant to the left side of the seat (right if you are left-handed and fly with your left hand on the stick) using long bolts and tubing spacers, using AN970 washers on either side of the seat walls. Some of the photos in the **Gyrobee Photo Gallery** on the **Rotorbyte Website** show one approach to throttle quadrant mounting. In this case, you will also have to install a bracket or other provision for mounting the engine kill switch. This switch should be located where you can reach it quickly in flight, but not where you could activate it accidentally!

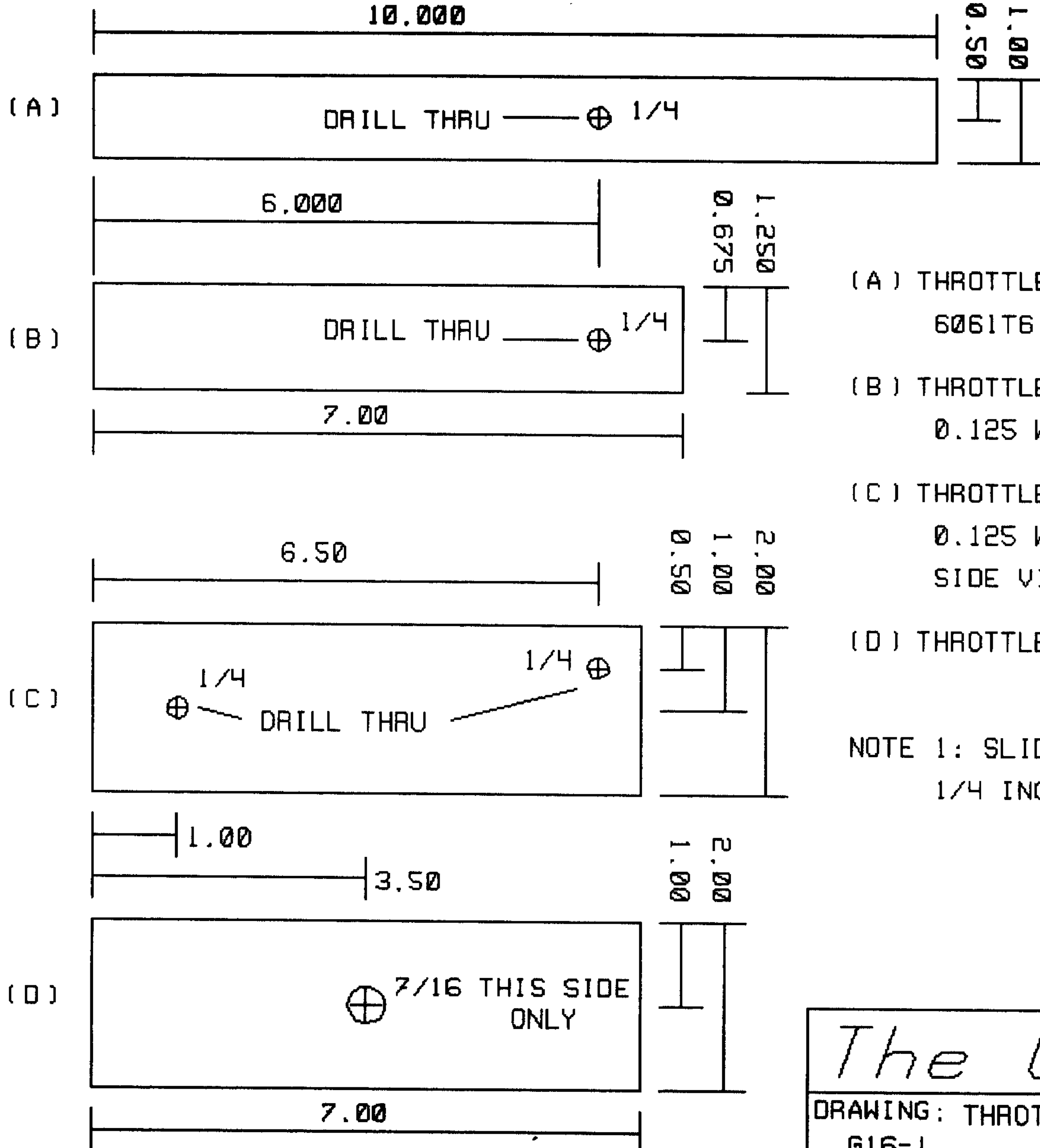
Hardware:
- **AN4-37A** bolt (1)
- **AN4-21A** bolt (1)
- **AN4-7A** bolt (1)
- **AN960-416** washer (3)
- **AN365-428** nylock nut (3)
- **AN970-4** washer (4)

Other Components:
- Saddle fittings (2) see **G2-3**
- 1 3/8 inch spacer from 3/8 inch OD 6061-T6 tube stock
- Heavy-duty industrial quality toggle switch (1)

Assembly:

Between the individual pieces (G16-1) and the assembly diagram (G16-2), assembly of the throttle unit should be straight-forward. It should be mounted on the side of the seat in a comfortable position to be reached by the left hand if you fly with your right hand on the stick or vice-versa if you fly with your left hand. Note that the prints assume a left hand position. The throttle mounting block should be made opposite to the one shown if it is to be mounted on the right side and the parts will assemble opposite the view shown in G16-2. Note that the throttle arm will pivot up or down (like the collective in a helicopter) so you can assume a position that is comfortable to you. The stop will prevent the handle from moving lower than horizontal. If desired, a push-to-talk switch for a radio can be installed at the end of the rubber throttle handle for easy actuation in flight.

The kill switch should be a heavy-duty, industrial quality double-throw/double-pole toggle switch - not a "cheapie". It mounts in the 7/16 hole at the top of the throttle mounting block (G16-1D).



(A) THROTTLE ARM - 1 INCH O.D. 0.063 WALL
6061T6 ALUMINUM TUBE

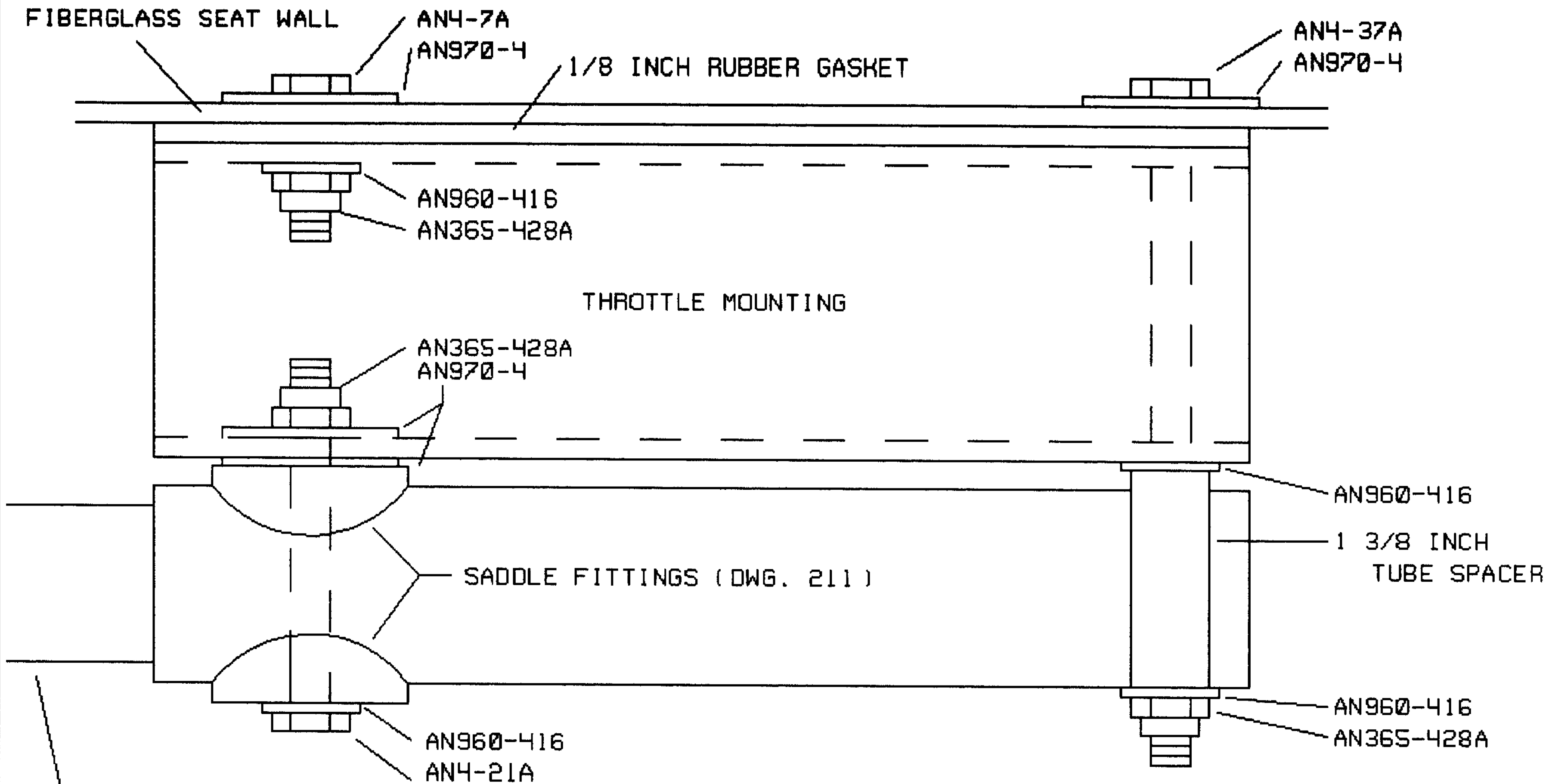
(B) THROTTLE ARM BASE - 1.25 INCH O.D.
0.125 WALL 6061T6 ALUMINUM TUBE

(C) THROTTLE MOUNTING BLOCK - 2 INCH SQ
0.125 WALL 6061T6 EXTRUDED ALUM.
SIDE VIEW.

(D) THROTTLE MOUNTING BLOCK - TOP VIEW

NOTE 1: SLIDE B OVER A AND MATCH DRILL THE
1/4 INCH HOLE

The GYROBEE	DATE: MAY 90 REV: 1
DRAWING: THROTTLE COMPONENTS G16-1	SCALE: PAGE OF



TUBE SPACER FABRICATED FROM 3/8 INCH O.D. (1/4 I.D.) 6061T6 ALUMINUM TUBE.

HARLEY-DAVIDSON TWIST-GRIP MOTORCYCLE THROTTLE TO BE MOUNTED ON 1 INCH OD THROTTLE ARM EXTENSION.

The GYROBEE	DATE: MAY 90 REV:
DRAWING: THROTTLE ASSEMBLY G16-2	SCALE: PAGE OF

DETAILS, DETAILS, DETAILS

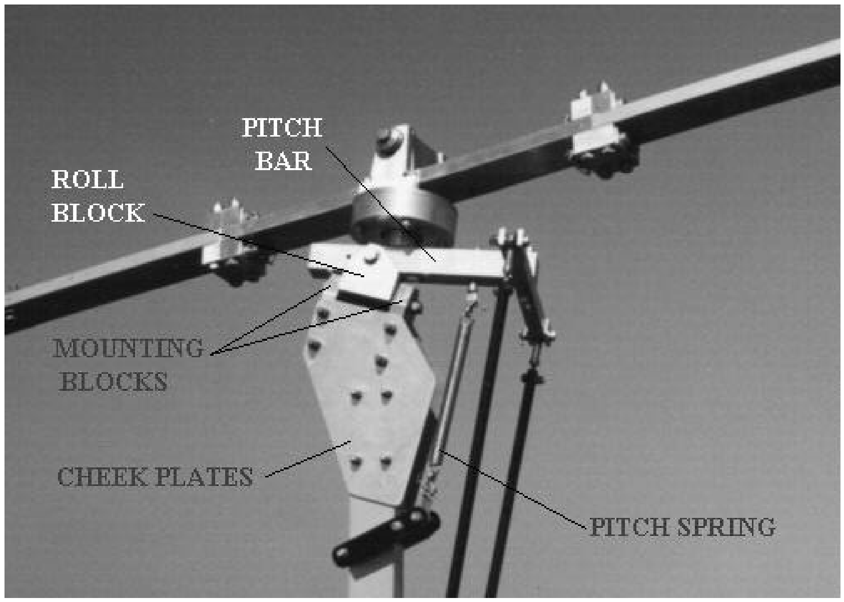
The aircraft is essentially done at this point, although there are still things that need to be done:

- **Wiring**. Wiring associated with the engine kill switch and any instruments has to be done in a quality fashion with the liberal use of cable ties to secure the harness to the airframe. No wiring should be positioned so that it would interfere with the prop of essential controls.
- **Rotor Control Limits**. When the rotor blades are first installed, bring the stick all the way to the rear stop (probably the front edge of the seat) and check the position of the rotor blade at the rear of the machine with full downward deflection of the blade. It should have about 1 foot clearance between the blade and the top of the vertical fin/rudder. If it is closer, install a plate (with rubber tubing on the forward edge) beneath the front of the seat so that the stick stops at a point that yields about 1 foot clearance.
- **Prop.** The most efficient prop for the **Gyrobee** is a wooden, two-blade 60-38. The only problem is that wood props tend not to last nowhere near as long as composite units. A two-blade, 60 inch IVO Prop set to 14 degrees is a reasonable substitute.
- **Engine Break-in and Care**. Follow the Rotax (or other manufacturer's) instructions precisely regarding break-in, engine operation, time-mandated inspections, etc. **Most engine problems can be traced back to ignoring some seemingly trivial recommendation**.
- **INSPECTION**: Now is the time to go over **EVERYTHING** in excruciating detail! Check that all bolts are snugged up and that safety or cotter pins are in place whenever a castle nut has been used. Now would be a good time to have an experienced pilot (even your instructor!) go over the machine. **Someone not associated with the project will often see things you have over-looked**.

FLIGHT INSTRUCTION: ***DO NOT ATTEMPT TO FLY WITHOUT HAVING COMPLETED A PROGRAM OF DUAL INSTRUCTION THROUGH CLEARANCE FOR SOLO FLIGHT!*** Once you are cleared, proceed carefully and do all your early flights in essentially calm conditions. Work up to more active weather gradually as you gain experience with the machine.

APPENDIX 1

SETTING UP YOUR ROTOR SYSTEM



Shown above is a nice photo of the ***Gyrobee*** head assembly made during our first flying season. I have labeled the critical parts to make it easier to make sense of the discussion which follows.

ROTOR HEAD SET-UP

Pitch spring

We installed a pitch trim spring since everybody had them. With our original 25 foot Rotordynes, so little spring tension was required, that we finally removed it entirely. With no spring, "hands-off" trim speed falls between 45 and 50 mph - perfect! The Brock blades also flew well with no spring. In contrast, the original version of the Dragon Wings (no trailing edge reflex) require a **lot** of spring pressure and we even had to move the spring attachment point out to the control-bar end of the pitch bar to make maximum use of available leverage. The current Dragon Wings blades have a reflexed trailing edge, which should reduce the downward pitching-moment, but I have yet to fly a set.

Why no trim-spring?

Well, I have already had arguments with several "experts" on this point who disagree with the explanation I will offer - so be it! The ***Gyrobee***, which hang-tests at 10 degrees nose down, is essentially the equivalent of tail-heavy, compared to the typical 14-16 degree hang angle (referenced to the keel!) of most gyros. This is essentially equivalent to moving the CG back, permitting the weight of the aircraft to set the trim speed as opposed to the use of springs. I won't argue this explanation, but the reality is that the aircraft flies with neutral stick pressure at 45-50 mph with most blades!

Range of Movement in Roll

On the prototype ***Gyrobee,*** the range of head movement in roll is 10° right and 11° left. Some heads have less and I would strive to try to get the 20 degree total range. In the photo above, note how the head mounting blocks are offset upward just a bit between the cheek plates to provide clearance for the bottom edge of the roll block. If they were lower, the roll block lower edge would hit the upper edge of the cheek plates, limiting the range of movement in roll. Little details like this can add precious degrees to your total range!

Rear Stick/Head Limit

During the early stages of blade spin-up, it is desirable to be able to hold the blades angled back as far as possible. The steeper the angle of the blades to the rear, the easier the initial stages of spin-up and the shorter will be the taxi distance required for takeoff. This is particularly critical for the ***Gyrobee***, since it does not rock very far back on the tail. The limits to rearward travel of the blades are the possibility of the blade tips striking the ground or the blades hitting the vertical fin. Given the tall mast of the **Gyrobee**, hitting the ground is not an issue, even with a 25 foot rotor disc. Hitting the tail is another story, since the tail-boom of the ***Gyrobee*** is longer than most, to simultaneous make the rudder more effective at low airspeed (or engine-out) yet less sensitive in normal flight. The practical rear limit of head movement can be determined by bringing the head all the way back and pulling the blades down to their teeter-limit stop on the head. At this point, you should have about **6-12 inches of clearance** between the blades and the point of closest approach to the tail. This occurs on the ***Gyrobee*** (with the Brock fin/rudder) at **20 degrees back** with the mast vertical.

Forward Head/Stick Limit

In practical terms, you need enough forward stick to maintain approach speed in the event of an engine-out landing. On the other hand, I did not want so much forward travel that it was easy for the rotor disk to "go negative". On the ***Gyrobee***, the head is set up so that, with the mast vertical, the pitch bar is dead level at the forward limit of travel. The only time we ever have the stick at its forward limit when we are moving on the ground and want to maximize vertical blade clearance in all directions. Both real and simulated engine-out landings have demonstrated ample stick range well short of fully forward, so it is possible that the forward-limit of head travel could stop at the +4-5 degree point without a problem.

Measuring Head Travel

All the head travel measurements quoted so far were made using a magnetic protractor, available at most Ace Hardware stores. It is a good idea to check your head, prior to mounting, to see the range of travel available. In the case of our Rotordyne head, we had a total of 20 degrees range in both pitch and roll. Some heads, such as the Rotor Hawk, see to have less range - about 16 degrees. Often you can widen the range a bit in the pitch axis by carefully filing or milling the top of the mounting blocks, since these often serve as the limiting factor in pitch travel. Any alterations should be slight (you don't have to take off a lot of metal to make a significant change, and the surface should be angled such that the pitch bar hits the limits parallel to the finished surface. This will minimize stress on the pitch bar, as opposed to coming to a stop against a sharp angle.

Cheek Plates and Head Angle

The cheek plates serve to hold the head at a specific angle to the mast, as well as a specific position, fore and aft, as determined in your hang test. On a Bensen-type machine, the mast is angled back 9-10 degrees and the head is aligned with the mast, resulting in the head axis being angled back approximately 10 degrees. This angle approximates the angle of the rotor thrust vector in flight, but there is a fair amount of latitude in this angle that we can use to our advantage in setting up the ***Gyrobee*** rotor system. You can work everything out in whatever way that suits you, but the following sequence of steps should get you into the ballpark with as little wasted time as possible.

> **(1) Dummy Cheek Plates**. It would be a good idea to have materials in hand to make several sets of dummy cheek plates out of half-inch plywood. At different stages, these plates can be attached to the mast and the head with hardware store bolts and washers (stainless hardware is excellent), as we will be simply doing set-up. The final aluminum flight-ready plates will be attached with aircraft hardware at a later point.
>
> **(2) Calculate the Head Angle**. The first step is to calculate a target angle (**HA**) for the head based on the range of head travel in pitch (**HT**) and the desired rear limit (**RL**) for head travel. The formula looks like this:
>
> **HA = RL - (HT x 0.5)**
>
> If I run these numbers for the prototype ***Gyrobee***, the desired rear limit of travel (**RL**) = 20^{o} and the total head travel (**HT**) on the Rotordyne head = 20^{o}: Substituting, we get:
>
> **HA = 20 - (20 X 0.5)**
>
> **HA = 20 -10**
>
> **HA = 10 degrees**

Thus, I would want to set the head at 10 degrees (aft) with respect to the mast (which is vertical).

Let's say you want the same rear limit (20^o) but are using a Rotor Hawk head that only provides 16 degrees of total travel (HT). In that case we would get:

HA = 20 - (16 x 0.5)

HA = 20 - 8

HA = 12 degrees

In the case of the Rotor Hawk head, we would need to set the head at 12 degrees (aft) with respect to the mast to get the same rear limit. You can plug in your own numbers to see what you will require.

(3) Calculate the Forward Limit of Travel. Having worked out the head angle for the rear travel limit (the most important parameter) we can now check out what that will give you in terms of the forward limit (**FL**):

FL = HA - (HT X 0.5)

Remember, with the ***Gyrobee*** prototype, **HT** was 20^o and **HA** was 10^o. Substituting, we get:

FL = 10 - (20 x 0.5)

FL = 10 - 10

FL = 0 degrees

Not surprisingly, this is what we actually get! In the case of the Rotor Hawk head (**HA** = 12^o and **HT** = 16^o), the numbers would be a bit different:

FL = 12 - (16 x 0.5)

FL = 12 - 8

FL = 4 degrees

As indicated earlier, we definitely don't want a negative angle for **FL**. In this case, 4 degrees positive would probably work just fine. Again, you can work out the numbers for your components and aircraft. If **FL** is greater than 5 degrees, you might want to work on the head to get a greater range of Travel (**HT**) and then repeat the last two steps.

(4) Check Out the Numbers. Now you have a set of target values, make a dummy set of cheek plates with the head mounted at angle **HA** and then see if the head travel limits (mast vertical) match your calculations.

(5) Do the Hang Test. If all is well, do the hang test with your dummy plates - remember, half a tank of fuel or water and you in the seat. The desired "hang angle" is 10 degrees nose down **as measured at the keel**. If you are willing to settle for a degree or so of error, it should be off on the nose high side, **not nose low**. If you have to make additional dummy plates, use the same value for **HA**, but simply more the head forward or backward with respect to the mast until you get the desired hang angle.

(6) Real Cheek Plates. Once you have the head positioned for the proper hang angle, make your "real" plates from 6061-T6 (1/8 inch), following the plywood dummy layout. Install the plates and head with the specified aircraft hardware.

(7) Control Rods. Once the head is properly angled and positioned and permanently installed, proceed to fabricate the control rods and do a check of actual head range with the stick. At this point, any fine-tuning should involve the stick and linkages, since everything else is known to be set up properly.

RIGGING YOUR BLADES

Proper blade rigging requires that the blades and hub bar system meet four criteria:

- The rotor must be properly balanced with respect to blade chord
- The rotor must be balanced span-wise
- Both blades must be set to equal pitch
- The blades must be "in-string"

I will cover each of these criteria in the sections below.

Chord-wise Balance

Chord-wise, your blades should balance at about the 25% point. With most modern blades, this is something that is taken care of by the manufacturer. If you are planning to use the Fleck extruded blades, you have to install the supplied rod stock inside the extruded blade section to achieve proper chord-wise balance.

Span-wise Balance

If you purchase your blades and hub bar as a set, the manufacturer will have set them up for proper span-wise balance. The one caution is that the blades will be individually labeled with a letter or number (1 and 2 or A and B) with corresponding labels at the end of the hub bar. Just make sure that you match up these labels when mounting the blades.

Blade Pitch

Although there are several ways of expressing the pitch of a rotor blade, when it comes to rigging, pitch is expressed in positive degrees (pitched up) with respect to the inboard section of the rotor hub bar. How much the blades are pitched is a trade-off between two attributes - lift and ease of spin-up. Increasing blade pitch, to a point, will increase lift and limit forward speed. Unfortunately, greater blade pitch settings make manual starting and spin-up more difficult. When flying our Rotordynes and testing the Brock blades, we pitched the blades at +0.75 degrees. Other blades may perform better at different pitch settings.

No matter what value you use for blade pitch, it is very important that both blades be set to the **same** value. If they are not, they will be out-of-track and stick-shake will be the result.

You do not need to worry about setting the pitch for Dragon Wings or Sky Wheels blades. Dragon wings use blade twist instead of pitch. The twist is built into the blades and there is no provision for adjustable pitch. Sky Wheels blades plug into the composite center-section and the pitch is thus preset. For other blades, you will have to set the desired pitch using the adjustable pitch blocks.

Pitch adjustment cannot be done accurately using the scribe marks on the hub bar. We use a pair of rods, clamped on either side of the pitch blocks (pointed forward relative to the blade). The rods are made of 1/2 inch aluminum angle stock (1/8 inch thick), so they don't bend easily and the chance of error is minimized. Small C-clamps are used to secure the rods against the surface of the hub bar. If the rods are set up to measure 57.3 inches from the center of the hub bar to the far end of the rods, 1 inch is displacement is equal to 1 degree of pitch. If the distance is reduced to 28.6 inches, 1 degree of pitch will equal a displacement of 0.5 inches. The ends of the angle-stock rods can be angled toward each other slightly so they almost touch at the far end, making it easier to measure the displacement.

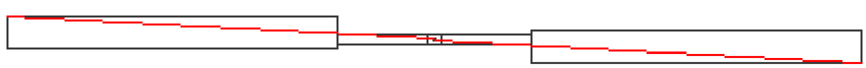
We use the longer rods, so that one-inch is displacement is equal to 1 degree of pitch. To set the blades at +0.75 degrees, for example:

1. Loosen the pitch block bolts slightly.
2. With the rods in place, rotate the outer (blade end) section of one pitch block until the outer (blade end) rod is 0.75 inches higher than the inboard rod.
3. Carefully tighten the bolts on the pitch block to retain the offset you used.
4. Repeat the process at the other end, trying to achieve exactly the offset you put into the first blade.

Setting the pitch this way is easy and accurate - far more so than any other way you can do the job.

Stringing Your Blades

Some blades, by virtue of how they mount, are automatically aligned. These include the Sky Wheels and Brock Blades. Some other blades are made to such close tolerances, such as Ernie Boyette's Dragon Wings, that they be aligned just fine from the start. It never hurts to check, since near perfect blade alignment is a requirement if you want to avoid stick shake.



Your blades are properly aligned with each other and the hub bar when a line projected from any point on one blade to the same point on the opposite blade, passes over the geometric center of the teeter block at the center of the hub bar - as shown in he simplified diagram above. Since we need something more practical than an imaginary line to check this, a "string" is usually strung from the reference point on one blade to the same point on the opposite blade. The blades are said to be "in-string" when the line passes directly over the center of the teeter block. The bolt holes on most blade straps are just slightly oversize, so when the straps are bolted to the bar (finger-tight) you can adjust blade alignment until they are in-string. At that point, you carefully tighten the blade strap retention bolts to keep them properly aligned as the nuts are torqued. While simple in principle, there are a few practical tips to make it easier to do.

1. If the top-center of the teeter block is not already marked, use a sharp pencil and straight edge and draw lines from opposite corners. Use a center-punch to

permanently mark where the lines cross. Do this job carefully or you will waste you time each time you have to string the blades!

2. Use a length of heavy (20 lb. Test) mono-filament fishing line as the "string".
3. Attach the blades to the hub bar with the bolts finger-tight.
4. Block up the blade tips and hub-bar center so when the line is strung between the blade tips it passes just over the teeter block, without touching the block.
5. String the line, taught, between the same two points on each blade tip. If you use the tip if the trailing edge, you can clamp the line with small, spring-loaded paper clamps.
6. Adjust the blades so the mono-filament line crosses the marked center point on the top of the teeter block.
7. Carefully tighten one set of blade-strap bolts/nuts, striving to hold the alignment.
8. Readjust the remaining blade slightly, if required, and tighten the bolts/nuts on the remaining blade straps.

Phase 1 Materials

Hardware

Type	Description	Qty
AN4-26A	bolt	2
AN960-416	Washer	4
AN365-428	Nylock nuts	2
AN3-26A	Bolt	7
AN960-316	washer	14
AN365-1032	Nylock nuts	7

Material

1 pc	2" x 2" x 1/8" x 48" Length –Grade 6061-T6 Aluminum Extruded Tube Stock Keel Tube
2 pcs	2" x 1" x 1/8" x 72" Length –Grade 6061-T6 Aluminum Extruded Tube Stock Mast Tube
2 pcs	2" x 7" x 1/8" thickness – Grade Stainless Steel Sheet Stock Keel / Mast Cluster Plate
2 pcs	1" x 1" x 1/8" x 44 ¼" Length –Grade 6061-T6 Aluminum Extruded Angle Stock Seat Braces

Phase 2 Materials

Hardware

AN4-21A	Bolt	4
AN960-416	Washer	8
AN365-428	Nylock nut	4

Material

2 pcs	1 ¼ OD – 0.120 Wall x 38" Length - Grade 6061-T6 Aluminum Tube Stock Axle Struts
2 pcs	small brackets – Equivalent LEAF E1500 Airframe Brackets

Phase 3 Materials

Hardware

AN490HT8P	Rod-end inserts	4
Heim HF-4	Female rod ends	4
AN3-11A	bolt	4
AN960-318	washer	8
AN365-1032	Nylock nut	4
AN4-17A	bolt	4
AN4-20A	bolt	2

AN4-26A	bolt	1
AN4-31A	bolt	1
AN960-416	Washer	24
AN970-4	Washer	2
AN365-428	Nylock nut	8

Material

2 pcs	small brackets – Equivalent LEAF E1500 Airframe Brackets
2 pcs	large brackets – Equivalent LEAF E1520 Airframe Brackets
10 pcs	(see text G2-3) - Grade 6061-T6 Aluminum Bar Stock Axle Saddle Fittings
2 pcs	9/16" OD – 0.065 Wall x 33 ¼ " Length - Grade 4130 Chromoly Tube Stock Axle Drag Struts
1 pc	1" x 2 3/8" x 1/8" thickness - Grade Stainless Steel Sheet Stock Lap Belt End Fitting

Phase 4 Materials

Hardware

AN3-14A	Bolt	2
AN960-316	Washer	4
AN365-1032	Nylock nut	2
AN4-17A	Bolt	2
AN960-416	Washer	12
AN365-428	Nylock nut	2

Materials

1 pcs	3.125" x 5 ¼" x 1/8" thickness - Any Grade Alloy Temporary Shock Plate
1 pcs	3.125" x 5 ¼" x 1/8" thickness - Grade Stainless Sheet Stock Shock Plate
2 pcs	1" x 1" x 3" Length - Grade 6061-T6 Aluminum Bar Stock Upper Strut Fitting (Machined Part)
2 pcs	1" OD – 0.063 Wall x 45 ½" Length – Grade 6061-T6 Aluminum Tube Stock

Phase 5 Materials

Hardware

AN3-26A	Bolt	8
AN960-316	Washer	16
AN365-1032	Nylock nut	8

Materials

1 pc	2" x 2" x 3 ½" Length – Any Grade Steel

	Nose Block
2 pcs	2" x 6 ½" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Nose Block / Keel Cheek Plate

Phase 6 Materials

Hardware

AN3-6A	Bolt	2
AN960-316	Washer	6
AN4-6A	Bolt	2
AN4-30A	Bolt	1
AN4-52A	Bolt	1
AN960-416	Washer	6
AN970-4	Washer	14
AN365-428	Nylock nut	6

Material

2 pcs	3/8" OD – ¼" ID x 1" Length – Grade 6061-T6 Aluminum Tube Stock Spacer
2 pcs	1 ½" x 1 ½" x 1/8" x 18.938" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Horizontal Engine Strut
2 pcs	1 ½" x 1 ½" x 14 ¾" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Diagonal Engine Strut

Phase 7 Materials

Hardware

AN3-6A	Bolt	6
AN3-30A	Bolt	1
AN960-316	Washer	14
AN365-1032	Nylock nut	6
3/16"	Pop-rivets	4

Material

2 pcs	1" x 1" x 1/8" x 13 ½" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Fuel Tank Mount (Eipper)
2 pcs	1" x 1" x 1/8" x 8 ½" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Fuel Tank Mount Diagonal
4 pcs	1" x 1" x 1/8" x 11 ½" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Fuel Tank Mount Side and Cross Beam

Phase 8 Materials

Hardware

AN3-6A	Bolt		6
AN3-7A	Bolt		6
AN960-316	Washer	2	4
AN365-1032	Nylock nut		12
AN4-7A	Bolt		4
AN4-11A	Bolt		2
AN4-22A	Bolt		2
AN960-416	Washer		38
AN8-27	Bolt		1
AN960-816	Washer		2
AN310-8	Castle nut and cotter pin		1
AN115-21	Shackle		2
AN316-4	Check nut		2
HM4	Heim rod end		2
HF4	Heim rod end		2
3/16"	Pop rivets		6

Material

1 pc	1" x 1" x 1/8" x 17 ½" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Pedal Bracket
4 pcs	2" x 2" x 1/8" x 7/8" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Pivot Bracket
2 pcs	4 ½" x 5 7/8" x 5/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Rudder Pedal Web
2 pcs	1" x 1" x 1/8" x 9" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Pedal Long Brace
2 pcs	1" x 1" x 1/8" x 5 ¾" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Pedal Short Brace
2 pcs	1" x 1" x 1/8" x 5" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Pedal Arch Brace
1 pc	3 ½" x 8" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Rudder Control Horn
1 pc	1" x 1" x 1/8" x 8" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Rudder Control Horn Brace
2 pcs	3/8" OD – ½" ID – Grade 6061-T6 Aluminum Tube Stock Control Horn Heim Spacer
4 pcs	3/8" OD – ¼" ID – Grade 6061-T6 Aluminum Tube Stock Control Horn Heim and Wheel Fork Spacer

Phase 9 Materials

Hardware

AN3-7A	Bolt	20
AN960-316	Washer	40
AN365-1032	Nylock nut	20
AN4-6A	Bolt	2
AN4-26A	Bolt	1
AN960-416	Washer	6
AN365-428	Nylock nut	3
3/16"	Aluminum pop rivet	3

Materials

1 pc	4" x 11" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Rear Seat Plate
1 pc	4" x 11" x 1/16" Thickness – Grade 6061-T6 Aluminum Sheet Stock Rear Seat Plate 1 pc 4" x 11" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Bottom Seat Plate
1 pc	4" x 11" x 1/16" Thickness – Grade 6061-T6 Aluminum Sheet Stock Bottom Seat Plate
2 pcs	1" x 1" x 1/8" x 10" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Seat Bottom Angle
2 pcs	1" x 1" x 1/8" x (see text)" Length – Grade 6061-T6 Aluminum Extruded Angle Stock Seat Support Strut

Phase 10 Materials

Hardware

AN3-26A	Bolt	4
AN4-26A	Bolt	2
AN4-27A	Bolt	4
AN960-316	Washer	8
AN960-416	Washer	12
AN970-5	Washer	10
AN365-1032	Nylock nut	4
AN365-428	Nylock nut	6
KB2	Tail group hardware	

Materials

1 pc	2" x 2" x 1/8" x 72" Length – Grade 6061-T6 Aluminum Extruded Tube Stock Tail Boom
2 pcs	3 ½" x 5 ¼" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Tail Wheel Plate

Phase 11 Materials

Hardware

AN4-26A	Bolt	4
AN960-416	Washer	8
AN365-428	Nylock nut	4
	Head Mounting hardware	

Material

2 pcs 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock - Head Cheek Plate

Phase 12 Materials

Hardware

AN115-21	Shackle	2
AN100-4	Stainless thimble	4
AN393-11	Clevis pin	2
3/32"	Oval nicopress sleeve (LEAF M1031)	8
3/4"	Cowling pin (LEAF F5110)	2
AN4-26A	Bolt	1
AN960-416	Washer	2
AN365-428	Nylock nut	1
3/32" (7x7)	Stainless control cable	25 ft

Material

1 pc	2" x 2" 1/8" x 2" Length – Grade 6061-T6 Aluminum Extruded Tube Stock Fairlead Block
1pc	2" x 2" x 2"Length - Hardwood Block

Phase 13 Materials

Hardware

AN3-32A	Bolt	2
AN960-316	Washer	22
AN365-1032	Nylock nut	2
AN4-6A	Bolt	3
AN4-26A	Bolt	1
AN4-34A	Bolt	2
AN960-416	Washer	8
AN365-428	Nylock nut	6
AN970-4	Washer	4
AN870-6	washer	4

Material

1 pc	1 ½" x 2" x 1/8" Thickness – Grade 6061-T6 Aluminum Sheet Stock Harness Plate
1 pc	3/8" OD x 7/8" Length – Grade 6061-T6 Aluminum Tube Stock Seat Brace Spacer
2 pcs	3/8" OD – 0.063 Wall x 1" Length – Grade 6061-T6 Aluminum Tube Stock Vertical Strut Spacer
1 pc	3/8" OD – 0.063 Wall x 0.3" Length – Grade 6061-T6 Aluminum Tube Stock Vertical Strut Spacer

Phase 14 Materials

Hardware

AN848-40	Fuel fitting	1
	Fuel line	5 ft
	Fuel filter	1
	Primer bulb	1
	Hose clamps	7
AN316-7	Stop nut	1

Materials

1 pc	Eipper Engine Mount
1 pc	4 ¾" x 6 ¾" x .063" Thickness – Grade Steel Sheet Stock Muffler Mounting Plate

Phase 15 Materials

Hardware

AN3-11A	Bolt	4
AN960-316	Washer	11
AN365-1032	Nylock nut	5
AN4-30A	Bolt	3
AN960-416	Washer	10
AN428-20	Eye bolt	1
AN393-11	Clevis pin	2
AN115-21	Shackle	2
AN490HT8P	Control rod inserts	4
AN316-4	Stop nut	4
HF-4	Heim rod ends	4
5/8" x 6"	Rotor Pitch Spring	1
3/8" ID	Vinyl Fuel Tube	4 inches

Materials

2 pcs	9/16" - .065 Wall x ? Length - Grade 4130 Chromoly Tube Stock Rotor Control Rod
2 pcs	1" x 4 ¾" x 1/8 Grade 6061-T6 Aluminum angle stock Pitch Spring Tension Brace
3 pcs	3/8" OD x ¼" Length – Grade 6061-T6 Aluminum Tube Stock

	Tension Spring Brace Spacer and Pitch Spring Mount Spacer
2 pcs	3/8" OD x 15/16" Length – Grade 6061-T6 Aluminum Tube Stock
	Tension Spring Brace Spacer
1 pc	½" x 1 ½" x 1/8" Thickness – Grade Stainless Steel
	Tang

Phase 16 Materials

Hardware

AN4-37A	Bolt	1
AN4-21A	Bolt	1
AN4-7A	Bolt	1
AN960-416	Washer	3
AN365-428	Nylock nut	3
AN970-4	washer	4
	Industrial Toggle switch	1
H7101 (LEAF)	Pusher type throttle quadrant	1

Material

1 pc	1" OD – 0.063" Wall x 10" Length – Grade 6061-T6 Aluminum Tube Stock
	Throttle Arm
1 pc	1 ¼" OD – 0.125" Wall x 7" Length – Grade 6061-T6 Aluminum Tube Stock
	Throttle Arm Base
1 pc	2" x 2" x 0.125" Wall x 7" Length – Grade 6061-T6 Aluminum Extruded Tube Stock
	Throttle Mounting Block
2 pcs	Saddle Fittings (see G2-3)
1pc	3/8" OD x ¼" ID x 3/8" Length – Grade 6061-T6 Aluminum Tube Stock

Catching a Bee by the Tail.
By Wayne "Doc" Watson

Are you among many who have wanted to build and fly something totally different? Alas, you look at your financial statement and sigh thinking maybe someday. Well that day has come! Dust off the old computer and navigate yourself over to the Gyrobee website. There you will find free plans to one outstanding gyrating machine.

My Gyrobee building adventure began by down loading these plans from Mr. Ralph Taggart's website in early November 1997. The plans were very well drawn and knowing the bee had flown so many years without mishaps made me feel secure with the design. After studying the plans, step by step construction notes and materials list I felt confident anyone, Including myself, could build one of these odd contraptions. To prove the point, I started building the Gyrobee on Dec 1,1997. I bought all the aluminum required for the main aircraft structure from Aerotec. Doug Reiley,owner of Aerotec, was glad to assist and help insure I had the right construction materials for the job. Ralph's plans really layed out the construction sequence in a nice orderly and precise fashion. This made it easy to just dive in and start building. Doug helped tremendously by providing the stainless parts and a great wheel kit.

Upon completing the main aluminum structure, the seat and all the little odds and ends were added. Then the big question came. What do we do for a tail section?

Ralph had used the brock tail assembly on his gbee but I really wanted something different. I looked at wood, metal and tube and fabric tail construction. All were nice but for one reason or the other didn't have the combination of items I wanted on my tail. I wanted a more modern tail appearance, a simple construction style and a fully symmetrical horiz.stab. I didn't want a plywood bolt on that looked like an after thought or a glorified rock guard. When it was said and done I choose the easy way out. I built the tail section from composites.

I know what your thinking.....woooh wait a minute, composites are really hard to build. They take a lot of specialized tools and equipment. You need a special environment to build in. Well keep reading and maybe I will change your mind about composite construction.

Mold-less Construction:

When you think of mold-less construction most people think of Burt Rutan. He used this type of construction in aircraft such as the Long-ez, Defiant and the Voyager. This construction style is great for one of parts such as the ones we will be making.

Before we jump into construction we will need a few items.
For cutting and shaping the parts we will need the following:
1. a hobbysaw 2. a sharp kitchen knife or razor blade knife. 3. sand paper 60,100,220,320 grit and different sanding blocks. 4. a couple of good felt pens. 5. carpenters corner square (large) 6. tape measure 7. foam cutter setup 8. paint spraying mask 9. yardstick 10. 10 dry wall screws

For completing the parts we will need these items:
1) box of 50 latex gloves 2) 1/2 gallon of west system epoxy and slow hardner with measuring pumps. 3) 1/16"x12"x24" plywood double faced. 4) 3/16"x12"x24" plywood double faced. 5) 10yds of Rutan bi-cloth from Aircraft spruce part no# RA7725 6) 1qt poly-fiber superfil epoxy a&b. 7) 1 roll of surface tape dacron 2"x50' (peel ply) 8) 1 lb glass bubbles (micro balloons) 9) 1 piece of 2"x1" redundant mast material 12" long. to make brackets from. 10) 1 sheet of 1/8" 6061-t6 12"x12" for making tail section mounting brackets. 11) 24"x1/2x.058 wall round alum.tubing for struts. 12) 7ea. an3-26a bolts. 13) 30ea. an960-316 washers 14) 4ea. an970-4 15) 7ea. an365-428a nuts. 16) 4ea. 11/4"brackets made from the

2x1 stock above. 17) misc items such as a good sander wheel, a bandsaw or table saw and a couple of different size squeegees . 18) grey automotive sandable primer. 19) enamel paints of your choice. Finish the 1/2 tubing the same as your airframe parts. 20) 50"rqd 3/8"x11/16" half round white pine stock for H.S. leading edge 21) 4 an3-5a bolts for hinge mounting with 4 an365-428a nut and 12 an960-316 washers. 22) 2 an3-6 bolts with 2 castle nuts with cotter pins and 6 washers. 23) 3ea. an3-31a bolts

Before we get started lets talk more about a few of the items above.

The Foam Saw:
You can construct a simple foam saw from the following materials. a) a car battery and charger. b) one 2"x4" board 40" long. c) 2ea. 1/2"x12"x.058 wall alum tubing round. d) an old extention cord. e) 2 small aligator clips and 2 large aligator clips. f) 120" of .030 mig welding wire. (found at most any welding shop or local garage.) See diagram 1. Take the 2x4 and drill 2 1/2"holes per locations shown. Install tubes, making sure they fit firmly in holes. String mig wire, installing 1"broom stick hand holds on wire. These are made by cutting 1"lengths off of a old broom handle. Drill the center of the pieces out with a 1/8" bit and install on wire prior to stringing. This system will not require a var. volt. regulator. As setup the saw will cut 1" every 2-4 seconds. To adjust the tension on the mig wire use a pair of pliers and twist one of the 1/2tubes until wire is tight.

DIAGRAM 1 LOCATION

Fiberglass Cloth:
We will be using Rutan Bi-Cloth for the tail construction.UNDER NO CIRCUMSTANCES should you substitute another type of cloth. The Rutan cloth is designed for this type of layup work to provide outstanding strength to weight ratio. While you perform layups you will lay each piece of glass 45 degrees to the last piece for added strength. All ajointing corner layups will be 45 deg. to each other down the length of the corner. Only 2 ply layers per side of each tail piece will be needed.

Epoxy Types:
Now let's talk about different types of epoxy used in this construction. There are 4 types of epoxy. The first is pure epoxy. This is the straight ratio mixture of resin to hardner. The second type is micro-slurry. This is pure epoxy mixed with an equal amount of micro-balloons. We use micro-slurry to fill in minor inperfections of the foam and a base for the first layer of glass. The third type is wet micro. The ratio is about 1 pure epoxy to 2-3 times the ratio of micro-balloons. When correct this has the consistancy of heavy syrup. Wet micro is used for bonding foam blocks togeather. The fourth and final type is dry micro. This is a ratio of micro-balloons to such a level that the epoxy looks like cake icing and holds its shape without running.
Dry micro is used for trailing edge buildup on glass and filling small imperfections in foam just before laying glass.

Constructing the tail section.

We will cut the foam for the H.S. first. Using one of the foam boards cut (4) 2"x24"x24" blocks. Once completed mix up some pure epoxy. Pour out a small amount on each panel side to be bonded. Now spread it thinly with your squeegee. Make sure you cover the entire surface. Take the remaining epoxy and mix micro-balloons until you have a wet micro mix. Pour a small bead of wet micro down the center of one panel for each pair to be bonded. Press the two panels togeather and move back and forth to push the epoxy out to the edges. Now you can weight the panels down, wiping off the excess epoxy and let cure for 24 hours.

Let's layout and cut the Fin and Rudder panels now from the sheet of foam you have left. Use diagram 2. Once completed set them aside for the moment. Cut the top and bottom ribs for the vert. fin using the 1/16" plywood. Sand the ribs and glue them to the top and bottom of the vert. fin. Use masking tape to hold until cured. Now cut the ribs for the rudder panel. Glue these into place and let cure.

DIAGRAM 2 LOCATION

DIAGRAM 3 LOCATION

We will now cut the rear fin hinge mount and forward rudder hinge mount from the 3/16" plywood. See diagram 2 for dimensions. After you cut and sand these parts, drill the required hinge mount bolt holes per diagram. Install the an3-5a hinge mount bolts. Use 1/8"scrap aluminum stock to make a lock between the bolts. This is so after bolts are glued in place they will not move while tightening the nuts. Once you have locked the bolts in place trial fit the mounts to the fin and rudder. Once satisfied with fit, glue assemblies in place and let cure.

While these parts are curing, we can cut the templates for the H.S. airfoil and the vortex endplates. See diagram 2 & 4. Take the cured horiz.stab. panels and draw a center line down each end of panels. Align the templates using the trailing edge ref. 2" from the end of the foam panel. Now align the centerline of the template with the centerline on the foam panel. Use dry wall screws to hold the template in place. This is the time to make sure your alignment is correct. See photo 1. Weight down the foam panel and using your foam cutter cut the airfoil out on each side. You will need to stop and turn over the airfoil to cut out the opposite side. Take your time and do not rush the cut. When you complete the cut pull the airfoil from the mold making sure you DO NOT remove the trailing edge ref block. Lightly sand the airfoil if you should notice high spots. DO NOT change the airfoil shape. Now remove the templates and sand the front of the airfoil flat until the 3/8x11/16 half round stock fit flush to airfoil shape. Glue on the leading edge stock and set aside to cure.

PHOTO 1 LOCATION

PHOTO 2 LOCATION

Once the vert.fin cures, sand the leading edge to match the upper and lower rib contour. Lightly sand the sides of the fin to remove any smooth finish from the factory. We wish to rough this up for a better glass bonding. We will now cut out the bolt thru mounts for the vert.fin from the 1/16"plywood. Each mount has a mininum diameter of 3". Cut out 8 mounts. Place the mounts on the fin and center the mounts as per Diagram 2. The bolt holes will be drilled once the fin is glassed. Center the mounts on the fin and use a felt pen to trace the mount on to the fin. You will notice the rear fin mounts have the sides cut off to fit flush against the hinge mount bracket.Use a single edge razor blade to cut out the circle to a depth of 1/16". Using a scraping motion will take small amounts of the foam off at a time until you reach the desired depth. Once the mounts are flush fitting epoxy into place. Use masking tape to keep the mounts in place and the epoxy from running while curing.

Now contour the rudder to shape. Remember the front of the rudder will be the same width as the fin and taper down to 1/2" at the trailing edge. Once completed, cut out the 1/16" plywood rudder horn mounts and install. Make the trim tab mount of .020 6061-t6 aluminum. The mount is 2"wide x 7"long. Using the same process mount on left side of the rudder. Later the trim tab will be riveted to the mount. See Photo 2. Builder Note: Top hole visible on rear fin mt. photo is no longer needed. Do not make. Also note rear bracket no longer needs upper 3rd hole. The rudder and fin are ready for glassing in this photo.

A word about quality:
Now that all the parts are cut,glued and sanded, its time to check and fill any problem areas. Use Superfil for this job. Understand that the glassing process will not cover up any mistakes,dents or scratches. This is the time to really smooth in those surfaces and be critical with your work.

Let's start by glassing the rudder first. Place the rudder on a piece of scrap foam leaving 2" of exposure under each side. Use duct tape and tape the under side 1" back from the curved surface to catch any stray resin runs. Cut 2 plys of glass the size of the rudder with a 2" over hang on all sides. The first ply should have the grooves running from bottom rear to top front of rudder. The second ply grooves should run 90 degrees to the first ply. Once correct, remove and mix up a small amount of micro-slurry. Pour a small amount in the center of the rudder and use your squeegee to spread over the complete surface. Before laying the first ply take pure epoxy and stemple edge of curved areas down the underside 1". This will allow the glass to have a tacky surface to stick to when you contour around the underside edges. Lay on first ply of glass checking the direction of grooves. Insure the grooves are straight to provide the most strength. Pour on pure epoxy and squeegee out wetting the surface completely. Trim excess glass to 1/4" on flat drop off surfaces and 1" past center of curved surfaces. Wrap the glass under the curved surfaces and stemple into place with pure epoxy. Now add 2nd layer of glass and complete as before. Once completed check for excess epoxy on layup by using light pressure and pulling the squeegee across the glass. If you see a ridge of epoxy when you stop then you will need to make light passes and remove excess epoxy. Use a light to check the layup. There should not be any silver looking areas indicating lack of epoxy or any excess wet areas indicating to much epoxy left on layup. Once your happy with layup cut and place peel ply on the top side of the curved areas. This is so you don't have to sand as much to prep the surface for the wrap around when you do the opposite side. Wait a couple of hours until the layup has the consistancy of a chewing gum feel and trim the flat sides up to the edges with a razor blade. Lay aside to cure 24 hrs.

Using the same technique glass the first side of the fin. The first ply grooves run from bottom front to top rear. The second ply grooves 90 degrees to first. Finish out as above and set aside to cure. After fin and rudder have cured, remove peel ply and sand. Complete glassing on the opposite sides. Lay peel ply down on all curved glass ends to seal glass threads. Let cure, remove peel ply and prep sand for primer.

We will start with the bottom of the horiz. stab. Make sure the trailing edge ref block is facing down and your duct tape is in place. Place a strip of peel ply down the length of the trailing edge and run down the ends of the block taping tightly in place. Stemple pure epoxy on peel ply and under leading edge, wetting completely. Use micro-slurry and wet out foam being careful not to get on trailing edge peel ply. Using the usual technique glass the H.S. with the first ply grooves 45 degrees to the leading edge and the second ply 90 degrees to the first. Set aside and complete the other horiz. stab. Don't forget as you finish a side to place a 2"strip of peel ply *running* the chord width on both ends. This will be for connecting root to fin and vortex tip to stab tip. Make sure peel ply doesn't cover last 2" of chord on the bottom side of layups. Let cure a couple of hours. Once the trailing edge is tacky make up a batch of dry micro and fill the trailing edge.Take peel ply and lay over the d/m. Using your squeegee, level out and contour the trailing edge to shape. Complete both horiz.stabs and set aside to cure 24 hrs. When cured sandout the horiz. stabs and remove the trailing edge ref.blocks. A hacksaw blade seems to work best. Remove the peel ply from the trailing edge. Sand the trailing edge to shape without sanding the bare glass as you contour. Use micro-slurry and wet out foam but DO NOT get slurry on trailing edge bare glass. Use pure epoxy and wet the bare glass trailing edge. Lay the glass and continue as before to finish.

While the H.Stabs are curing let's build the fin/rudder hinges. Use 1" 6061-t6 alum.angle and cut 4 pieces 1/8"less than your rudder /fin width. Match drill bolt holes with your completed hinge mounting bolts as a guide. Drill the holes for the hinge bolts. When pre installing to check fit a washer goes between each hinge. Make the rudder horns and fairlead arms from 2"x1"mast stock. See diagram 3. Use left over 1" round tubing from strut assembly 1"long to build fairlead block. Cut one side the full length of the tubing. Put in vise and bend around 1/2"wooden dowel. The ends will flatten and be riveted to the fairlead arms. Drill a 1/8" hole thru the dowels for the cable. Attach fairlead arms to the bottom of the front fin bracket with 1/8" rivets. See photo 3.

PHOTO 3 LOCATION.

Once horiz.stabs have cured reinstall the root templates. Mark tube spar locations. Drill spar locations with 3/8" drill bit to a depth of 5". It is critical the holes are drilled exactly parallel to the length of the stab. Drill 3/8" holes in fin at correct location using template as a guide. Glue 3/8"x12" tubing in right H.S. front and rear holes to a depth of 5". Glue 1/2" tubing into left H.S.

to a depth of 5". Set aside and let cure 24hrs. After cured remove peel ply and lightly sand horiz.stabs. Slide left H.S. into fin holes until flush with opposite side. Slide right H.S. into 1/2" tubing until flush with fin. It is critical that you have a flush fit to the fin, so sand as needed. When satisfied with fit remove and mix up some pure epoxy. Make a holding jig from scrap foam to hold horiz.stabs in correct location. Epoxy the H.S. foam roots, outside 3/8" and 1/2" tubing. Install 1/2"tubing and H.S. to fin followed by sliding in 3/8" tubing into the 1/2"tubing until H.S. flush to fin.

Let setup for about 2-3hrs and check alignment frequently. Cut 8 plys of glass 5"x12" long. Lay first ply down and wet out at 45deg. to fin and hor.stab. Lay 2nd ply down 90deg. to first. Stemple and wet out glass. When completed place peel ply on each side of glass and wet out to smooth out edges.

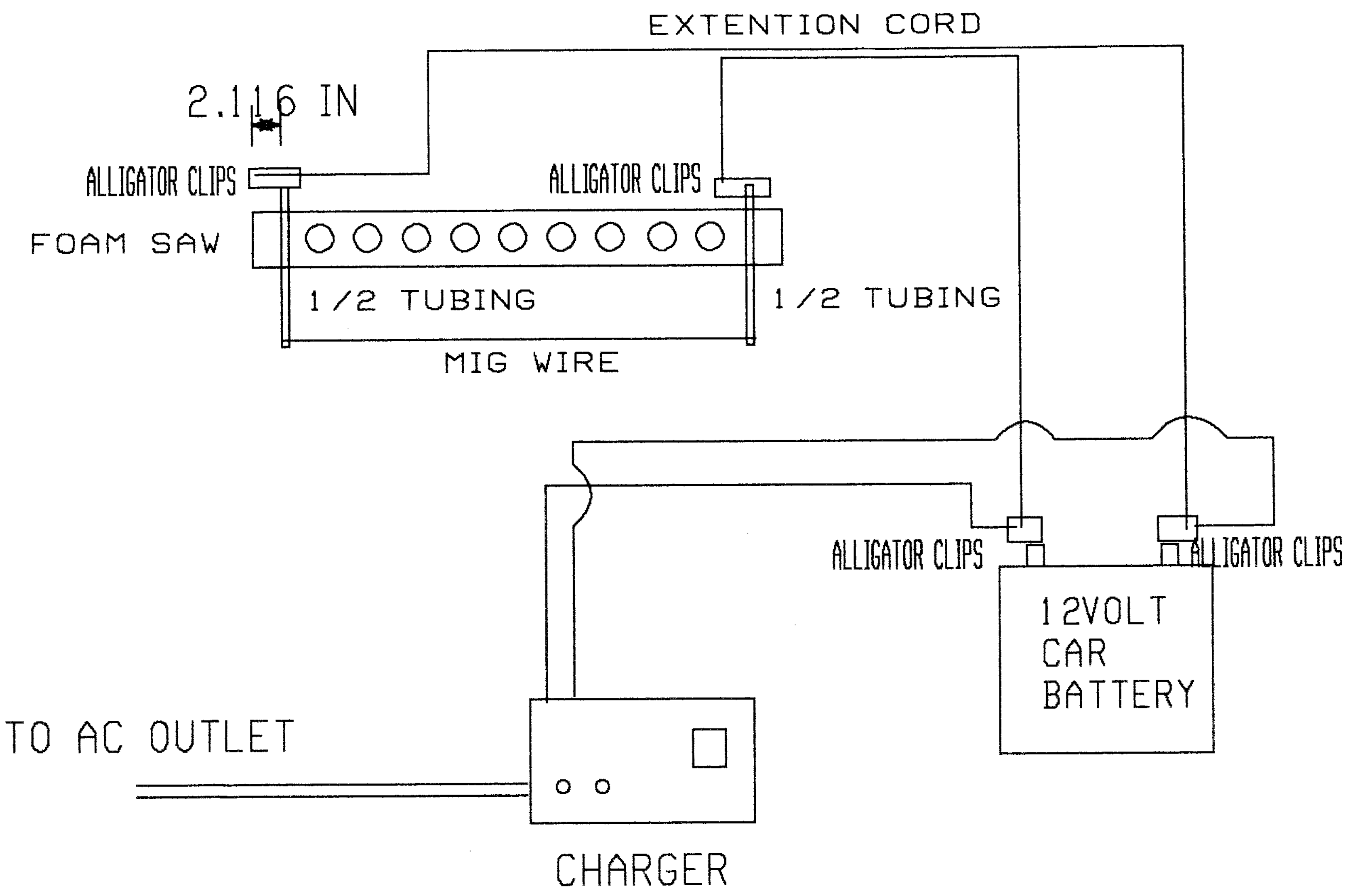
Complete both top horiz.stab to fin connections and let cure. After cure complete opposite side in the same manner. If you would like you may glue on and glass vortex tips at the same time you glass each fin connection using same technique. Once layup cures remove all peel ply and sand to a smooth finish. Use Superfil to fill any small pin holes etc and to contour front and rear of H.S. to fin. You may wish to superfil the whole surface and sand to a glass finish before you prime. This is fine but remember what you don't sand off will leave extra weight. Seal the wood tips for painting. Use automotive sandable grey primer to do final finish work. Put on a few good coats since this is also your U.V. protectant. When your happy with the finish use your favorite enamel colors and a few coats of clear enamel to finish the job.

Strut Assembly:

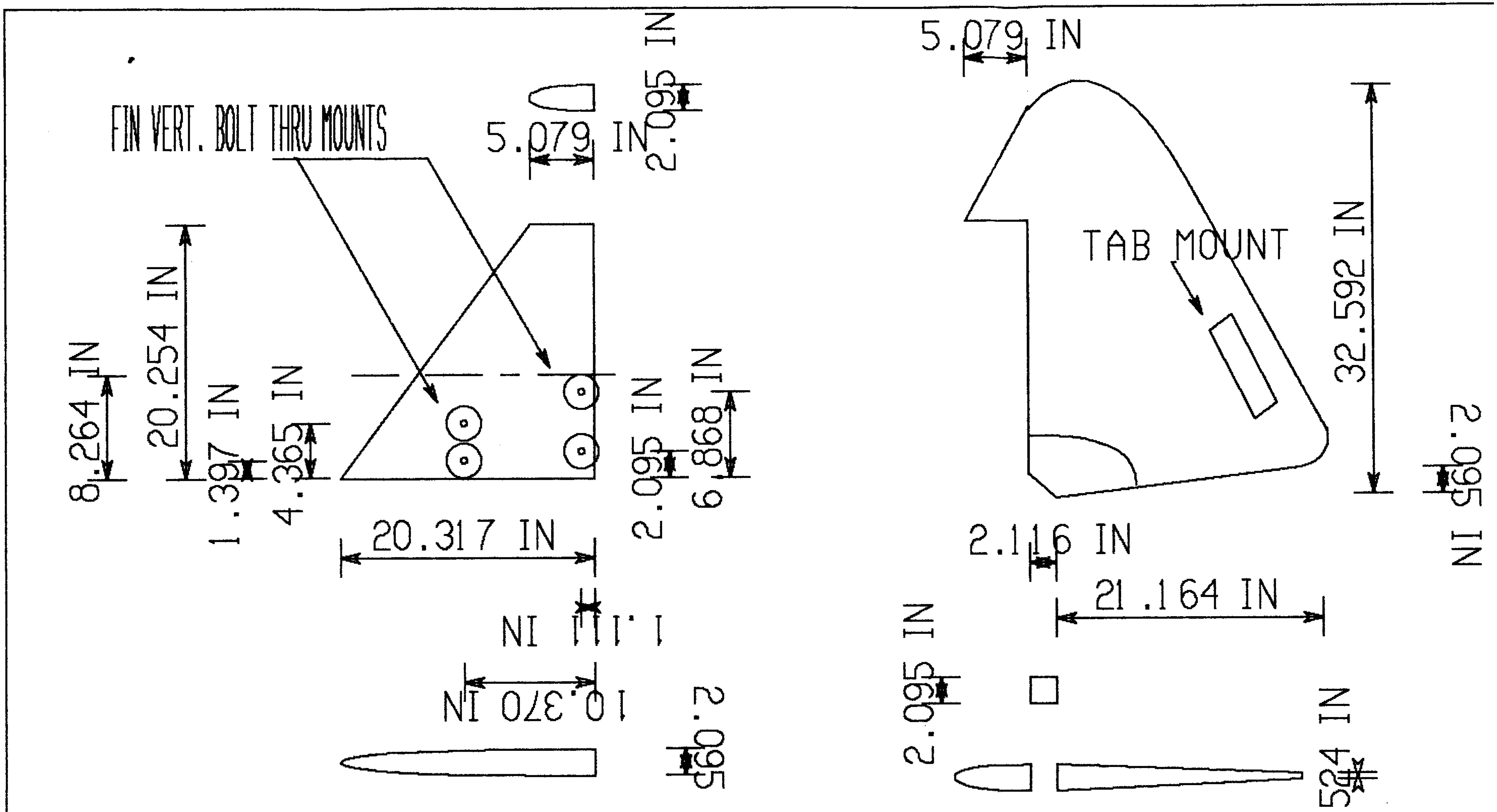
Make the vert.fin. brackets per diagram 4. Install brackets and set fin on the tail boom. The rear of the fin should be flush to the end of the boom. Match drill the vert. fin. holes using the fin brackets as a guide. Install Fin assembly with an3-26a bolts and tighten. DO NOT OVERTIGHTEN NUTS and deform the vert.fin glass. Make the strut brackets from 2"x1" spare mast stock. See diagram 3. Build down struts per diagram. Replace the front top tail wheel bracket bolt with a an3-31a bolt. Install the brackets in this sequence: washer,bracket,washer,bolt thru boom,washer,bracket,washer and nut. Use extra washers on end of bolt as needed. Install the 1/2"x12"down struts and extra 2 brackets to end of each strut swinging up flush with H.S. surface using large flat washer between bracket and fiberglass. Mark the location of the bolt hole making sure the strut is 90 deg. to the boom. Drill holes and install bracket with following sequence: use an3-26a bolt down thru hole with 3 washers and one large washer against glass, thru glass, one large washer,smaller washers as needed,nut. All nuts installed should have a min. of 3 threads showing when tight. DO NOT OVERTIGHTEN NUTS and put any compression on horiz. stab. Cut a piece of .020 alum sheet 7"x4" for the trim tab. Clean, prep and paint the aluminum tab. Install tab to rudder tab mount with 1/8" pop rivets. Now reach over your right shoulder with your left hand and pat yourself on the back for a job WELL DONE.

As you can see building with composites isn't that hard. I hope you enjoyed the building experence and will use these techniques on future projects.

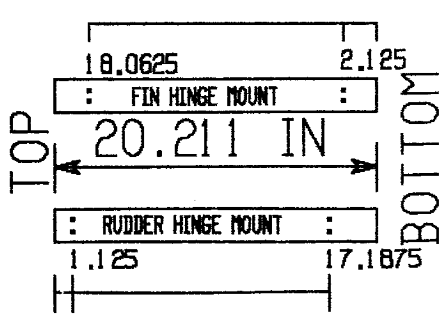
DIAGRAM 1.



SEE TEXT FOR DETAILS OF PARTS.



SEE TEXT FOR MATERIAL DETAILS



DOWN STRUTS.
EACH STRUT IS 12"LONG X 1/2" X.058
6061-T6 ALUM.ROUND TUBING.
DRILL 1 HOLE AT EACH END
1/2"FROM END WITH 3/16"BIT.
HOLES SHOULD ALIGN FROM END TO END

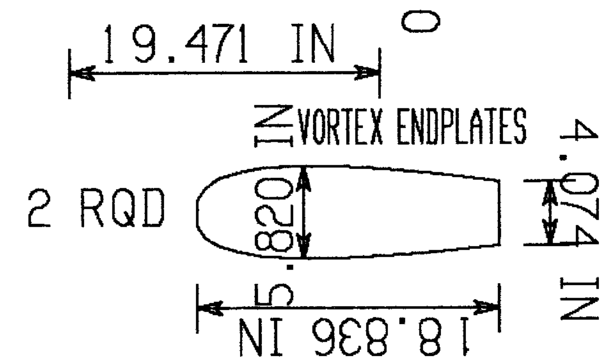
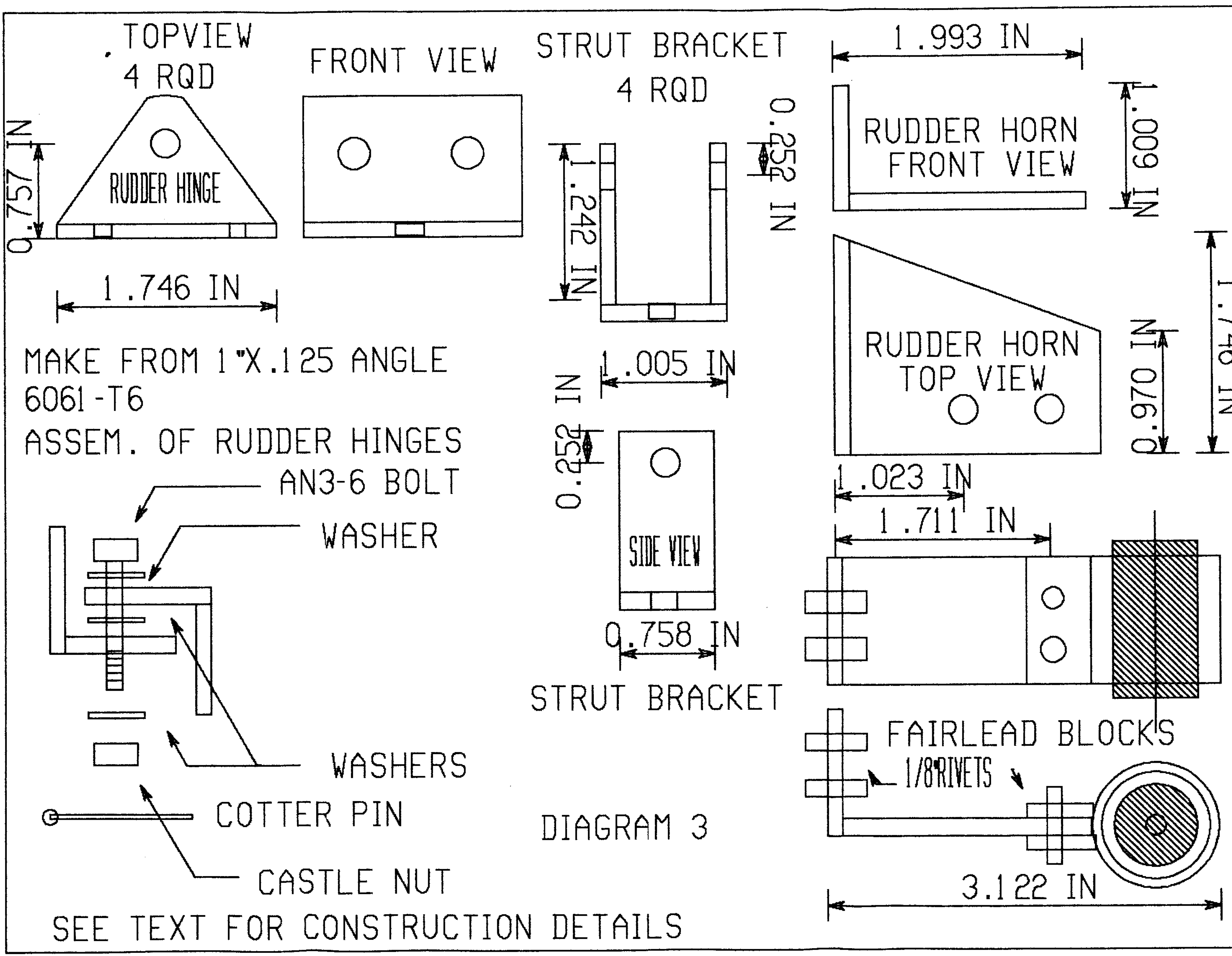
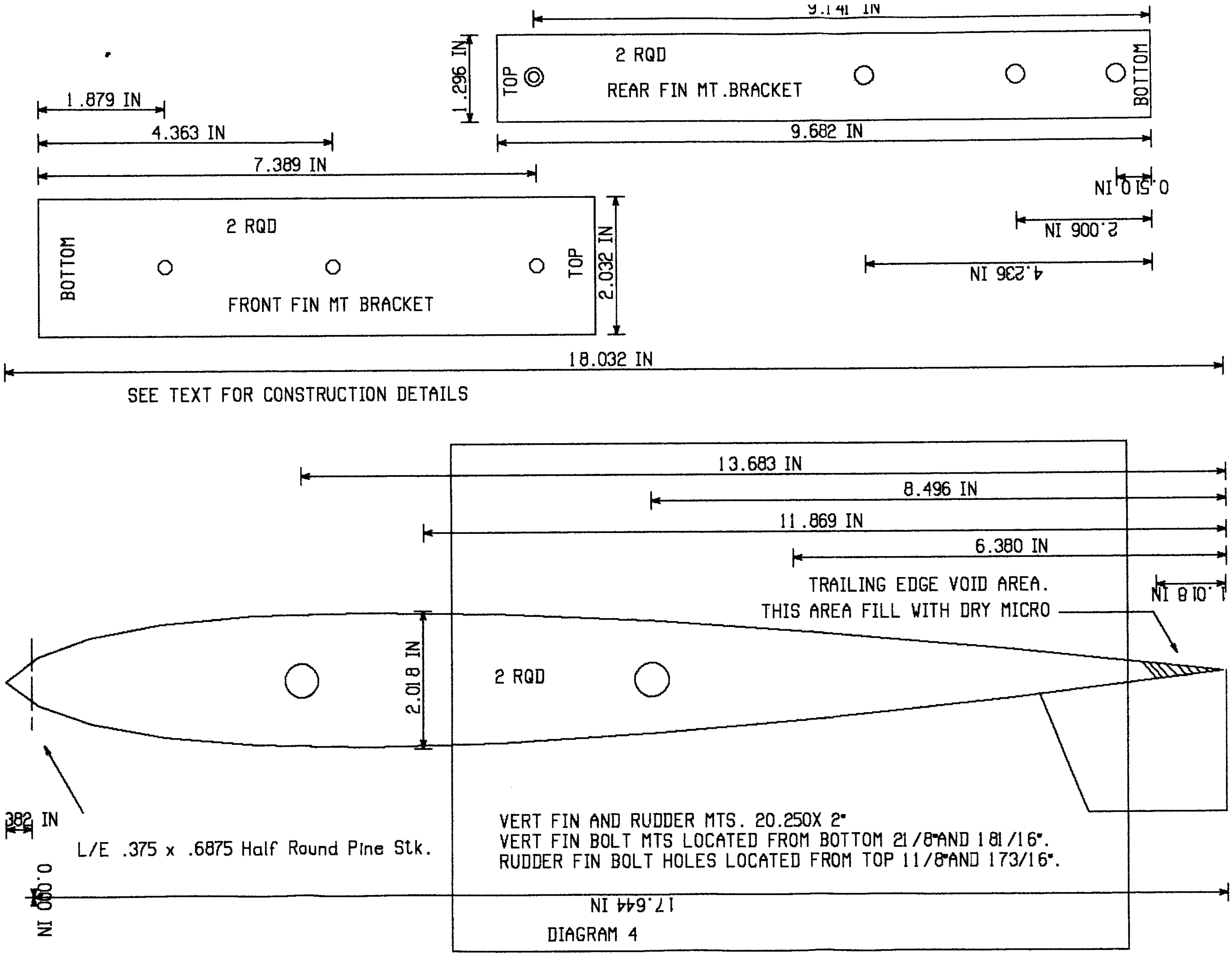


DIAGRAM 2



TOPVIEW
4 RQD
RUDDER HINGE
0.757 IN
1.746 IN
FRONT VIEW
STRUT BRACKET
4 RQD
1.242 IN
0.252 IN
1.005 IN
SIDE VIEW
0.758 IN
STRUT BRACKET
RUDDER HORN
FRONT VIEW
1.993 IN
1.009 IN
RUDDER HORN
TOP VIEW
0.970 IN
1.746 IN
1.023 IN
1.711 IN
FAIRLEAD BLOCKS
1/8"RIVETS
3.122 IN
MAKE FROM 1"X.125 ANGLE
6061-T6
ASSEM. OF RUDDER HINGES
AN3-6 BOLT
WASHER
WASHERS
COTTER PIN
CASTLE NUT
DIAGRAM 3
SEE TEXT FOR CONSTRUCTION DETAILS


9.141 IN
2 RQD
TOP
REAR FIN MT.BRACKET
BOTTOM
1.296 IN
9.682 IN
1.879 IN
4.363 IN
7.389 IN
0.510 IN
2.006 IN
4.236 IN
2 RQD
BOTTOM
FRONT FIN MT BRACKET
TOP
2.032 IN
18.032 IN
SEE TEXT FOR CONSTRUCTION DETAILS
13.683 IN
8.496 IN
11.869 IN
6.380 IN
TRAILING EDGE VOID AREA.
THIS AREA FILL WITH DRY MICRO
1.018 IN
2.018 IN
2 RQD
.382 IN
L/E .375 x .6875 Half Round Pine Stk.
VERT FIN AND RUDDER MTS. 20.250X 2"
VERT FIN BOLT MTS LOCATED FROM BOTTOM 21/8"AND 181/16".
RUDDER FIN BOLT HOLES LOCATED FROM TOP 11/8"AND 173/16".
0.000 IN
17.644 IN
DIAGRAM 4

GYROBEE MASTER HARDWARE LIST

PART CATEGORY	SIZE/ DESCRIPTION	QUANT.	PHASES USED
AN3 BOLTS	6A	14	6-8
	7A	26	8-9
	11A	4	3
	14A	2	4
	26A	20	1, 5, 10
	30A	1	7
	32A	2	13
AN4 BOLTS	6A	7	6, 9, 13
	7A	4	8
	11A	8	2
	17A	6	3-4
	20A	2	3
	21A	10	1, 2, 13
	22A	2	8
	26A	12	1, 3, 9-13
	27A	2	10
	30A	1	6
	31A	1	3
	34A	2	13
	37A	1	
	52A	1	6
AN8 BOLTS	32 (un-drilled)	1	8
AN428 EYE BOLT	20	1	
WASHERS	AN960-10	175	AS NEEDED
	AN960-416	150	AS NEEDED
	AN960-816	2	8
	AN970-4	20	3, 6, 13
	AN970-5	10	10
	AN970-6	4	13

CASTLE NUTS	AN310-8 + cotter pin	1	8
STOP NUTS	AN316-4	6	3, 8
	AN316-7	1	
NYLOCK NUTS	AN365-1032	75	AS NEEDED
	AN365-428	60	AS NEEDED
POP-RIVETS	3/16”	13	
STAINLESS THIMBLE	AN100-4	4	12
SHACKLES	AN115-21	4	8, 12
ROD INSERTS	AN490HT8P	4	3
HEIM ROD ENDS	HM-4	2	
	HF-4	6	
NICOPRESS SLEEVES	NICO-28-2-G 3/32"	8	12
CLEVIS PINS	MS20392-2C11	2	12
COWLING PINS	F5110 (LEAF) ¾ "	2	
STAINLESS CONTROL CABLE	3/32"	25 FT	
THROTTLE QUADRANT	H701 (LEAF) PUSHER	1	
FUEL FITTING	AN848-40	1	

FUEL COMPONENTS	Vinyl fuel tube	4 in.
	Fuel line (3/8 OD)	5 ft.
	Fuel filter	1
	Primer bulb	1
	Hose clamps	7
ROTOR PITCH SPRING	5/8" x 6"	1
TOGGLE SWITCH	DPDT HVY DUTY	1

HARDWARE NOT SPECIFIED:

KB2	Tail group hardware
Rotor	Head mounting hardware

This listing represents the work of a number of builders, including **Scot White**, **Doug Riley**, and **Jim Layer**. While every effort has been extended to make this list accurate and complete, errors or omissions are always possible. With respect to common items such as nuts and washers, it is always a good idea to order more than needed, as they are easy to misplace.

GYROBEE/HONEY BEE DIGIPOD MOUNT

The ***Digipod*** mount for the ***Gyrobee*** is built up of 0.125 inch 6061-T6 strip stock, 1.5 inches wide. This material is available from Sky Sports in Linden, MI, the source for the fuel sender and the Winter venturi ASI sender. Two pieces, each 13 inches long, are used to make the main support pylon while a third piece is used to make the mounting cradle as shown on the diagram on the following page. The ends of the cradle/U-bracket should have the corners radiused so there are no sharp edges.

The cradle or U-bracket is attached to the vertical pylon pieces using two 1.5-inch pieces of 1-inch aluminum angle stock. I used a total of four 3/16 bolts on either side on the prototype, but there is no reason why you shouldn't be able to use pop-rivets instead. Just make sure the vertical supports are centered on the U-bracket and spaced 2.25 inches apart!

The lower ends of the vertical support pieces are drilled to match the holes on the nose-block/cheek plates. The existing pair of AN4 bolts on the nose will need to be replaced with bolts that are 1/4 inch longer to account for the additional thickness of the vertical support pieces.

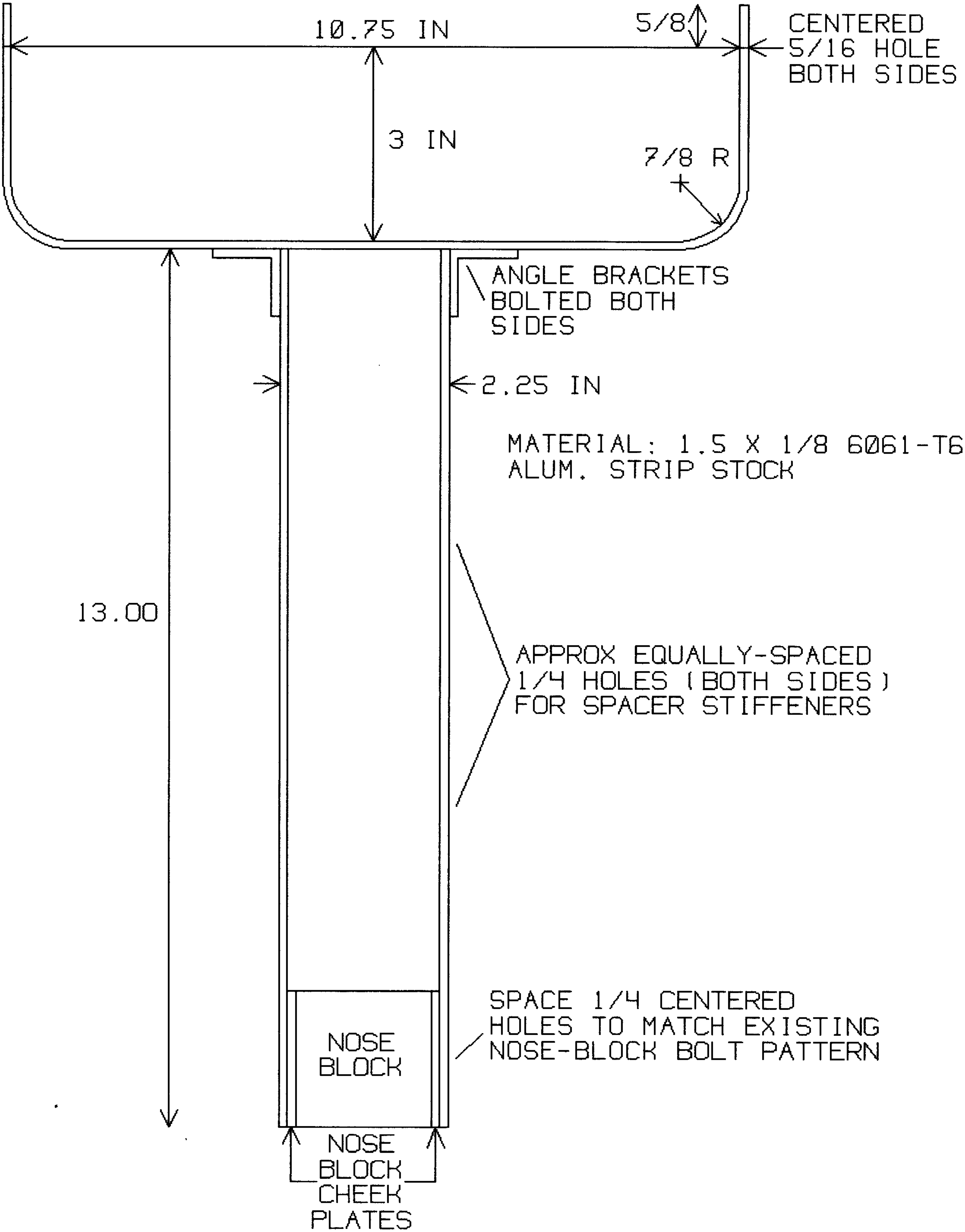
The next step is to stiffen the support column in one of two ways:

- Make some shear webs of light aluminum sheet stock and pop-rivet them into place, front and back, between the vertical support pieces. This is what I did on the prototype ***Gyrobee***.

- For the ***Honey Bee*** mount, a pair of AN4 bolts with 2.25 inch 3/8 OD aluminum tube spacers were used to tie the two vertical support pieces together.

Finally, you can make a mounting bracket for the venturi ASI sender and mount the venturi on the right side of the U-bracket/cradle.

Numerous pictures of the ***Gyrobee*** on the web site show the mount, so between the drawing here and the photos, you should be able to figure it out.


10.75 IN
5/8
CENTERED
5/16 HOLE
BOTH SIDES
3 IN
7/8 R
ANGLE BRACKETS
BOLTED BOTH
SIDES
2.25 IN
MATERIAL: 1.5 X 1/8 6061-T6
ALUM. STRIP STOCK
13.00
APPROX EQUALLY-SPACED
1/4 HOLES (BOTH SIDES)
FOR SPACER STIFFENERS
SPACE 1/4 CENTERED
HOLES TO MATCH EXISTING
NOSE-BLOCK BOLT PATTERN
NOSE
BLOCK
NOSE
BLOCK
CHEEK
PLATES