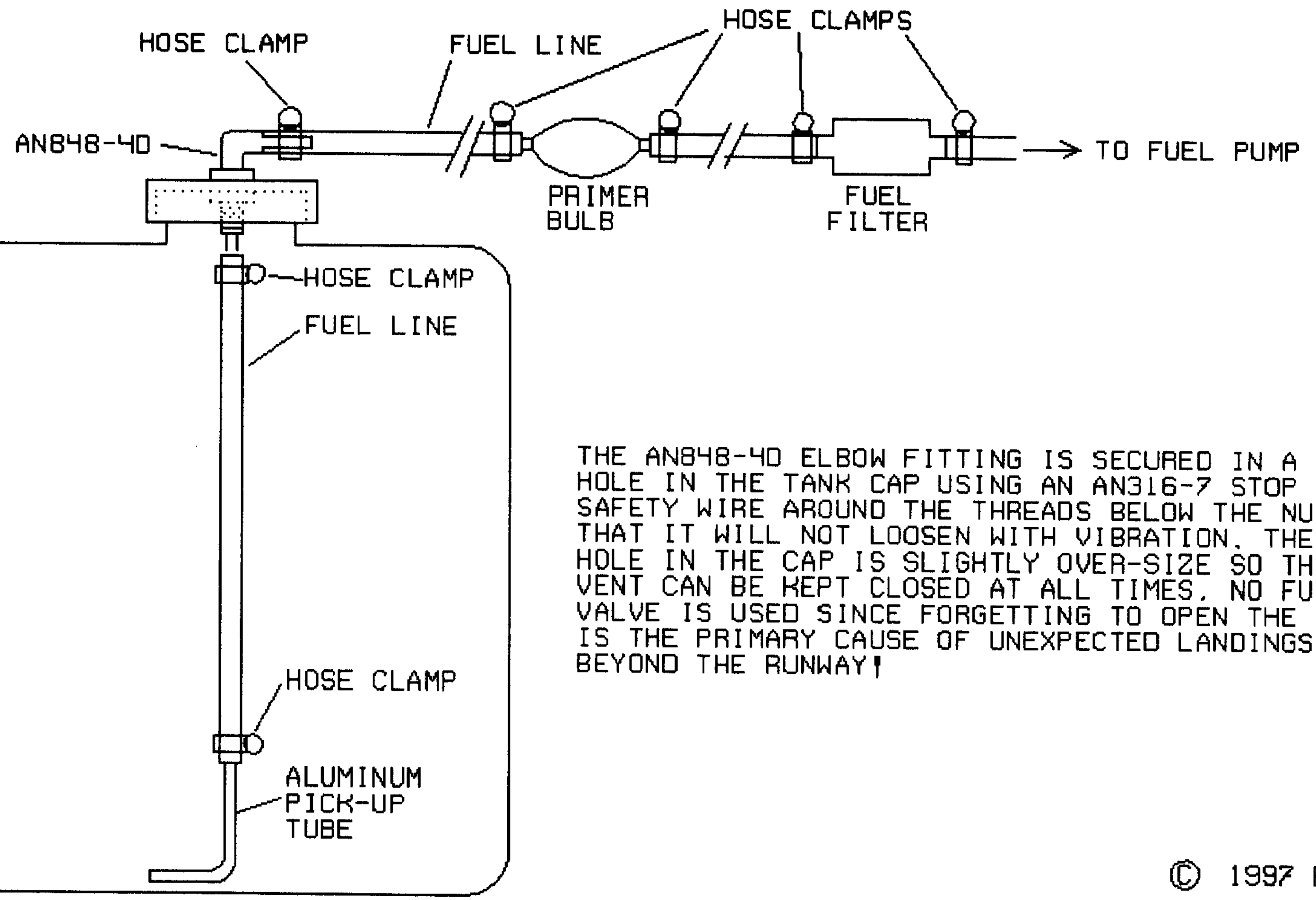

THE AN848-4D ELBOW FITTING IS SECURED IN A 1/2 INCH HOLE IN THE TANK CAP USING AN AN316-7 STOP NUT. WRAP SAFETY WIRE AROUND THE THREADS BELOW THE NUT TO ASSURE THAT IT WILL NOT LOOSEN WITH VIBRATION. THE 1/2 INCH HOLE IN THE CAP IS SLIGHTLY OVER-SIZE SO THE TANK VENT CAN BE KEPT CLOSED AT ALL TIMES. 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!

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

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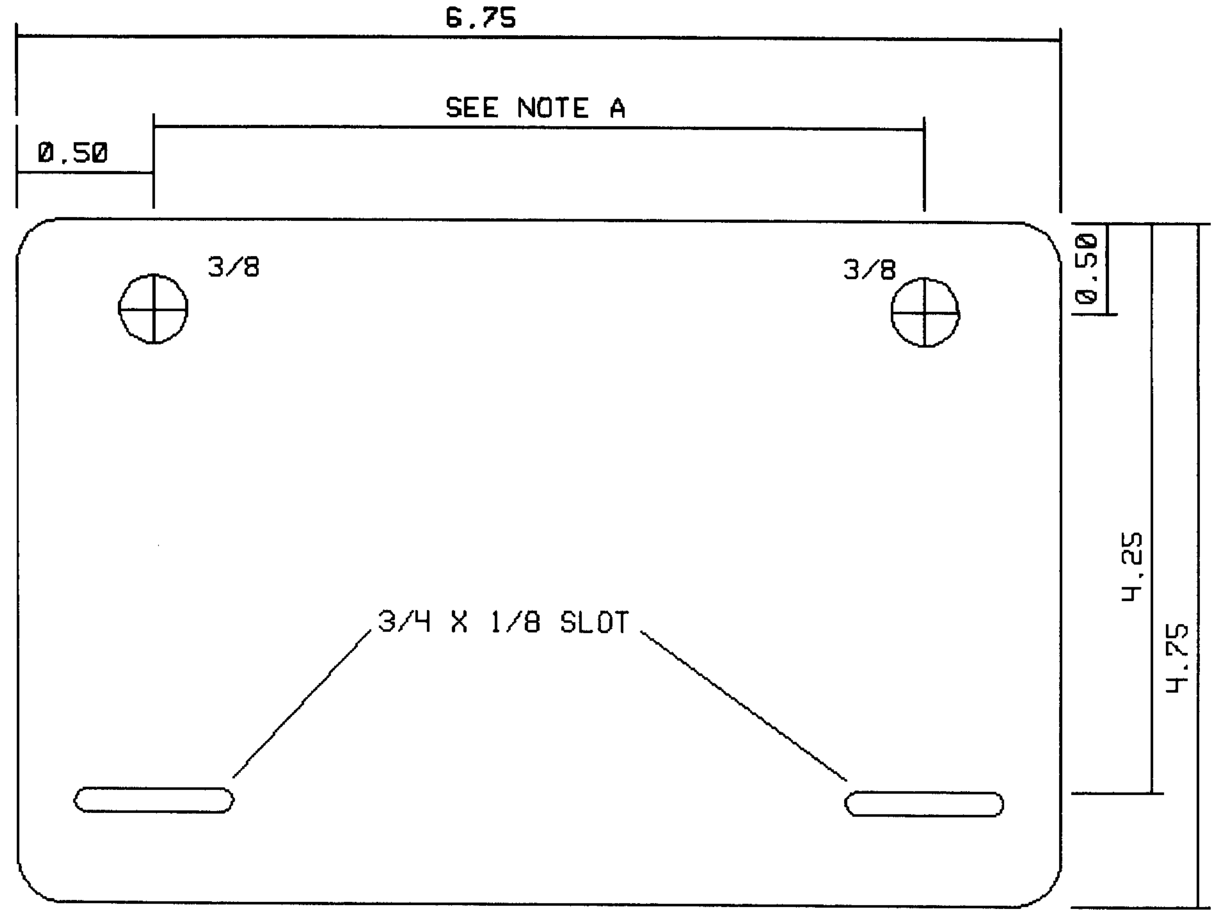


MATERIAL: 0.063 THK STEEL SHT STOCK

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

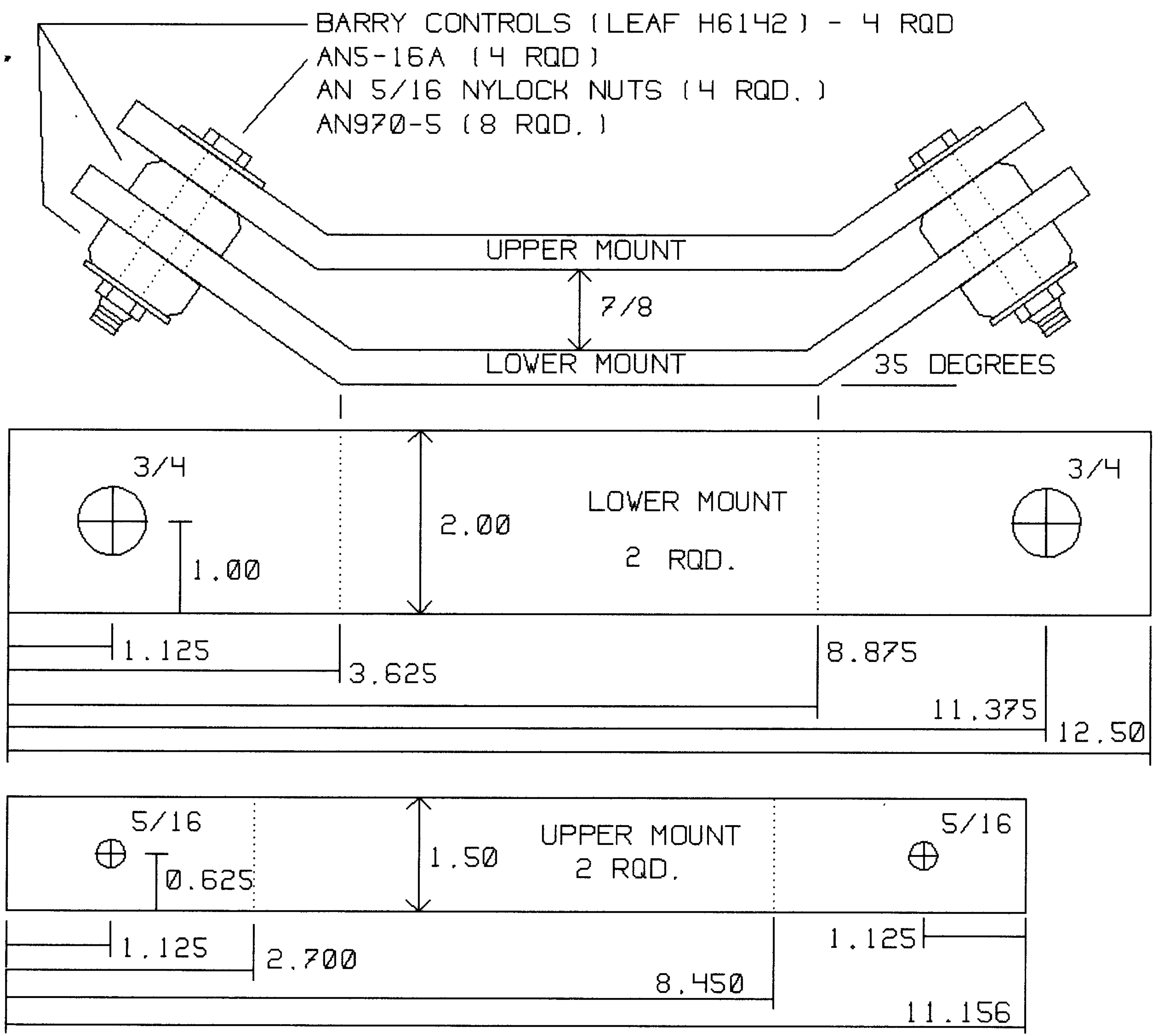
LEAF DYNAFOCAL ENGINE MOUNT

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
1.00
2.00
LOWER MOUNT
2 RQD.
3/4
1.125
3.625
8.875
11.375
12.50
5/16
0.625
1.50
UPPER MOUNT
2 RQD.
5/16
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)

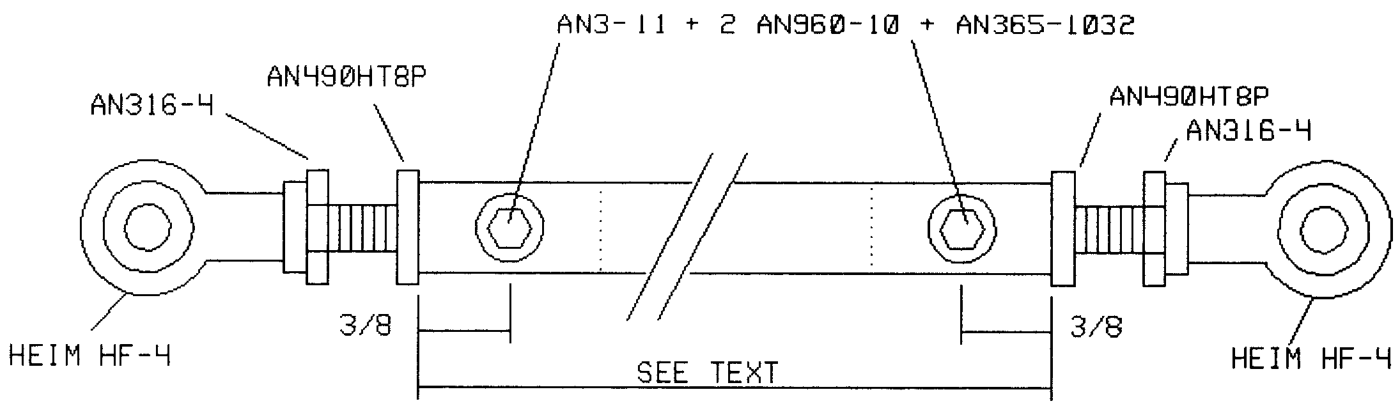
Assembly:

- 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

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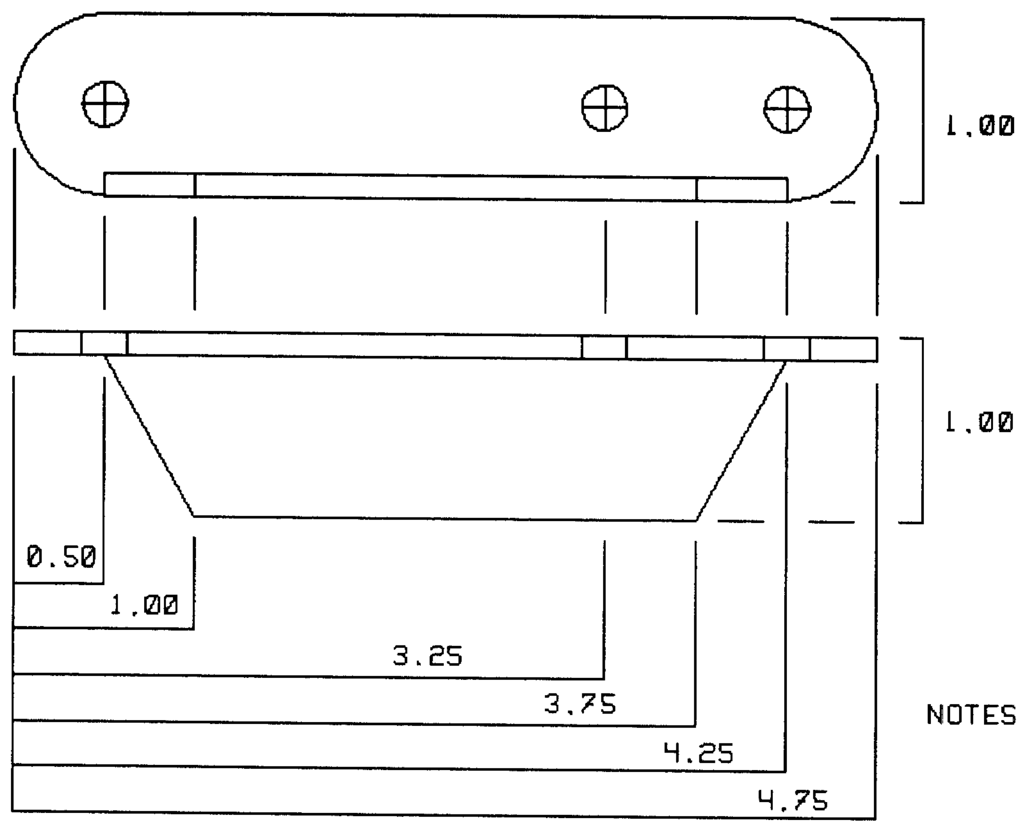
The GYROBEE	DATE: MAY 98 REV: 2.10
DRAWING: ROTOR CONTROL RODS (2 RQD) G15-1	SCALE: INCHES PAGE OF



NOTES: ALL DIMENSIONS INCHES
ALL HOLES Ø.25 INCH

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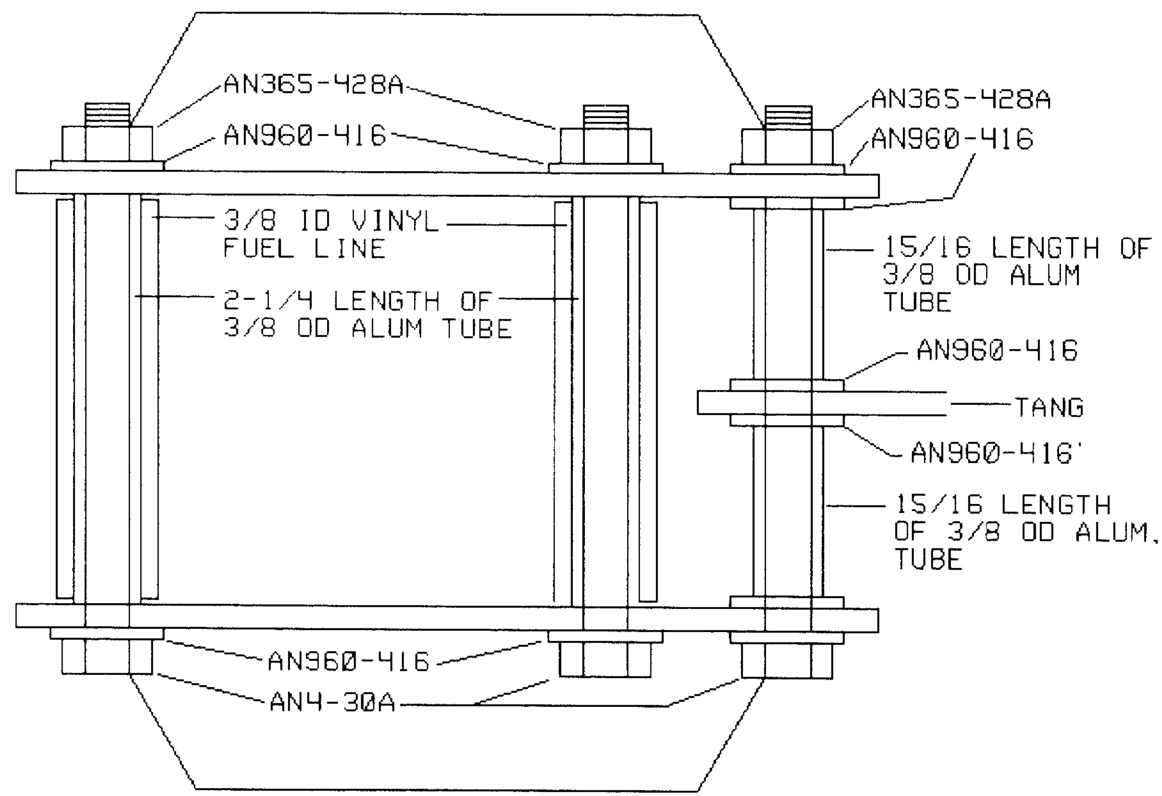
The GYROBEE	DATE: Ø59Ø REV: 1.Ø
DRAWING: PITCH SPRING TENSION BRACE G15-2 (2 RQD), SECOND IS OPP.	SCALE: NA PAGE 1 OF 2



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.

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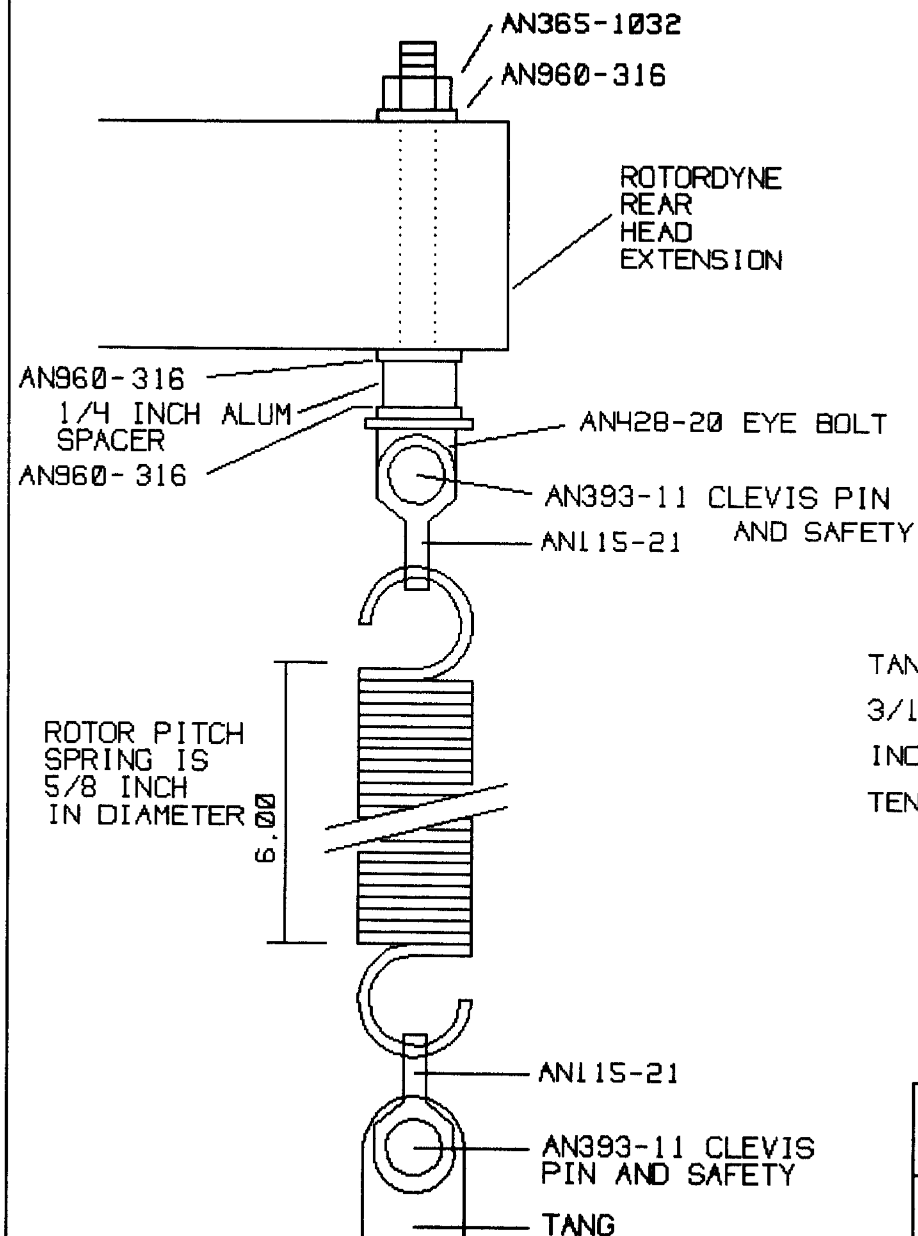
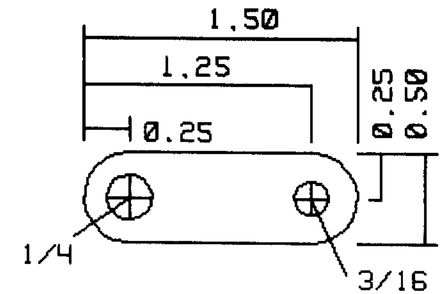
The GYROBEE	DATE: MAY 90 REV:
DRAWING: TENSION SPRING BRACE ASSEMBLY G15-3	SCALE: NA PAGE 2 OF 2





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.

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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)

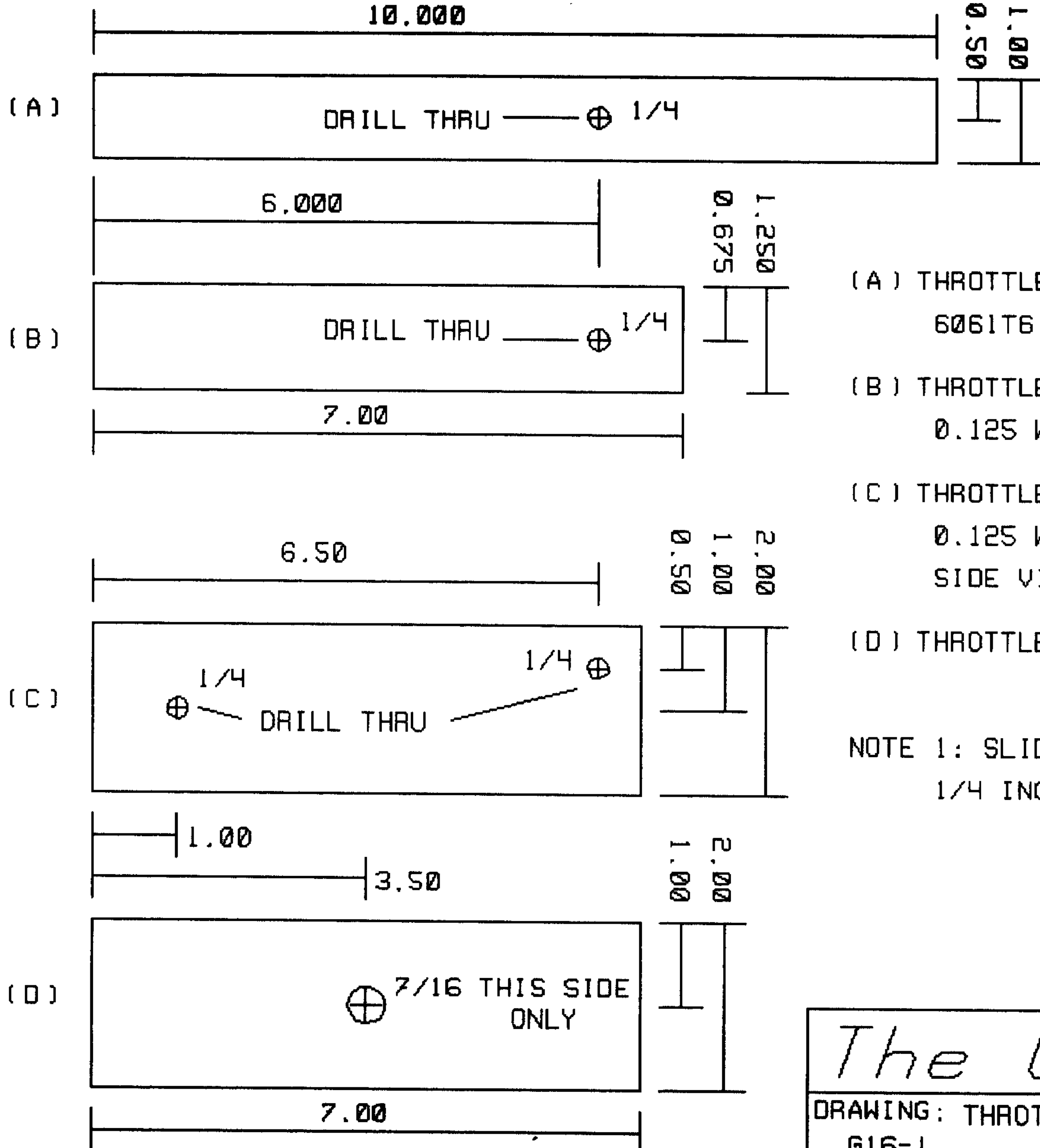
Other Components:

- 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

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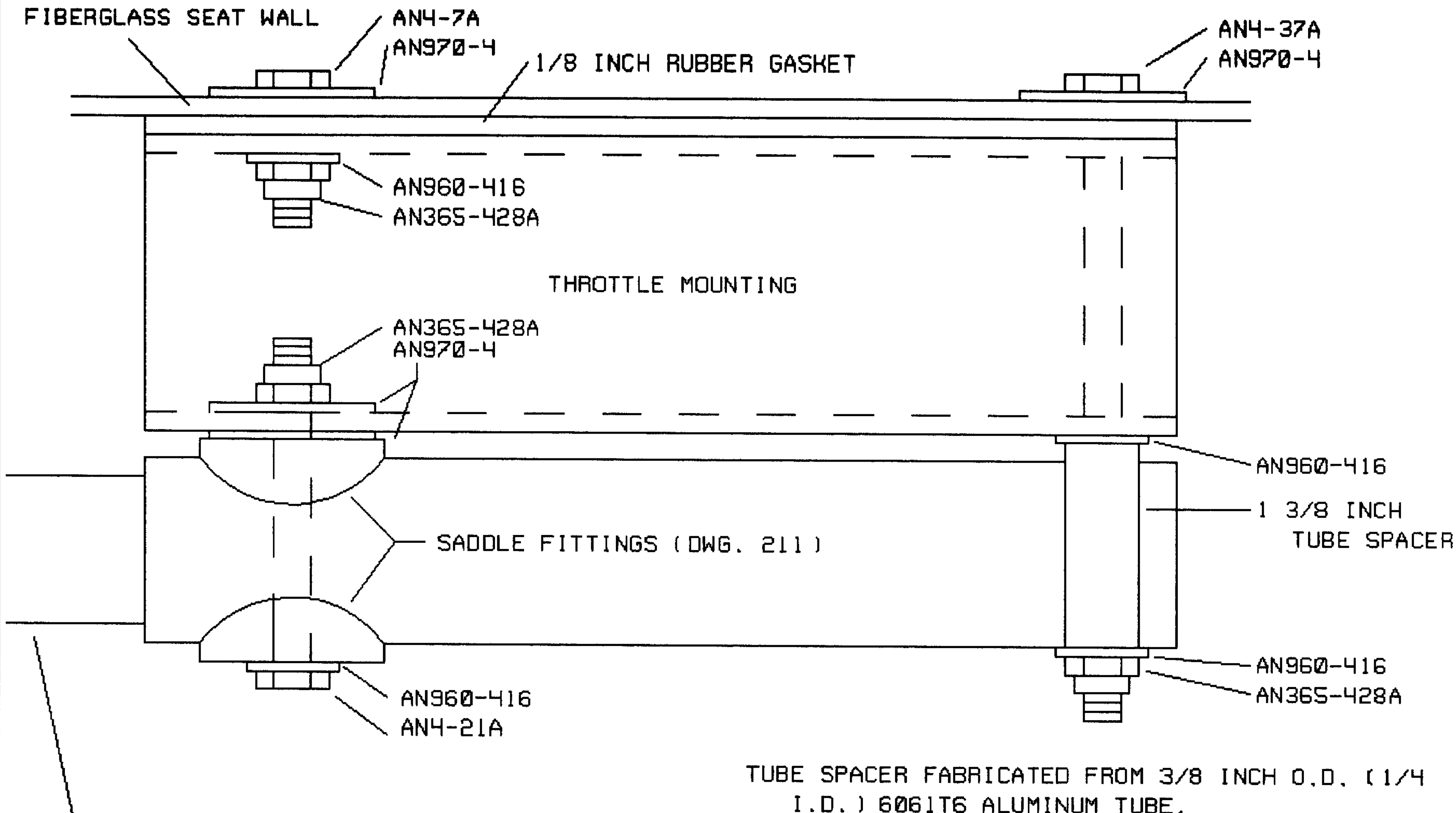
The GYROBEE	DATE: MAY 90 REV: 1
DRAWING: THROTTLE COMPONENTS G16-1	SCALE: PAGE OF



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

DETAILS, DETAILS, DETAILS

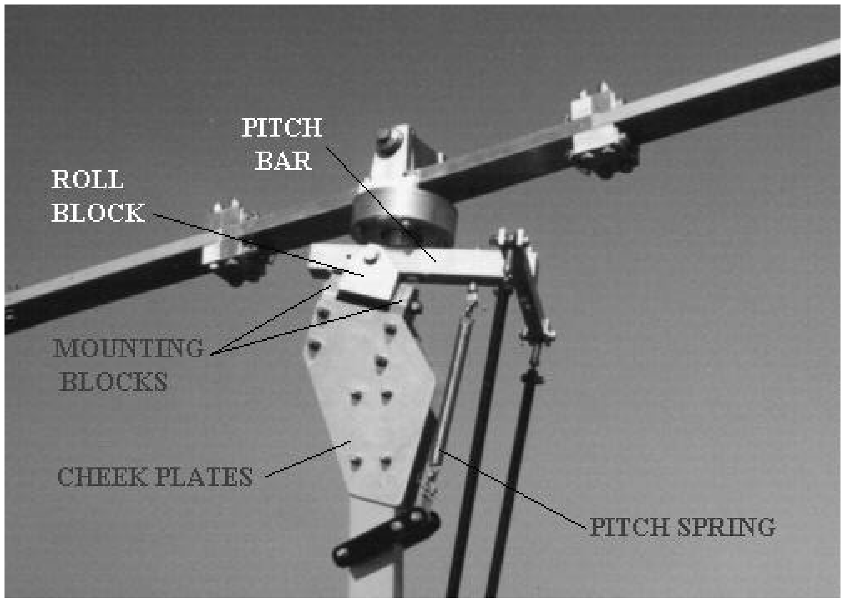
The aircraft is essentially done at this point, although there are still things that need to be done:

- **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^o right and 11^o 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:
>
> $$\mathbf{HA = RL - (HT \times 0.5)}$$
>
> 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:
>
> $$\mathbf{HA = 20 - (20 \times 0.5)}$$
>
> $$\mathbf{HA = 20 - 10}$$
>
> $$\mathbf{HA = 10\ degrees}$$

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.

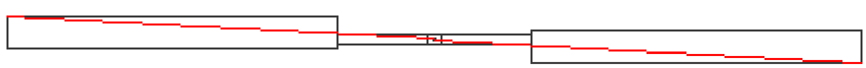
We use the longer rods, so that one-inch is displacement is equal to 1 degree of pitch. To set the blades at +0.75 degrees, for example:

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 hom 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.

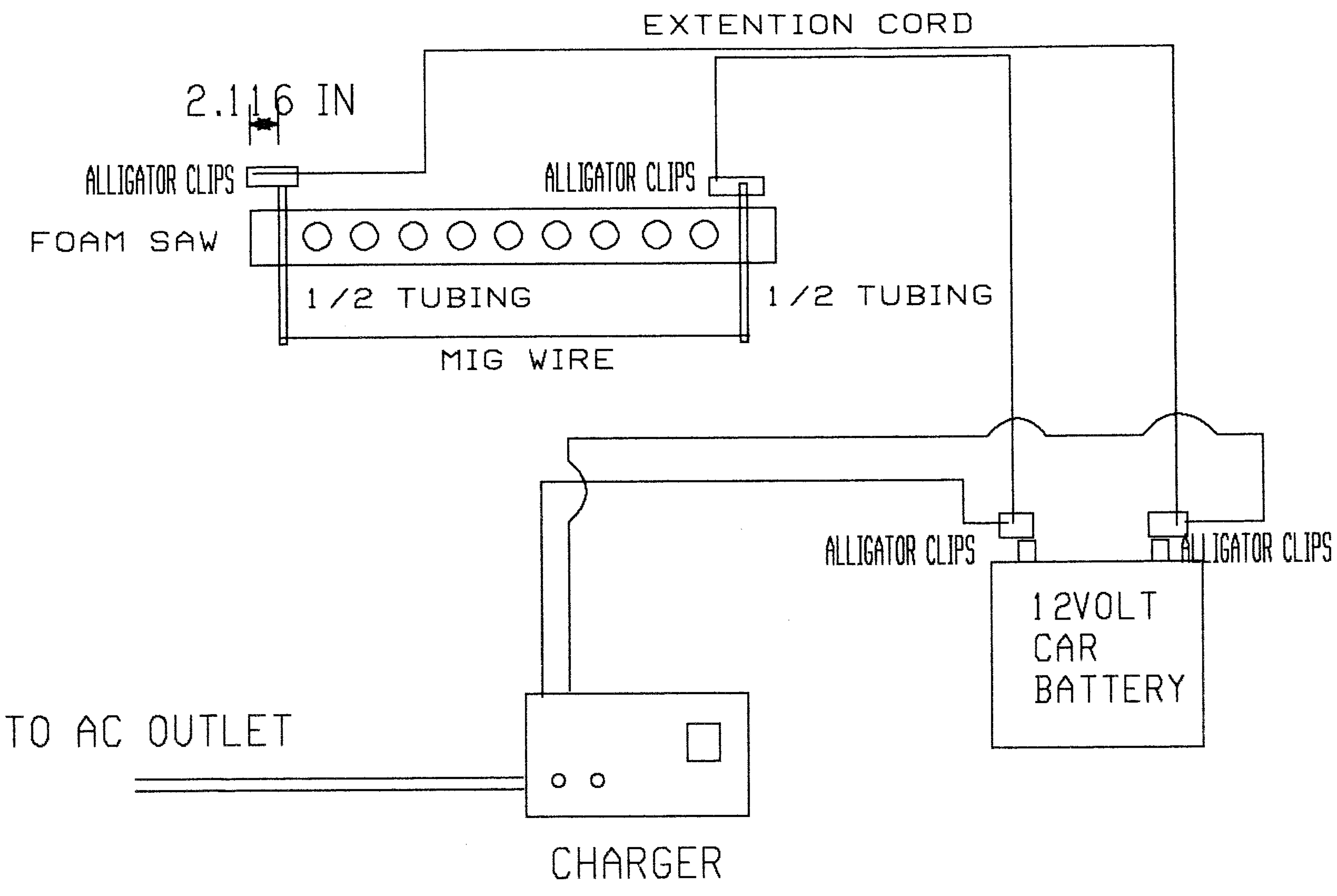
Complete both top horiz.stab to fin connections and let cure. After cure complete opposite side in the same manner. If you would like you may glue on and glass vortex tips at the same time you glass each fin connection using same technique. Once layup cures remove all peel ply and sand to a smooth finish. 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.

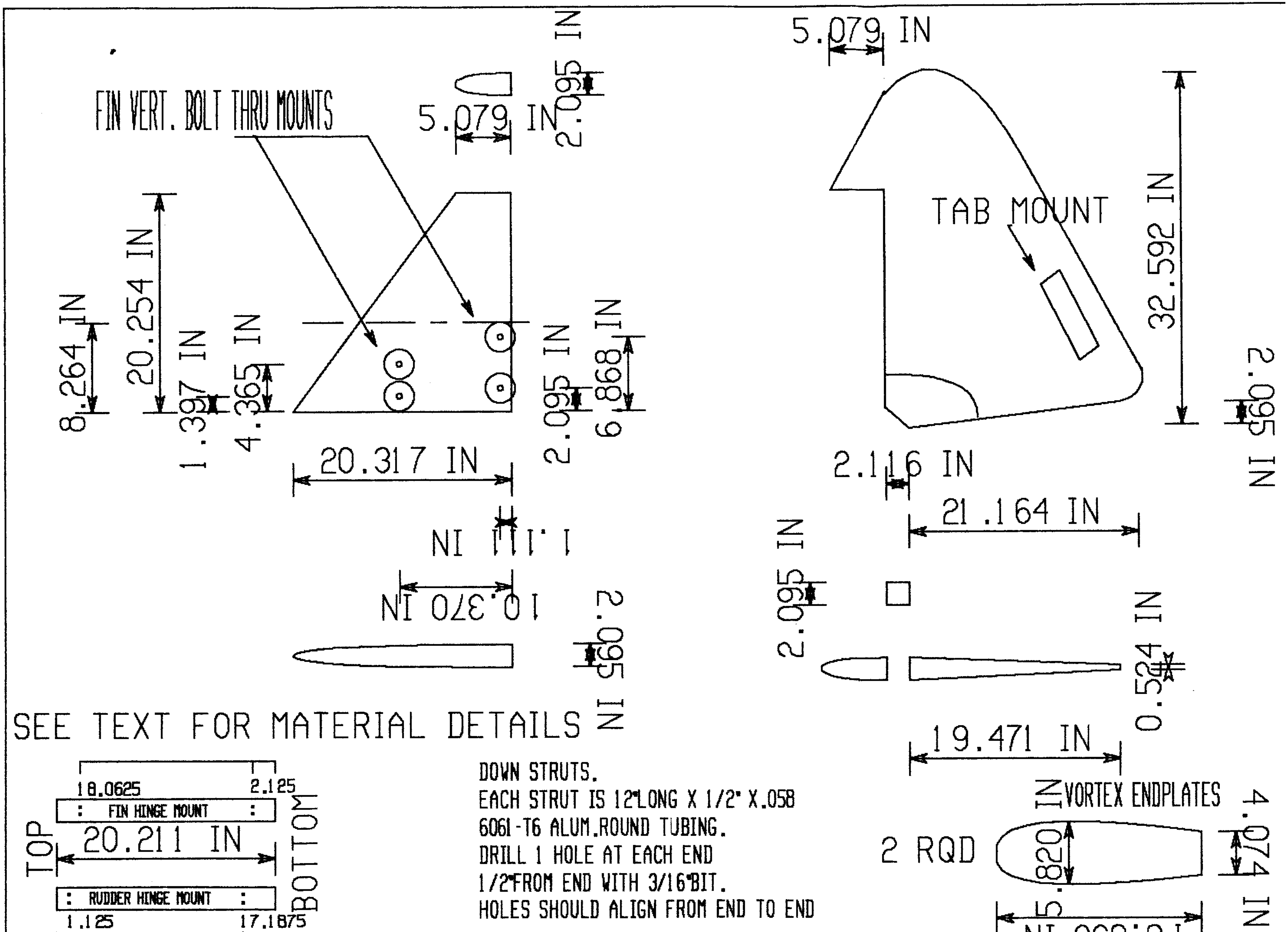
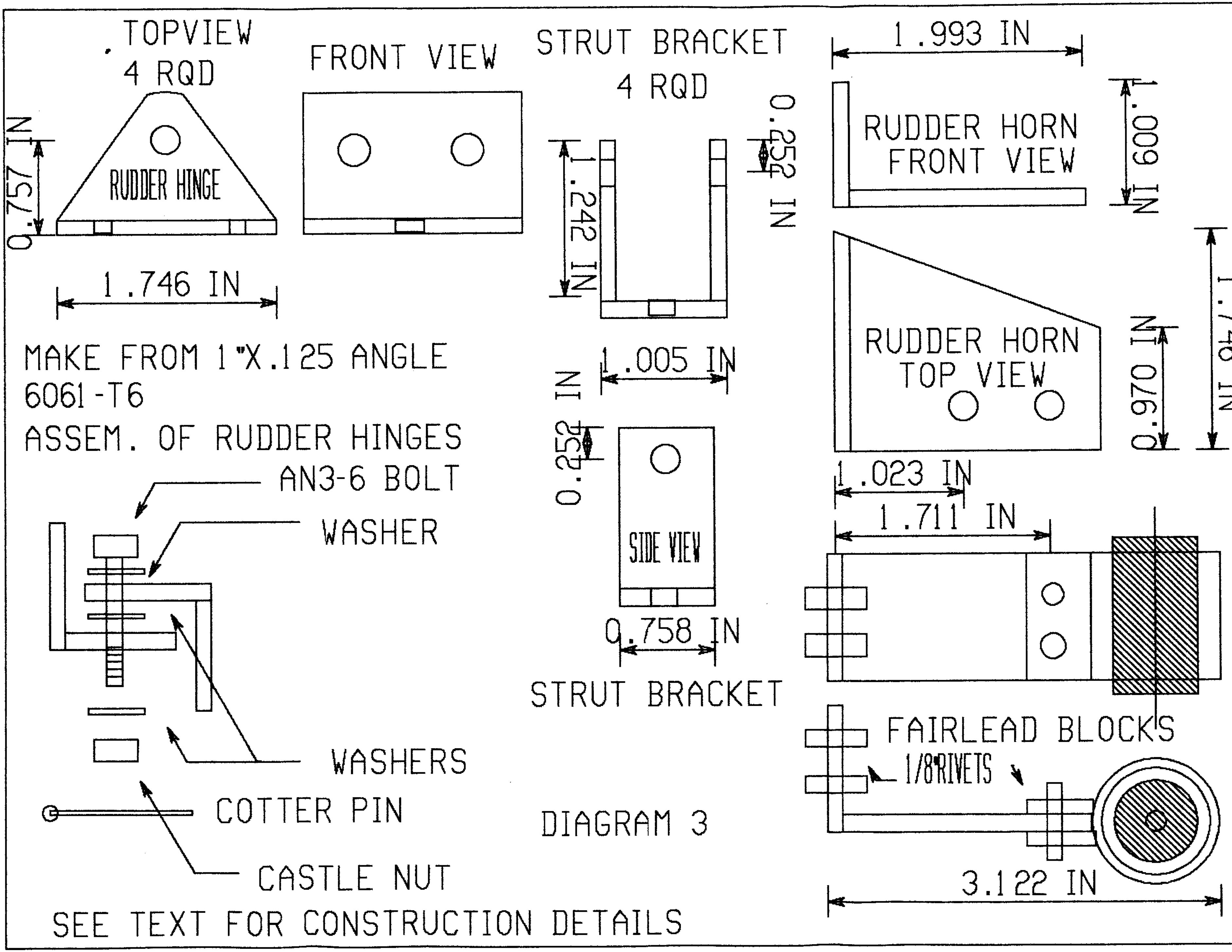
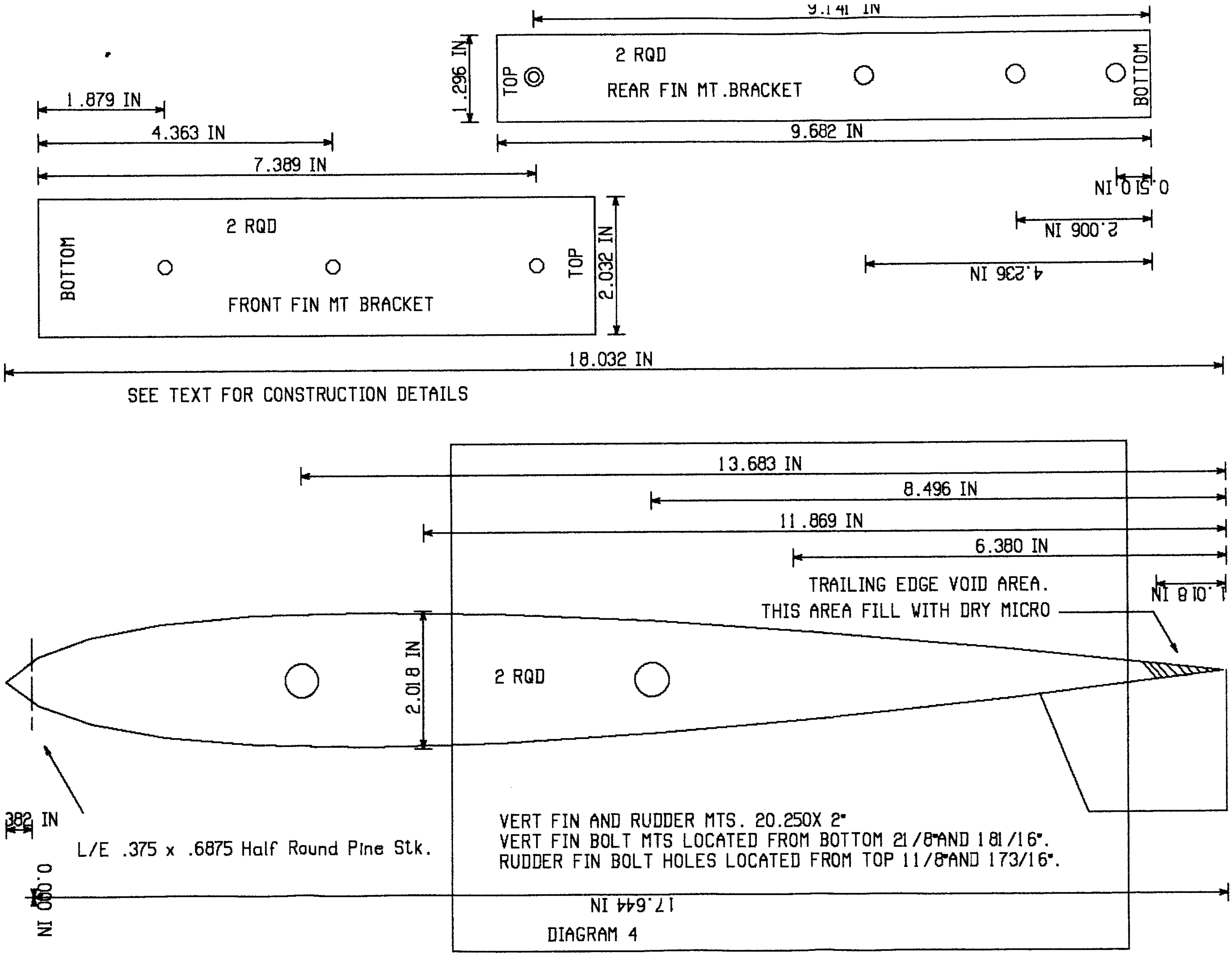

FIN VERT. BOLT THRU MOUNTS
5.079 IN
2.095 IN
20.254 IN
8.264 IN
1.397 IN
4.365 IN
2.095 IN
6.868 IN
20.317 IN
1.111 IN
10.370 IN
2.095 IN
SEE TEXT FOR MATERIAL DETAILS
18.0625
2.125
FIN HINGE MOUNT
TOP
20.211 IN
BOTTOM
RUDDER HINGE MOUNT
1.125
17.1875
5.079 IN
TAB MOUNT
32.592 IN
2.095 IN
2.116 IN
21.164 IN
2.095 IN
0.524 IN
19.471 IN
VORTEX ENDPLATES
2 RQD
.820 IN
4.074 IN
5
18.836 IN
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
0.252 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
1.296 IN
TOP
2 RQD
REAR FIN MT.BRACKET
BOTTOM
9.682 IN
0.510 IN
2.006 IN
4.236 IN
1.879 IN
4.363 IN
7.389 IN
BOTTOM
2 RQD
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