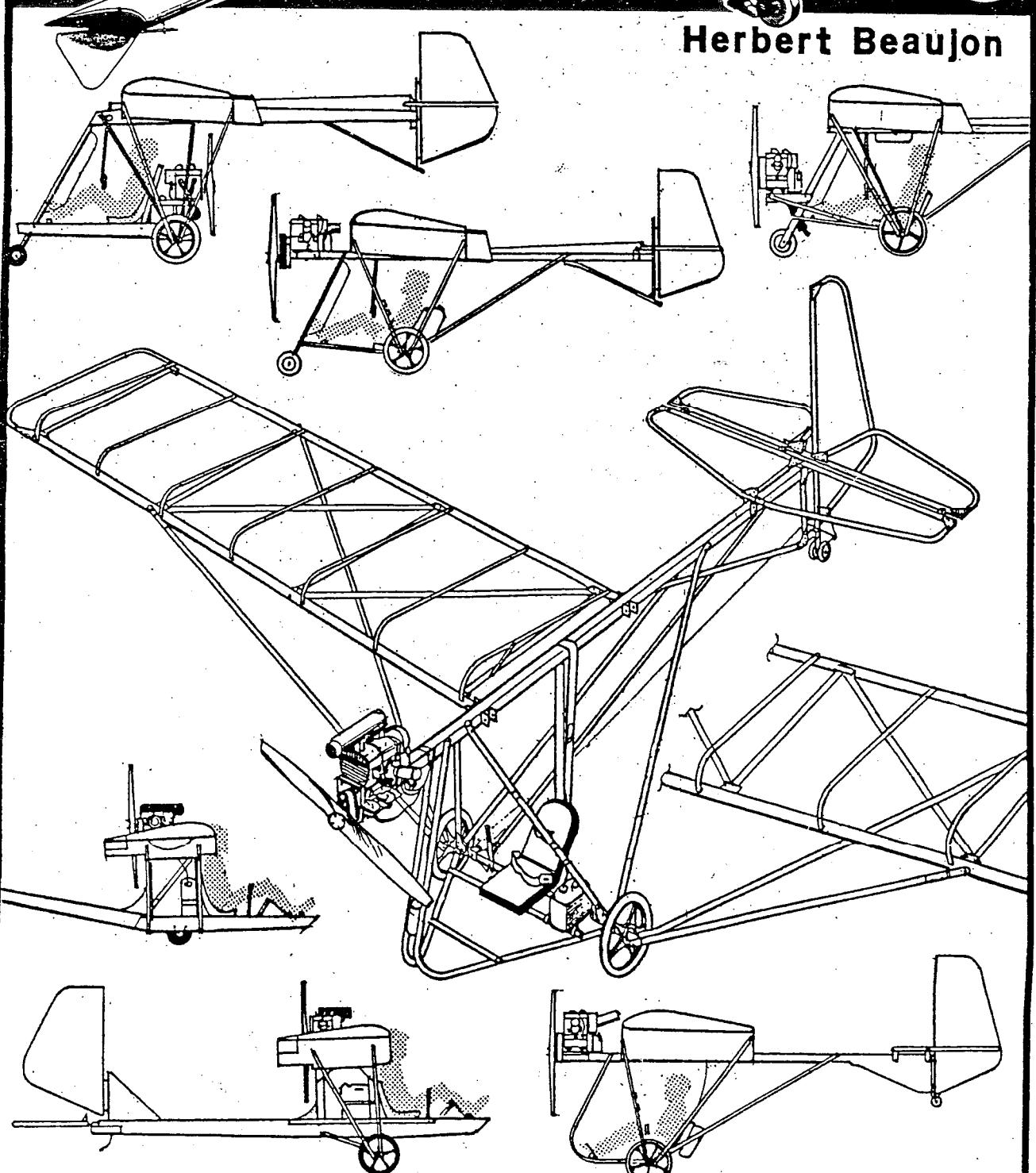
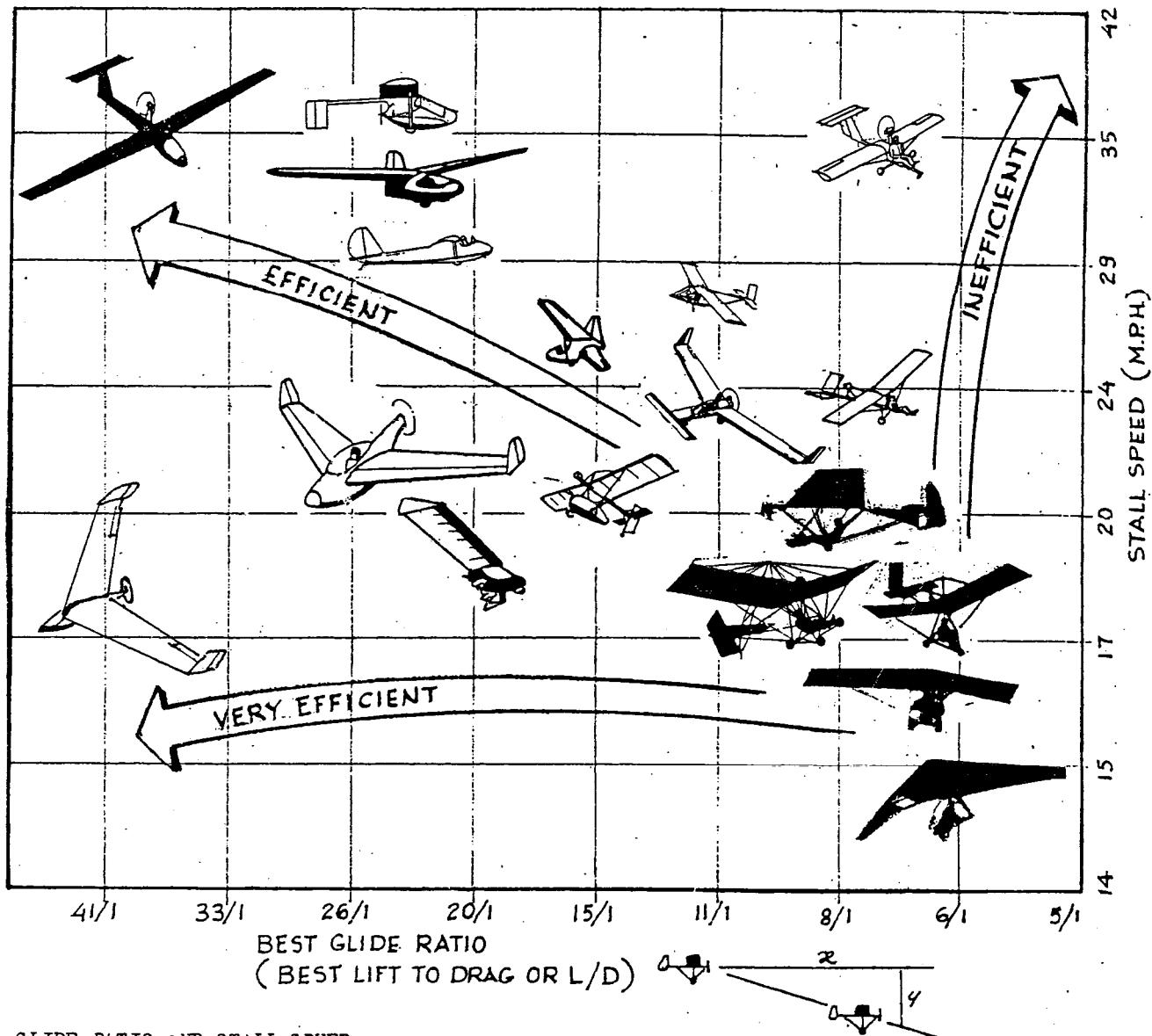


# HOW TO BUILD ULTRALIGHTS

Herbert Beaujon



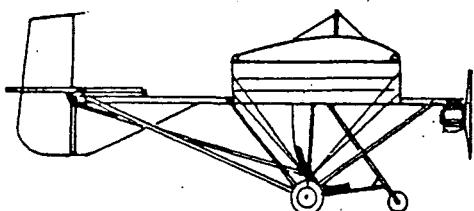
# General Design Requirements



## GLIDE RATIO AND STALL SPEED

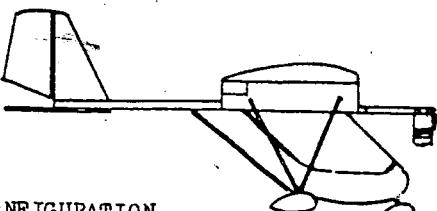
From the above chart, it becomes immediately obvious that the most efficient ultralight aircraft have both a flat glide and a low stall speed. Such craft require less power to maintain level flight. To achieve this goal, a low span loading, low wing loading, and a clean design are necessary. The older type rogallos and gliding parachutes had very low wing loadings, but very high span loadings, resul-

ting in a very steep glide angle. A typical rogallo grossing 250 lbs needs a 12 H.P. engine to maintain level flight at 25 M.P.H. A high performance sailplane grossing 1100 lbs requires the same 12 H.P. engine to maintain level flight at 50 M.P.H. Very often, ultralight aircraft defeat their purpose with excess drag and high span loading that must be compensated for with a powerful engine capable of pulling a conventional aircraft. The samples below speak for themselves.



## HIGH DRAG CONFIGURATION

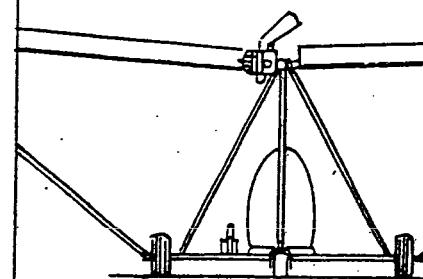
Gross: 350 lbs.  
Glide ratio: 6/1 @ 30 M.P.H.  
4.7 thrust H.P. needed for level flight.  
7.8 brake H.P. needed with 60% efficient propeller.



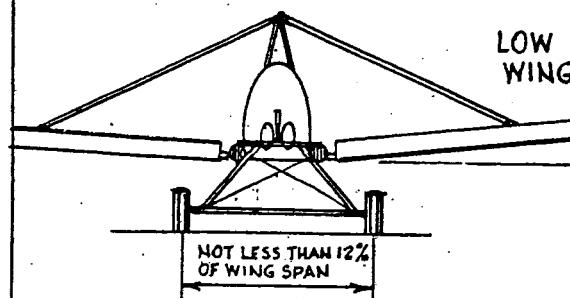
## LOW DRAG CONFIGURATION

Gross: 350 lbs.  
Glide ratio: 14/1 @ 30 M.P.H.  
2.0 thrust H.P. needed for level flight.  
3.4 brake H.P. needed with 60% efficient propeller.

# General Design Requirements



NOT LESS THAN 16%  
OF WING SPAN



NOT LESS THAN 12%  
OF WING SPAN

$L$  = Distance from Center of Lift line  
to Elevator Hinge line.  
Best  $L = 2.5 \times$  wing chord

Total minimum area FIN & RUDDER:

Gross Weight x Wing Span

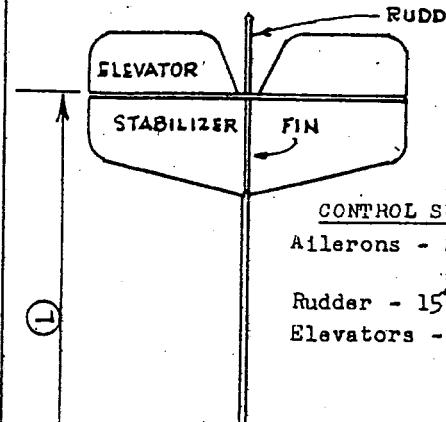
Gross W

Rudder 60% or more of total vertical tail area.

Total minimum area STABILIZER & ELEVATOR:  
Wing Span  $\times$  (Chord) $^2$   $\times$  .33

Wing Span x (Chord) = x .33

Elevator 40% or more of total horizontal tail area.

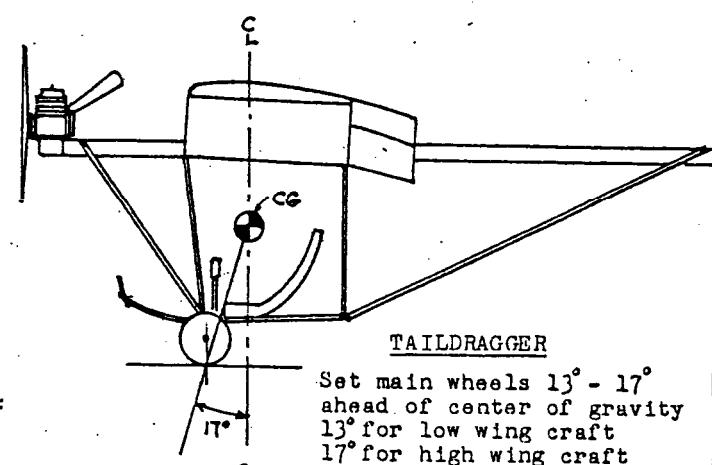


## CONTROL SURFACES

Ailerons -  $20^{\circ}$  -  $25^{\circ}$  up  
 $0^{\circ}$  -  $15^{\circ}$  down

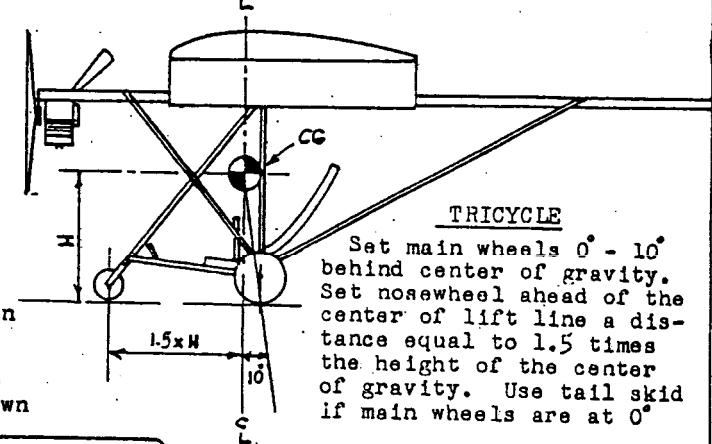
Rudder =  $15^\circ$  -  $30^\circ$  yaw

Elevators -  $20^\circ$  -  $30^\circ$  up  
                   $15^\circ$  -  $20^\circ$  down



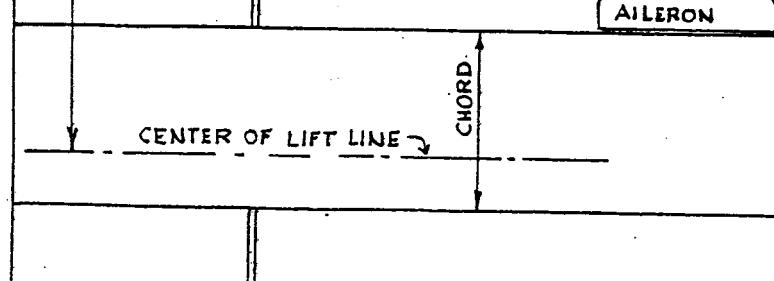
TAILDRAGGER

Set main wheels 13° - 17° ahead of center of gravity  
13° for low wing craft  
17° for high wing craft



## TRICYCLE

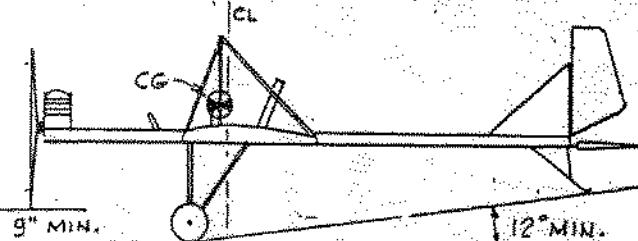
Set main wheels 0° - 10° behind center of gravity.  
Set nosewheel ahead of the center of lift line a distance equal to 1.5 times the height of the center of gravity. Use tail skid if main wheels are at 0°



V-TAIL

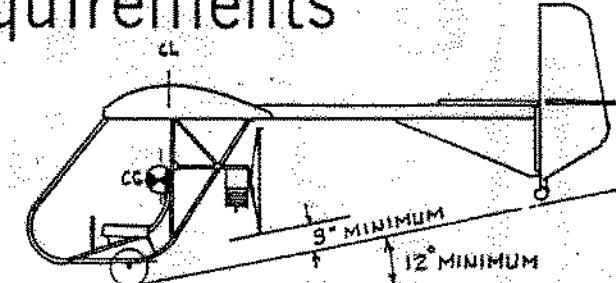
To find total area ruddervators and stabilizer, calculate total area of vertical and horizontal surfaces of conventional tail and multiply by .85

# General Design Requirements



## CONVENTIONAL LOW WING TRACTOR DESIGN

Propeller should have at least 9 inches ground clearance when wing is at 0 degree angle of attack. With main wheels and tail wheel (tailskid) on level ground, the wing angle of attack should be 12 degrees or greater.

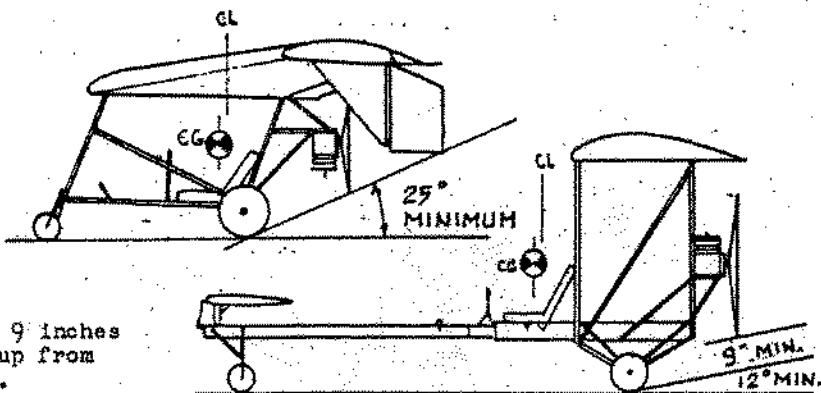


## CONVENTIONAL HIGH WING PUSHER DESIGN

With main wheels and tail wheel (skid) on level ground, propeller clearance should be at least 9 inches while wing angle of attack is 12 degrees or more.

## ALL WING PUSHER DESIGN

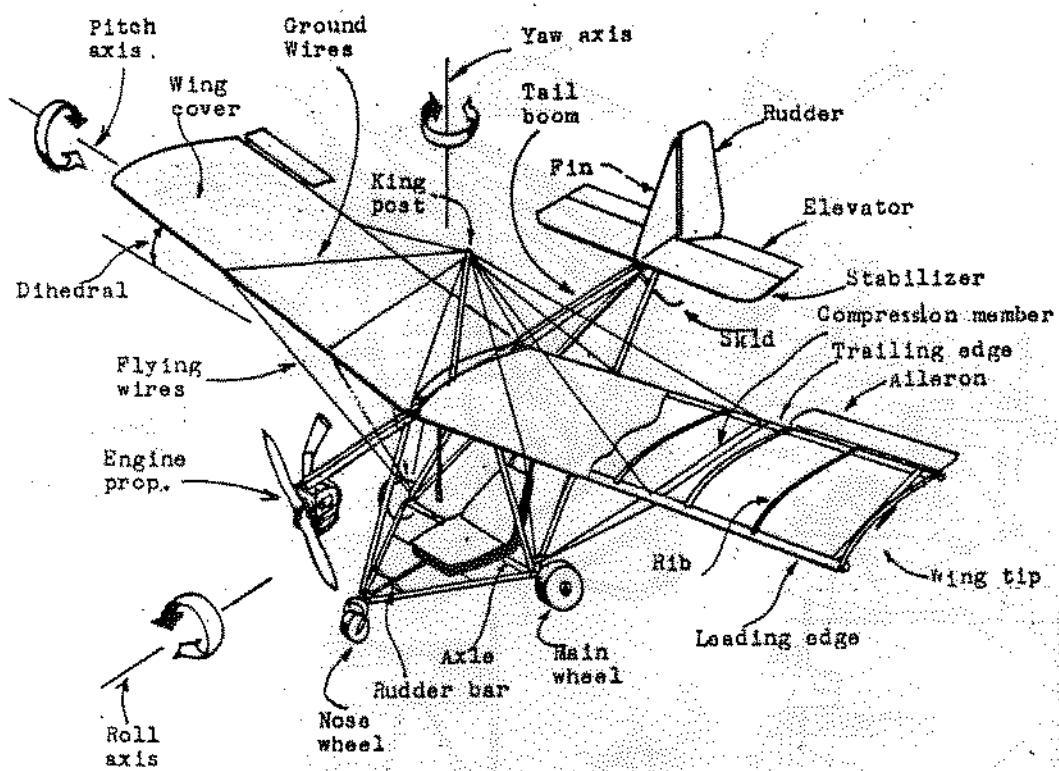
Allow at least 25 degree angle between main wheels and lowest point at wing-tips for safety during ground yaw.



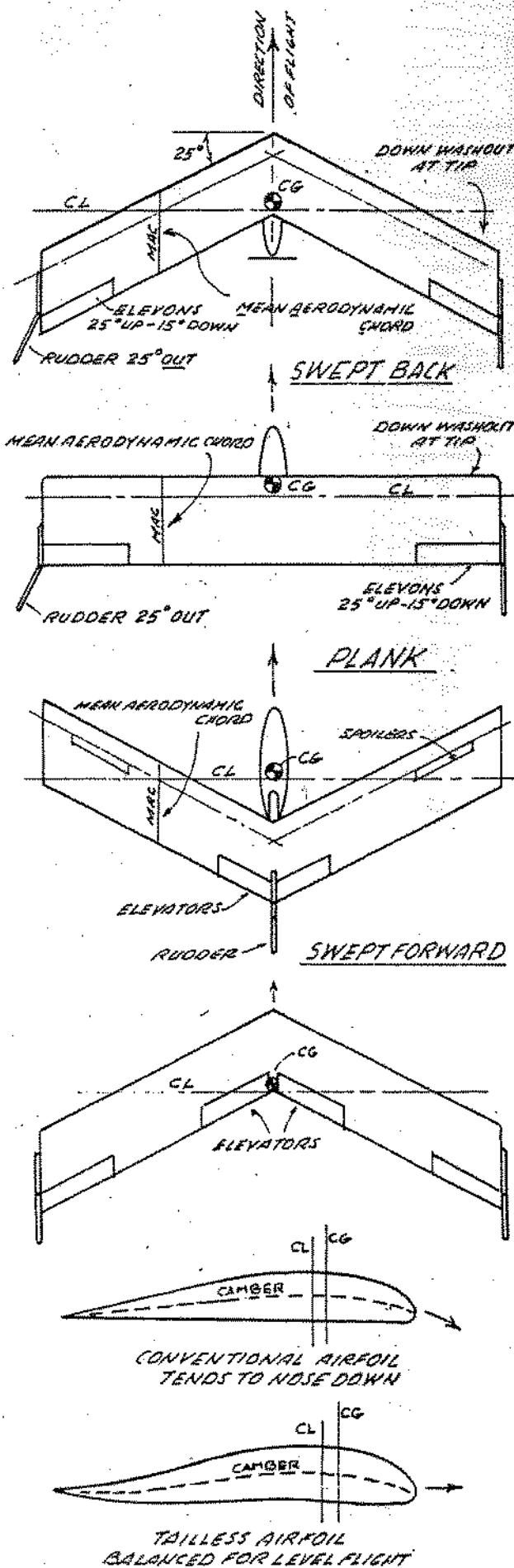
## HIGH WING PUSHER CANARD

Propeller clearance should be 9 inches or more to a line 12 degrees up from the bottom of the main wheels.

## NOMENCLATURE



# Tailless Ultralights



## ADVANTAGES

- \* Reduced drag
- \* Reduced weight
- \* Less power required

## DISADVANTAGES

- \* Reduced Center of Gravity range
- \* Reduced pitch control
- \* More complex airfoil and wing structure

**SWEPT BACK:** Best all around all wing design. More stable and forgiving than Plank or Swept Forward designs. Elevons ( combination aileron and elevator ) provide good roll and relatively good pitch control. As ailerons, the elevons are far out near the wing tip. As elevators, the elevons are farther behind the CG than on the Plank design. The wing tip rudders, which turn outward only, provide very positive turns by dragging the wing back.

**PLANK:** Good, but reserved for the experts. The center of gravity range is very narrow. Pitch control is sensitive. Of all the tailless designs, this one requires the least amount of power to stay aloft. The airfoil needs a carefully designed reflex trailing edge, with large elevons. Wing tip rudders must be far behind the wing tips. In tri-gear configuration, the main wheels should be as close as possible to the center of gravity because the elevons have weak pitch reactions. If the main wheels are too far behind the CG, the nose wheel will not leave the ground and the craft will not take off. Use very little or no dihedral.

**SWEPT FORWARD:** - DANGEROUS - not recommended for ultralight aircraft. Wing tips must have upward washout in order to stall before the rest of the wing. This causes additional wing tip drag. In a turn, the outside wing gets less lift and drops.

The elevators shown on the swept back at left produce the opposite effect expected. A downward deflection increases the lift of the wing section directly in front. Since this wing section is mostly ahead of the CG, the craft will actually nose up. An upward deflection of the elevators will nose the craft down. Not recommended.

A conventional airfoil has a tendency to nose down, and requires strong elevator/stabilizer counter reaction to maintain level flight.

A tailless craft has weak elevator control, and the airfoil must be trimmed for level flight. This can be done with a reverse reflex of the aft portion of the camber line. The reflexed area loses some lift, allowing the wing to 'balance' in flight, but also moves the center of lift and center of gravity forward. With weak pitch control, a tailless craft is unforgiving if the center of gravity should ever get behind the center of lift.

# Performance Calculations

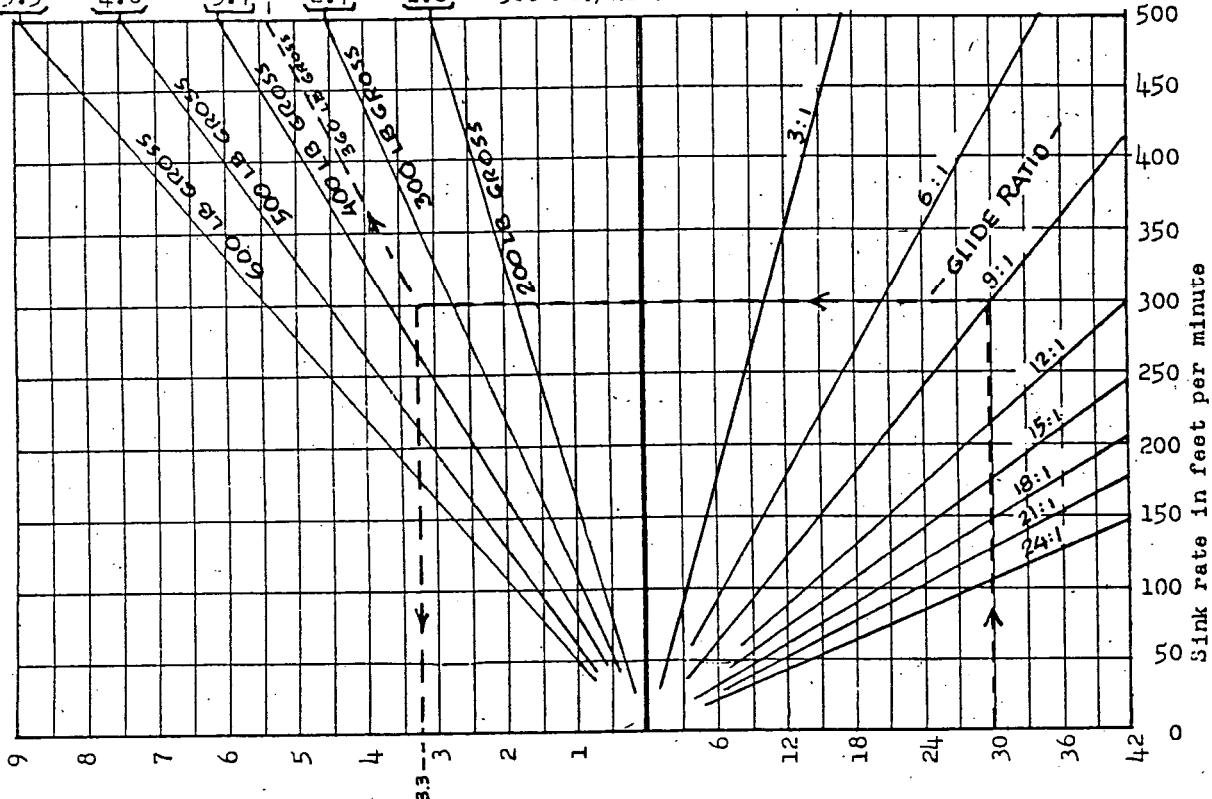
Thrust H.P. required for climb.

( Divide by prop efficiency to find brake H.P. required )

$$16.5 - 13.8 - 11.1 - 8.1 - 5.4 \quad \text{-- 900 Ft./Min. climb}$$

$$10.9 - 9.2 - 7.4 - 5.4 \quad \text{-- 600 Ft./Min. climb}$$

$$5.5 - 4.6 - 3.7 - 2.7 - 1.8 \quad \text{-- 300 Ft./Min. climb}$$



Minimum thrust H.P. for level flight  
( Divide by prop efficiency to find  
actual brake H.P. required )

Best horizontal glide speed  
in M.P.H.

You have just finished designing your ultralight aircraft, but you cannot decide what size powerplant to use. The powerplant is the single most expensive item on your aircraft, and you cannot afford to make a mistake.

Your design requires a direct drive tractor ( pulling ) engine. From your notes, and from information gathered in other parts of this manual, the following information is available.

Gross weight: 360 lbs.

Best glide speed: Approx. 30 M.P.H.

Best glide ratio: Approx. 9 : 1

Required climb rate: 600 Ft./Min.

Looking at the chart above, draw a line vertically from the 30 M.P.H. point until you hit the 9 : 1 glide ratio line. Move left to the interpolated 360 lb. gross line. From this point, move down to find 3.3 thrust horsepower required for level flight at sealevel. From this same point, move up along the gross weight line and find 6.6 thrust horsepower required for a 600 feet per minute climb at sealevel. Add both climb and sealevel thrust H.P. Your ultralight aircraft will require a total of 9.9 thrust horsepower.

Thrust horsepower is simply the power output at the propeller.

Brake horsepower is the power output at the driveshaft, and is always greater.

The efficiency of your propeller is the ratio of power delivered ( thrust H.P. ) and power supplied ( brake H.P. ), and is expressed as a decimal fraction.

If you use a 42 inch diameter wood propeller, your efficiency rating is .57, and the brake H.P. required is...

$$\text{B.H.P.} = \frac{\text{Thrust H.P.}}{\text{efficiency}} \text{ or } \frac{9.9}{.57} = 17.4 \text{ B.H.P.}$$

Your last figure represents the maximum brake horsepower output at the rated R.P.M. of your engine. To be on the safe side ( engines seldom perform at maximum ), add 30% or about 5 B.H.P.

Your ultralight aircraft will need 22 B.H.P. engine to achieve a climb rate of 600 feet per minute at sealevel.

# Performance Calculations

## POWER REQUIRED VERSUS SPAN LOADING

For a given weight ultralight, increasing the wing span decreases the thrust horsepower necessary for level flight. The thrust horsepower required is proportional to...

$$\left( \frac{\text{WEIGHT}}{\text{SPAN}} \right)^2$$

Thus, increasing the span of a 400 lb. gross ultralight aircraft from 28 feet to 36 feet, will reduce the required thrust horsepower to only 60% of the original power needed for level flight.

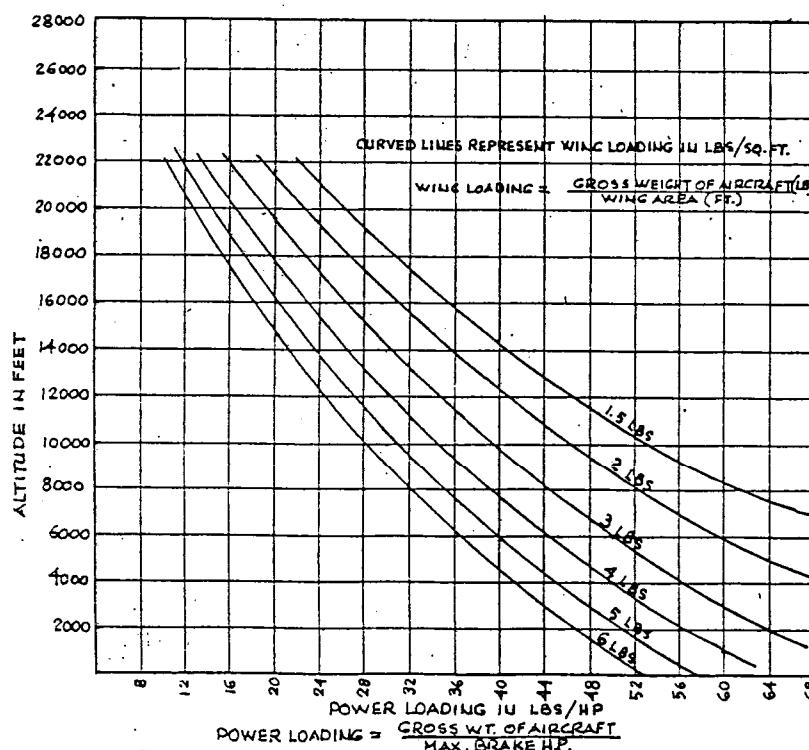
$$\left( \frac{\text{GROSS}}{\text{SPAN 1}} \right)^2 \times \left( \frac{\text{GROSS}}{\text{SPAN 2}} \right)^2 \times 100$$

$$\text{Or: } \left( \frac{400}{36} \right)^2 \times \left( \frac{400}{28} \right)^2 \times 100 = 60\%$$

Maintaining the same chord, but increasing the span, will reduce span loading and induced drag. The lower your span loading, the less power is needed to maintain your ultralight in level flight. High performance sailplanes have high aspect ratios ( span divided by chord ) and low span loadings. Rogallo's ( old types ) are just the opposite and have steep glide angles.

Thrust horsepower for level flight at sea level is equal to....

$$\left( \frac{.83}{\text{Best Climb Speed}} \right) \times \left( \frac{\text{Gross Weight}}{\text{Span}} \right)^2$$



WING LOADING LBS/SQ.FT.	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
STALL SPEEDS IN MPH.										
THIN WING	20	23	28	32	36	39	43	45	48	51
THICK WING	17	20	24	28	32	35	37	39	42	45

If your ultralight weighs 400 lbs. gross, has a span of 32 feet, and climbs best at 30 M.P.H., then you will need....

$$\left( \frac{.83}{30} \right) \times \left( \frac{400}{32} \right)^2 = 4 \text{ thrust H.P.}$$

Let's assume that you have purchased a Cuyuna 430D engine rated at 30 B.H.P. at 5,500 R.P.M. With a 36 inch diameter metal tipped propeller ( 16 inch pitch ), this engine will produce 22 B.H.P. at 5,000 R.P.M. The efficiency of a 36" propeller is .50. This means that you will get only  $22 \text{ B.H.P.} \times .50 = 11 \text{ thrust H.P.}$  Your ultralight weighs 400 lbs. gross, and must climb at 600 feet per minute. You estimate your best climb speed at 30 M.P.H. Find the right wing span.

First we find the thrust horsepower needed to climb at a rate of 600 feet per minute.

$$\text{T.H.P. for climb} = \frac{\text{Gross Weight} \times \text{Climb Rate}}{33,000}$$

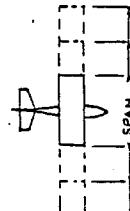
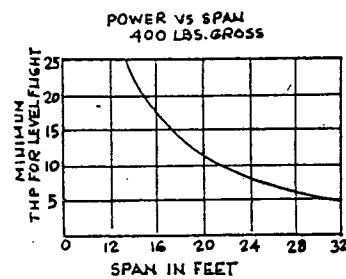
$$\text{Or: } \frac{400 \times 600}{33,000} = 7.3 \text{ T.H.P.}$$

This leaves us  $11.0 - 7.3 = 3.7 \text{ T.H.P.}$  for level flight at sealevel.

The required wing span can be found with the following formula.

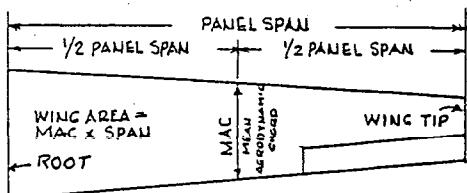
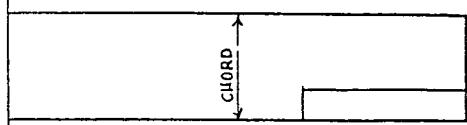
$$\frac{\text{Gross Weight} \times .91}{\sqrt{\text{Level Flight T.H.P.} \times \text{Best Climb Speed}}}$$

$$\text{Or: } \frac{400 \times .91}{\sqrt{3.7 \times 30}} = 34.7 \text{ foot span}$$

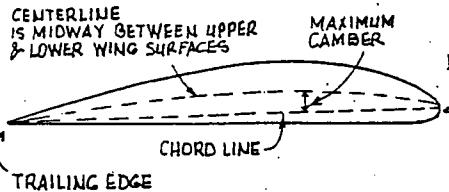
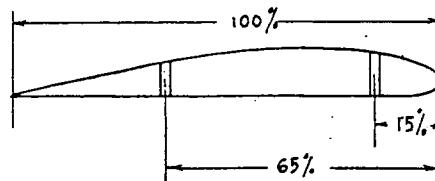


# Wing Design

CONSTANT CHORD WING  
(STALLS AT ROOT FIRST)

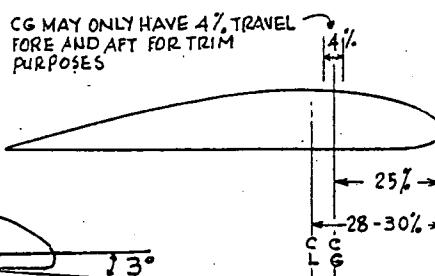


TAPERED WING STALLS AT TIP FIRST. REQUIRES DOWN WASH AT TIP.



PLACING FRONT & REAR SPARS AS SHOWN WILL DISTRIBUTE THE LOADS IN PROPORTION TO THE SPAR HEIGHTS. EQUAL SAFETY FACTORS ARE INCORPORATED IN BOTH SPARS.

THE GREATER THE MAX.CAMBER, THE GREATER WILL BE THE LIFT (...AND DRAG.)

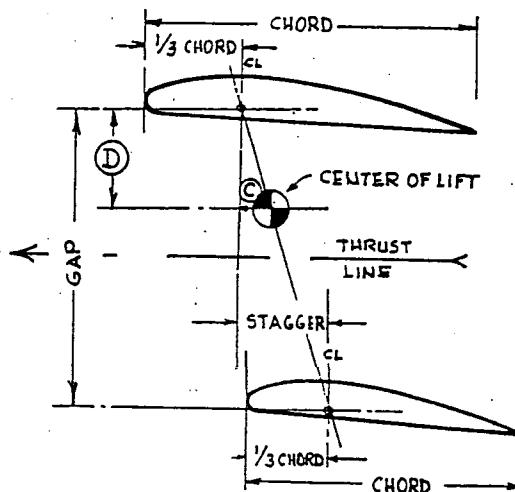
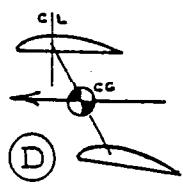
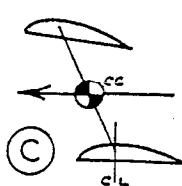
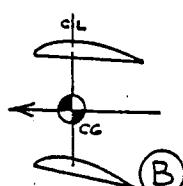
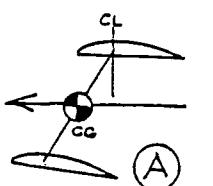
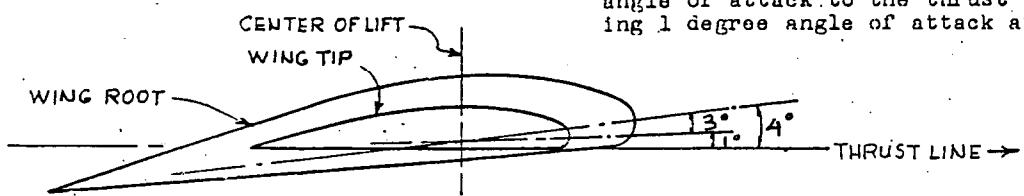


THE CENTER OF LIFT (CL), ALSO CALLED CENTER OF PRESSURE (CP) MOVES FOREWARD AT HIGH ANGLES OF ATTACK. THE CENTER OF GRAVITY (CG) MUST ALWAYS REMAIN AHEAD OF THE CL TO PREVENT CATASTROPHIC STALLS IN ENGINE OFF FLIGHTS



FOR TAPERED WING, ALLOW 3° DOWNWASH AT WING TIP. THIS WILL CAUSE ROOT TO STALL FIRST, THUS RETAINING AILERON CONTROL

TAPERED WING - From wing root to wing tip there is a 3 degree downwash to prevent outboard stalls. The root has a 4 degree angle of attack to the thrust line, leaving 1 degree angle of attack at the tip.



## HOW BIPLANE WINGS PERFORM

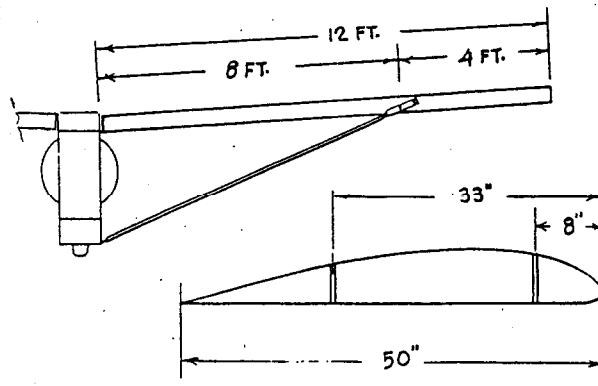
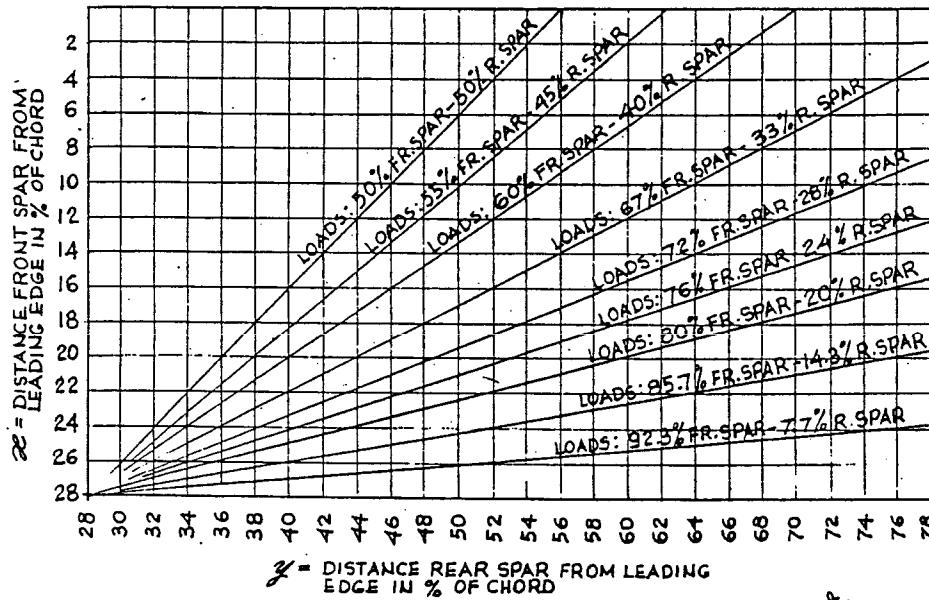
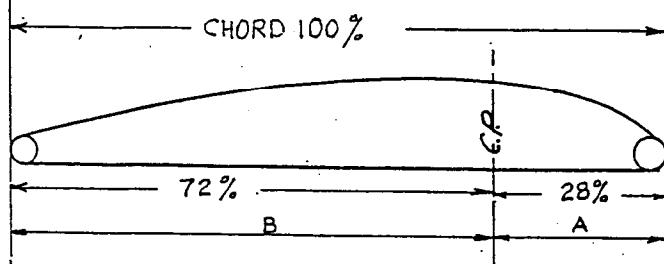
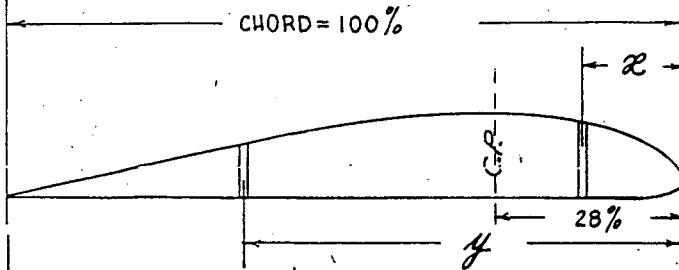
- (A) Stall resistant staggerwing. Low wing stalls first, moving CL behind CG. Nose drops to recover full lift.
- (B) Low wing stalls first, giving pilot warning to nose down.
- (C) Top wing stalls first, moving CL behind CG. Nose drops to recover lift, but roll control is affected.
- (D) Low wing stalls first, CL moves ahead of CG and catastrophic stall could occur.

The Center of Lift (CL) of a BIPLANE can be closely estimated with the following formulas.

$$D = \frac{\text{Area low wing} \times \text{Gap}}{\text{Area low wing} + \text{Area High Wing}}$$

$$C = \frac{D \times \text{Stagger}}{\text{Gap}}$$

# Wing Design



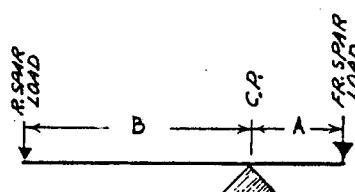
GROSS WEIGHT: 400 LBS.  
STRESSED 3.8 G'S  
FRONT & REAR SPARS STRUT SUPPORTED

POSITION AND PERCENTAGE OF LOAD CARRIED BY FRONT AND REAR WING SPARS

The center of pressure or center of lift of an airfoil represents a point where all forward and rearward lift forces are balanced. The exact location varies with the type of airfoil and the angle of attack. For most common airfoils riding at 0 - 4 degrees angle of attack, the center of pressure is located at 28% of the chord, measured from the leading edge.

Spar loads will depend on their position relative to the center of pressure. For illustrative purposes, the center of pressure may be considered a pivot point on a seesaw bounded at one end by the front spar, and at the other end by the rear spar. The end loads must keep the seesaw in a level position.

For typical ultralight wings with tubular spars making up the leading and trailing edges, the front spar carries approximately 70% of the wing load, while the trailing or rear spar carries about 30% of the wing load. Incidentally, compression loads between front and rear tube spars of this type wing is greater than for any other type wing.



$$\text{LOAD PR. SPAR} = \frac{\text{DIST. B}}{\text{DIST. A+B}} \times \text{TOT. LOAD}$$

$$\text{LOAD R. SPAR} = \frac{\text{DIST. A}}{\text{DIST. A+B}} \times \text{TOT. LOAD}$$

The Ultralight Aircraft at left must withstand a maximum of 3.8 G's, or  $3.8 \times 400 \text{ lbs.} = 1520 \text{ lbs.}$  Find the lightest spars capable of supporting this load.

The front spar is  $8/50 \times 100 = 16\%$  from the leading edge. The rear spar is  $33/50 \times 100 = 66\%$  from the leading edge. From the above graph we see that the front spar supports 76% of the wing load. The rear spar supports 24% of the wing load. Each wing panel must support  $1/2 \times 1520 \text{ lbs.} = 760 \text{ lbs.}$  The outer 4 feet of the wing panel must support  $4 \text{ feet}/12 \text{ feet} \times 760 \text{ lbs.} = 253 \text{ lbs.}$  The front spar takes up 76% of this load, or  $.76 \times 253 \text{ lbs.} = 192.3 \text{ lbs.}$  This load is evenly distributed along the length, and can be considered concentrated at a point midway, or at 2 feet from the strut support. Thus we have the equivalent of an end load at 24 inches. On graph #9 we follow the end load and distance coordinates to the next highest curved line marked (①) (②). Refer to the spars designated by these letters. Use the same procedure in finding the outboard load of the rear spar, and the inboard loads of both front and rear spars.

# Calculating Wing Stresses

## PERMISSIBLE LOADS - SPRUCE SPARS

A safety factor of 4 has been included in the permissible loads shown in the graph below.

Example: You wish to find the wing tip load of the front spar of a strut supported wing. The length from strut to wing tip is 60 inches. The plain wood spar is 6 1/8 inch deep, 1/2 inch thick. Find 60 inches at the bottom of the graph, move up to the curved line indicated by 'J', then left until you hit the 100 pound permissible end load. The safety factor of 4 means that you will need 4 x 100 lbs = 400 lbs. end load to break the spar at the strut.

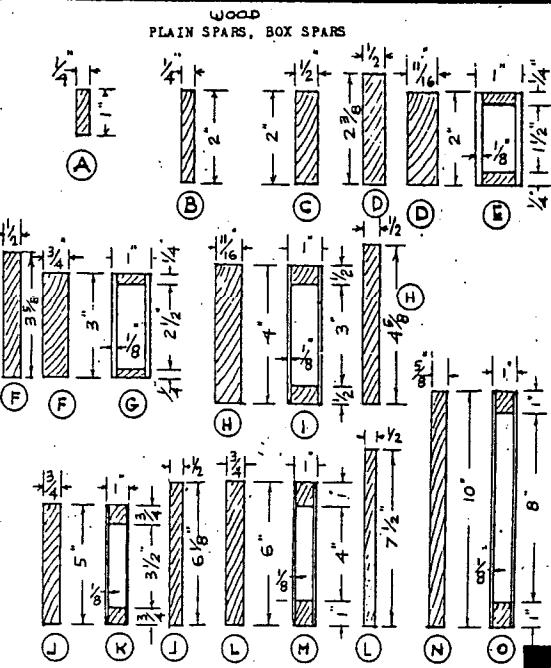
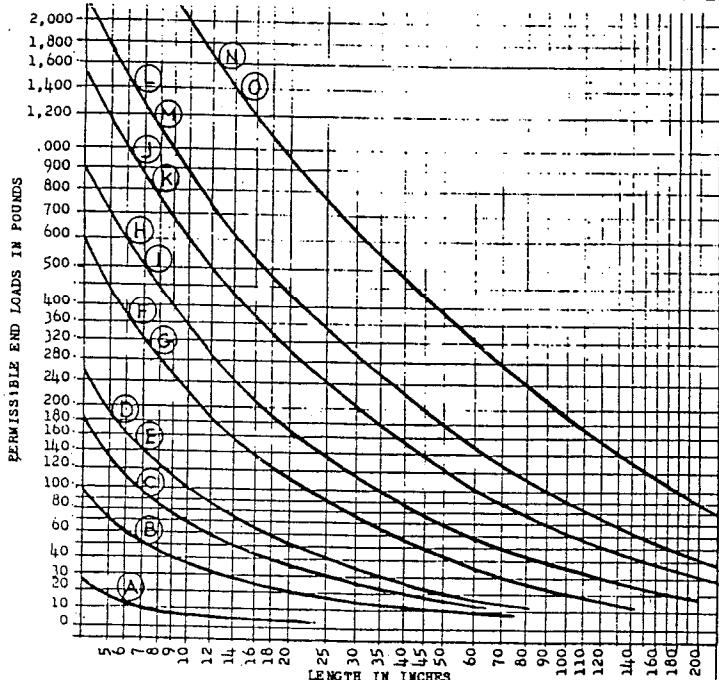
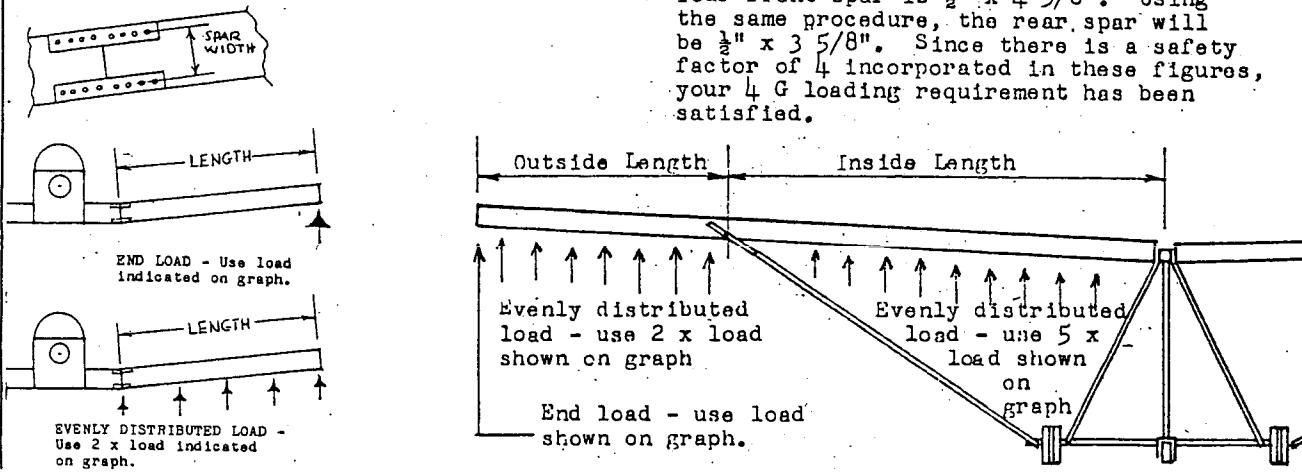
Permissible loads increase or decrease in direct proportion to the thickness of the spars. Thus, increasing the spar used in the previous example from 1/2 inch thickness to 1 inch thickness, will double the permissible load from 100 lbs. to 200 lbs. The ultimate breaking end load will be 4 x 200 lbs. = 800 lbs.

Wood spars fail in compression, i.e., at the area of failure, the point under compression begins to crush while the rest breaks from bending and tension.

## TYPICAL PROBLEM

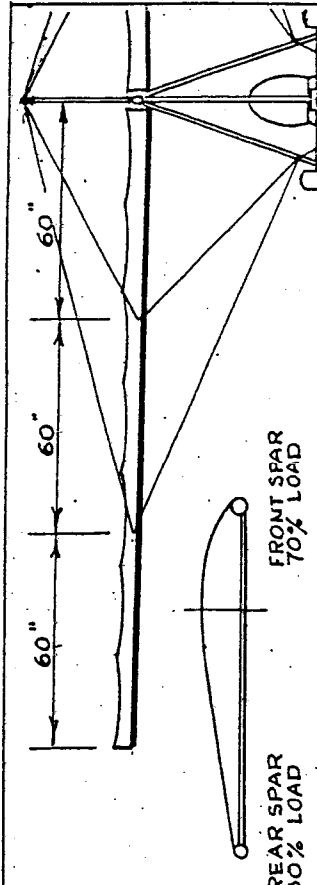
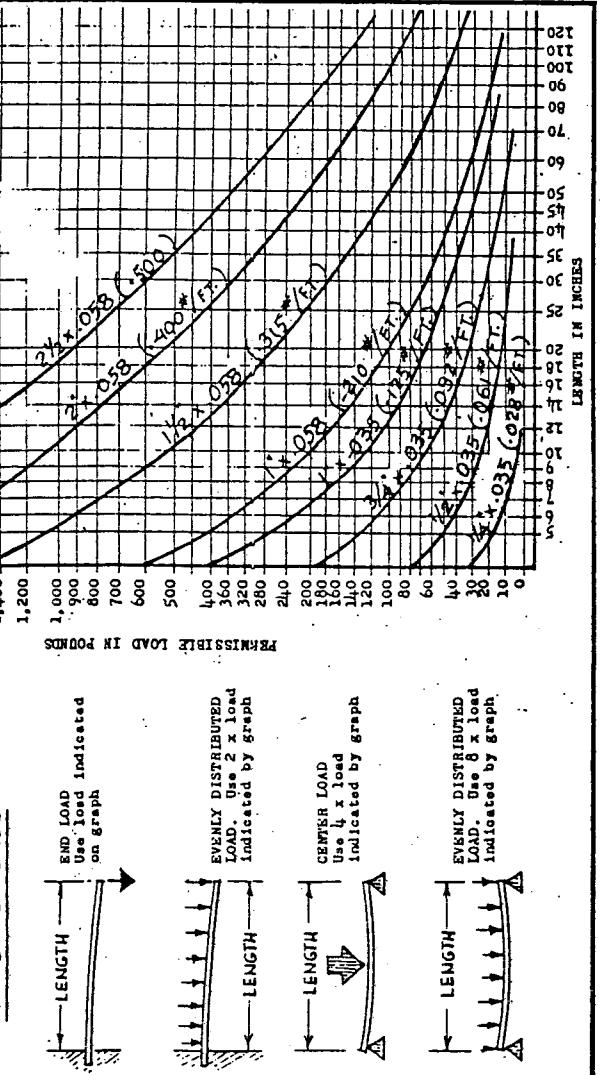
Your strut braced light airplane will gross 665 lbs., has a wing span of 350 inches, and must be stressed for 4 G's (4 x gross weight). The outside wing panel section is 70 inches. The front spar must support 75% of the wing load, the rear spar supports 25%. Find the right spars to support the outside wing panel load.

The outside wing panel length of 70 inches supports  $70/350 = 20\%$  of the gross weight, or  $.20 \times 665 \text{ lbs.} = 133 \text{ lbs.}$  The front spar carries 75% of this load, or  $.75 \times 133 \text{ lbs.} = 100 \text{ lbs.}$  The rear spar carries 33 lbs. The front spar is carrying an evenly distributed load of 100 lbs., but the end load is only  $\frac{1}{2}$  this amount, or 50 lbs. (See sketch below). On your graph below, find the 70 inch vertical line and the 50 lbs. horizontal line. These two lines meet a diagonal line marked (H) (I), representing the type spars which can be used. Your front spar is  $\frac{1}{2}'' \times 4 \frac{5}{8}''$ . Using the same procedure, the rear spar will be  $\frac{1}{2}'' \times 3 \frac{5}{8}''$ . Since there is a safety factor of 4 incorporated in these figures, your 4 G loading requirement has been satisfied.



### 6061-T6 ALUMINUM TUBING

#### BENDING LOADS



Given: A 450 lbs. gross, wire braced highwing ultralight with a 360 inch wing span braced in 60 inch sections. The front spar is 2" x .058 6061 T6 aluminum tubing. The rear spar is 1 1/8" x .058 6061 T6 aluminum tubing. Find G loading.

Starting with the front spar of the wing tip section, find 60" on the graph at left, move up to the diagonal marked 2" x .058, then left to the end load of 180 lbs. The evenly distributed load is  $2 \times 180 = 360$  lbs. The front spar carries 70% of the load. Thus, the entire 60" wing tip section carries 360 lbs / .70 = 514 lbs. The rear spar carries 514 lbs - 360 lbs = 154 lbs. of evenly distributed load. The end load of the rear spar is  $\frac{1}{2} \times 154 = 77$  lbs. On your graph at left, the junction of 77 lbs. and 60 inches indicates a 1 1/8" x .058 tube, which agrees with our wing design.

Using the same procedure for the center sections, we find that they are more than adequately stressed, so we do not worry about them. Since the wing tip section is the weakest, we'll use it as a basis for figuring the G load.

There are 6 sections, each capable of supporting 514 lbs. The entire wing will support  $\frac{6}{6} \times 514 = 3084$  lbs. G loading is maximum stress limit divided by the gross weight, or:

$$\frac{3084}{450} = 6.05 \text{ G's}$$

MATERIAL	MODULUS OF RUPTURE P.S.I.	ULTIMATE TENSILE STRENGTH P.S.I.	SHEAR STRENGTH P.S.I.	COMPRESSION PARALLEL TO GRAIN P.S.I.	COMPRESSION VERTICAL TO GRAIN P.S.I.	WEIGHT/CU. IN. (LBS)	WEIGHT/CU. IN. (LBS)
SITKA SPRUCE	9,400	10,000	750	5,000	750	.016	.016
ASH	14,800	16,000	1,380	7,000	2,000	.023	.023
BIRCH	15,500	17,000	1,300	7,300	1,300	.025	.025
BALSA	3,000	4,000	200	2,200	100	.006	.006
PLYWOOD, SPRUCE F 3 PLY/90°				1,300		.017	
PLYWOOD, BIRCH 3 PLY/90°				2,200		.027	

MATERIAL	TENSILE STRENGTH P.S.I.	SHEAR STRENGTH P.S.I.	COMPRESSION STRENGTH P.S.I.	WEIGHT/CU. FT. (LBS)
URETHANE FOAM (TAN)	45	30	20	2.0
EXTRUDED FOAM (BLUE)	95	65	40	2.2

MATERIAL	TENSILE STRENGTH P.S.I.	SHEAR STRENGTH P.S.I.	COMPRESSION WEIGHT/CU. FT. (LBS)
4130 CHROME MOLY STL	60,000	95,000	60,000
1025 MILD CARBON STL	36,000	55,000	35,000
2024-T3 ALUMINUM	50,000	70,000	42,000
6061-T6 ALUMINUM	39,000	45,000	30,000
6061-T4 ALUMINUM	21,000	35,000	24,000

MATERIAL	WEIGHT/SQ. YARD (OZ.)	TENSION LBS/PER 1" WIDE STRIP
DACRON GREIGE	1.8	60
"	"	95
"	"	150
GRADE A COTTON	4.4	80
DYNE FABRIC	4.0	250

# Airfoils

## A NOTE ABOUT AIRFOILS

In slow flying ultralight aircraft, the wing airfoil is less important than the span loading ( gross weight : span ) and the wing loading ( gross weight : wing area ). Construction limitations have also resulted in some strange airfoils ( see below ) which work very well.

**C<sub>L</sub>** - A high Coefficient of Lift means low landing speeds. Mild stalls are associated with a rounded curve, sharp stalls are shown by a sudden drop in the curve.

**L/D** - The higher the Lift to Drag ratio, the less power is required for flight.

## FINDING STALL SPEED, GROSS WEIGHT

Your ultralight design has a wing area of 150 sq. ft., and you want it to stall at 20 M.P.H. Find gross weight.

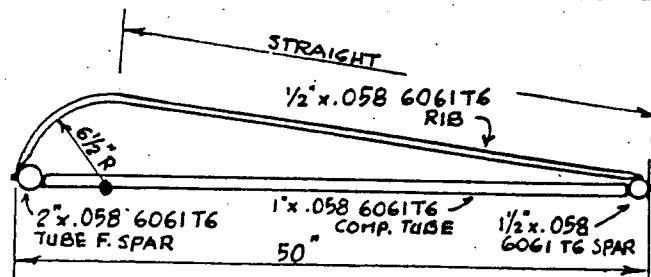
$$\frac{\text{Wing area} \times (\text{stall speed})^2}{170} = \text{gross weight}$$

$$\frac{150 \times (20)^2}{170} = 353 \text{ lbs.}$$

An advertisement claims a stall speed of 18 M.P.H., a wing area of 120 sq.ft., and a gross weight of 450 lbs. Check out this exaggerated claim.

$$13 \times \sqrt{\frac{\text{gross weight}}{\text{wing area}}} = \text{stall speed}$$

$$13 \times \sqrt{\frac{450}{120}} = 25 \text{ M.P.H. stall speed.}$$

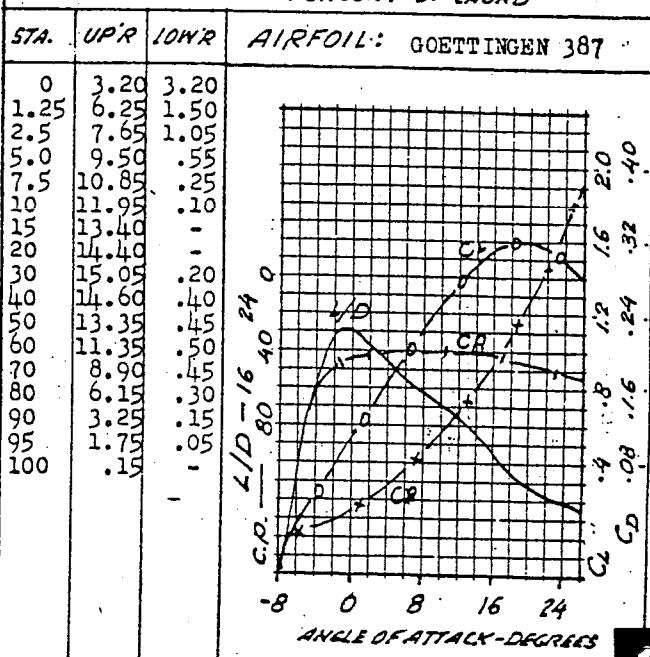
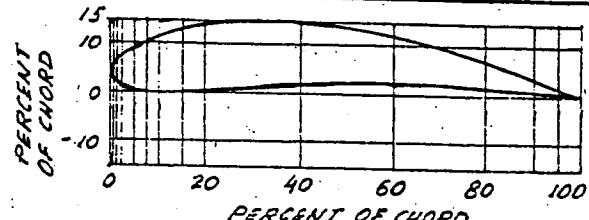
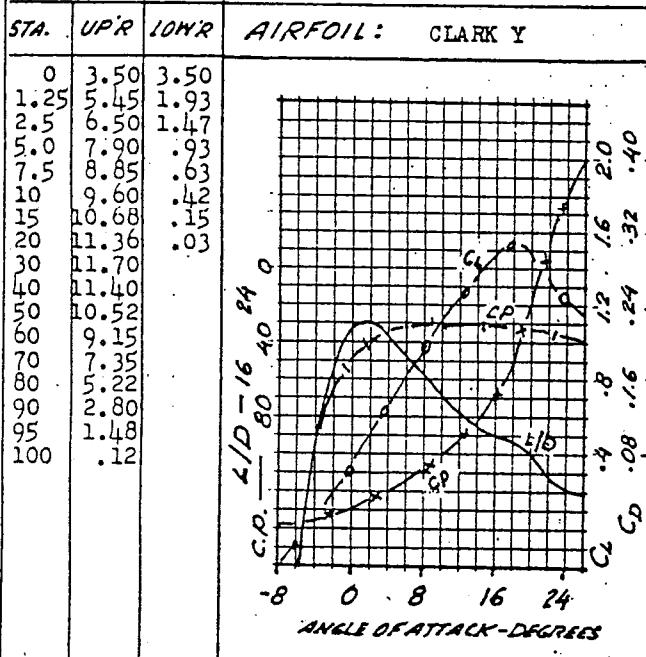
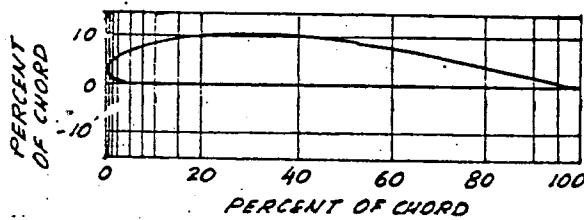


## TUBE WING AIRFOIL

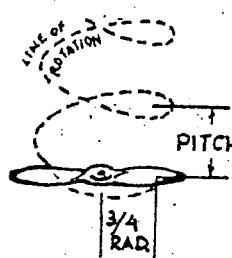
Some ultralight aircraft are presently using the above airfoil. The utter simplicity is worth the extra 2 or 3 extra horsepower required to overcome the additional drag. Anyone who has worked with a tube bender realizes that it is almost impossible to

shape an aluminum tubing into a complex airfoil configuration. The stretched fabric area between the ribs will assume a more conventional shape, thus improving the aerodynamic qualities. During flight, the ribs will bend slightly upwards, further increasing lift. If double surfaced, and flying at less than 45 M.P.H., this airfoil is only a little less efficient than a more conventional airfoil.

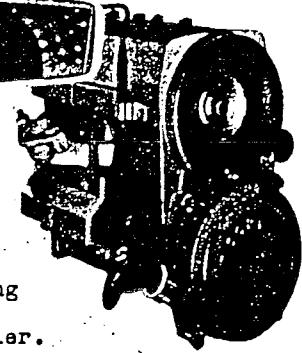
For a constant chord wing, this configuration offers the simplest type of construction.



# Propellers & Engines

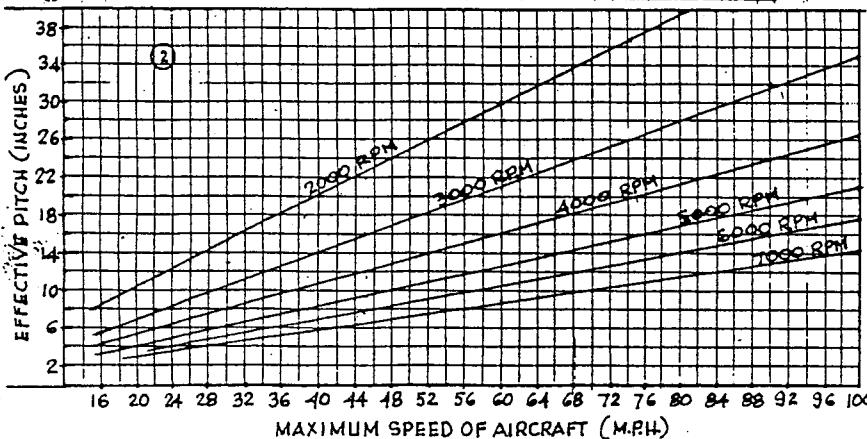
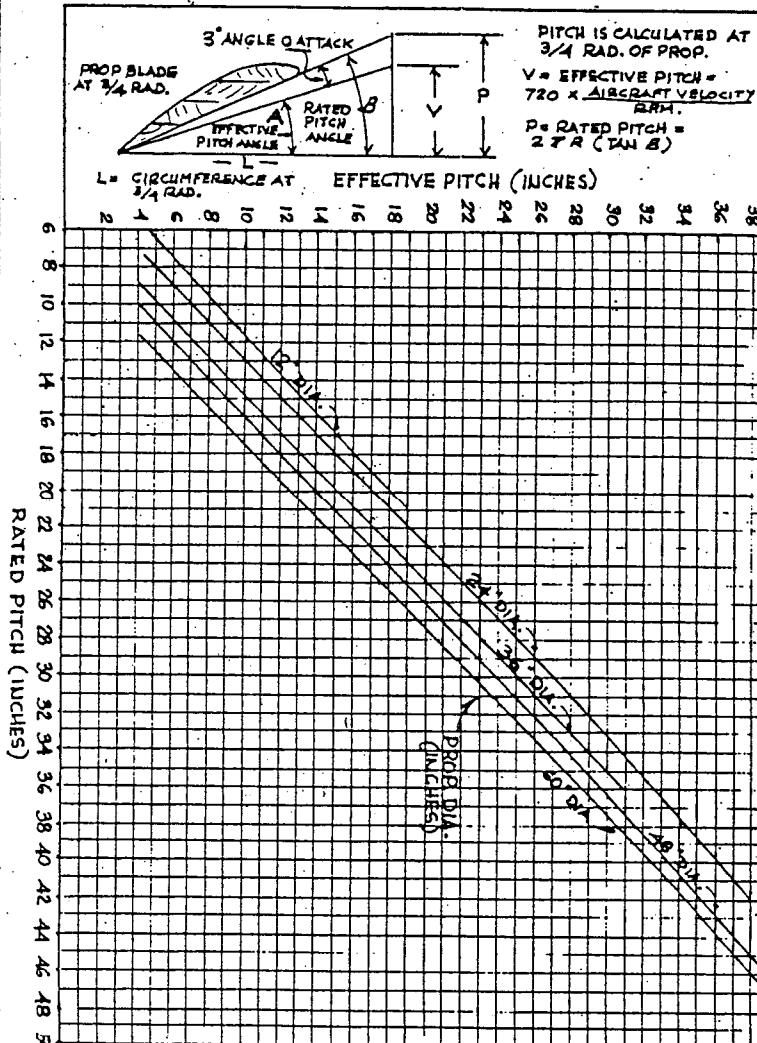


Propeller pitch is the distance traveled during one complete revolution.



Rated or geometric pitch: This is the distance traveled forward by the propeller during one complete revolution by a point located at  $3/4$  of the blade radius, and following the line of rotation at the exact pitch angle. The rated pitch is stamped on your stock propeller.

Effective pitch: This is the distance traveled by the propeller during one full revolution, and the line of rotation is followed by the rated pitch minus the blade angle of attack ( slip angle ).



## STATIC THRUST

The following formula gives a relatively close estimate of static thrust.

$$S. \text{ Thrust} = \frac{BHP \times \sqrt{\text{Prop. Dia. - 10}}}{.06 \times \text{Pitch}}$$

Example: Your ultralight engine produces 20 B.H.P. while turning a 16 inch pitch, 36 inch diameter propeller. Find static thrust.

$$\frac{20 \times \sqrt{36} - 10}{.06 \times 16} = 110 \text{ lbs.}$$

A two place helicopter produces 80 B.H.P. to hover with a 300 inch diameter rotor set at 20 inch pitch. Find gross weight of helicopter.

$$\frac{80 \times \sqrt{300} - 10}{.06 \times 20} = 1133 \text{ lbs.}$$

A drone produces 12 B.H.P. with a 16 inch propeller, 12 inch pitch.

$$\frac{12 \times \sqrt{16} - 10}{.06 \times 12} = 42 \text{ lbs.}$$



ENGINE TORQUE, measured in foot/lbs., is a rotational force pushing along a circumference one foot diameter away from a central driveshaft.

$$\text{Torque} = \frac{\text{B.H.P} \times 5254}{\text{R.P.M.}}$$

Example: Your engine produces 20 BHP at 4000 RPM.

$$\frac{20 \times 5254}{4000} = 26.3 \text{ Ft/lbs.}$$

# Propellers & Engines

**NOTE:** Tip speeds of wood props do not exceed 700 ft/sec. For tip speeds between 700 and 880 ft/sec., one must use all metal or metal tipped wood props with a tip thickness not exceeding 6% of the tip chord. Prop tips must not exceed 880 ft/sec., as air compressibility places undue strain on the prop and also absorbs energy which is not translated into propulsion.

FOR AIRCRAFT SPEEDS BETWEEN 30 and 80 MPH

PROP RPM	BRAKE HP	THRUST HP	PROP DIA.	TYPE MAT'L	PROP RPM	BRAKE HP	THRUST HP	PROP DIA.	TYPE MAT'L
2000	5	3	49"	wood	4500	5	2.1	29"	wood
	10	6.5	54"	wood		10	4.4	32"	wood
	15	10	58"	wood		15	7	34"	wood
	20	13.8	62"	wood		20	10	36"	wood
2500	5	2.9	43"	wood	5000	5	1.3	38"	metal
	10	6	47"	wood		10	16.5	40"	metal
	15	9	50"	wood		15	19.5	41"	metal
	20	13	54"	wood		20	22.2	42"	metal
	25	16.8	58"	wood		5	2	28"	wood
	30	20.5	61"	wood		10	4.3	30"	wood
3000	5	2.6	38"	wood	5500	15	6.6	32"	wood
	10	5.6	41"	wood		20	9.3	34"	wood
	15	8.7	44"	wood		25	12.5	36"	metal
	20	12	48"	wood		30	15.2	37"	metal
	25	15	50"	wood		35	18.2	38"	metal
	30	19	52"	wood		40	21	39"	metal
	35	22.6	54"	wood		5	1.8	26"	wood
	40	26.2	55"	metal		10	4.1	28"	wood
	5	2.3	34"	wood		15	6.4	30"	wood
3500	10	5.1	37"	wood		20	9	32"	metal
	15	8.2	40"	wood		25	11.6	34"	metal
	20	11.5	43"	wood		30	15	35"	metal
	25	14.4	45"	wood	6000	5	1.6	25"	wood
	30	18	47"	metal		10	3.8	27"	wood
	35	21	49"	metal		15	6.3	29"	metal
	40	25	50"	metal		20	8.8	31"	metal
	5	2.2	31"	wood		25	11.4	33"	metal
4000	10	4.7	34"	wood					
	15	8	36"	wood					
	20	10.6	39"	wood					
	25	14	41"	metal					
	30	17.1	43"	metal					
	35	20	44"	metal					
	40	23.5	46"	metal					
	5	2.2	31"	wood					
	10	4.7	34"	wood					

THRUST VERSUS SPEED FOR VARIOUS ENGINES  
( Calculations based on most efficient prop for each speed )

MCCULLOCH 101 A/A Single cyl. 2 Cycle  
Displ. 123 cc/ Wt. 12 lbs./  
13 HP @ 9000 RPM  
Derated to 7 HP @ 5500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 30 | 26 | 21 | 17 | 14 | 12 | 10 | 9 | 8

ROCKWELL JLO MODEL L-230 Single cyl.  
2 Cycle/ Displ. 223 cc/ Wt. 29 lbs./  
15.5 HP @ 6000 RPM  
Derated to 12 HP @ 4500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 58 | 50 | 40 | 33 | 28 | 24 | 20 | 18 | 16

JLO ROCKWELL MODEL L-395 Single cyl.  
2 Cycle/ Displ. 395 cc/ Wt. 59 lbs./  
24.5 HP @ 5500 RPM  
Derated to 22 HP @ 4500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 35 | 14 | 94 | 76 | 64 | 54 | 48 | 42 | 39

JLO ROCKWELL MODEL 2P-440 Single cyl.  
2 Cycle/ Displ. 440 cc/ Wt. 62 lbs./  
40 HP @ 6500 RPM  
Derated to 28 HP @ 4500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 75 | 55 | 26 | 100 | 87 | 73 | 65 | 56 | 51

BRIGGS & STRATTON SERIES 190400 Single cyl.  
4 cycle/ Displ. 19.44 Cu. In./ Wt. 45 lbs./  
8 HP @ 3600 RPM  
Derated to 7.3 HP @ 3000 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 46 | 42 | 33 | 26 | 22 | 19 | 17 | 14 | 13

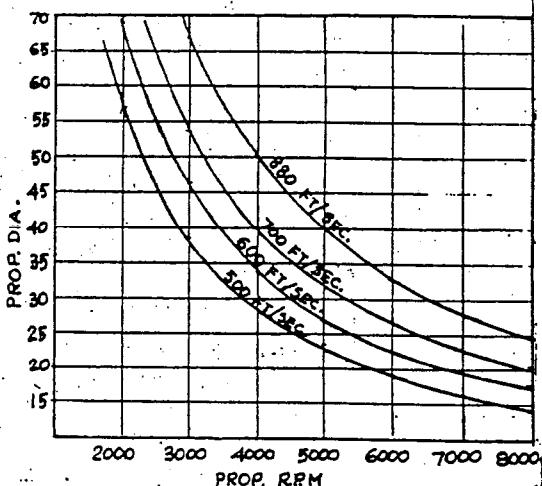
YAMAHA Y 292 Single cyl.  
2 Cycle/ Displ. 292 cc/ Wt. 46 lbs./  
21 HP @ 5500 RPM  
Derated to 17 HP @ 4500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 100 | 87 | 70 | 57 | 48 | 40 | 36 | 31 | 29

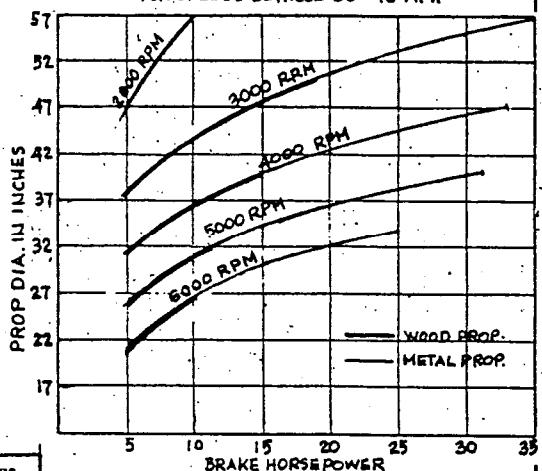
YAMAHA Y 433 2 cyl.  
2 Cycle/ Displ. 433 cc/ Wt. 68 lbs./  
31 HP @ 5500 RPM  
Derated to 26 HP @ 4500 RPM

SPEED MPH | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95  
THRUST LB | 165 | 142 | 116 | 95 | 80 | 67 | 60 | 51 | 46

Propeller tip speed may not exceed 600 MPH  
( 880 ft/sec.), because air compressibility  
will require an excessive counteracting  
force. Metal props with thin tips may  
operate close to this speed, but wooden  
props must be kept around 500-700  
ft/sec.



FOR SPEEDS BETWEEN 30 - 70 MPH



Example: You need 5.8 thrust HP for level flight, plus 3.7 thrust HP for a 300 ft/min. climb. Total thrust HP required is  $5.8 + 3.7 = 9.5$ .

Your prop diameter is 30 inches, and has an efficiency rating of .42. To find actual BHP required, divide thrust HP by efficiency rating.  $9.5 / .42 = 22.5$  BHP

Example: Your engine is rated at 22.5 BHP with a 30 inch diameter prop. To find thrust HP, multiply BHP by efficiency rating.  $22.5 \times .42 = 9.5$  Thrust HP.

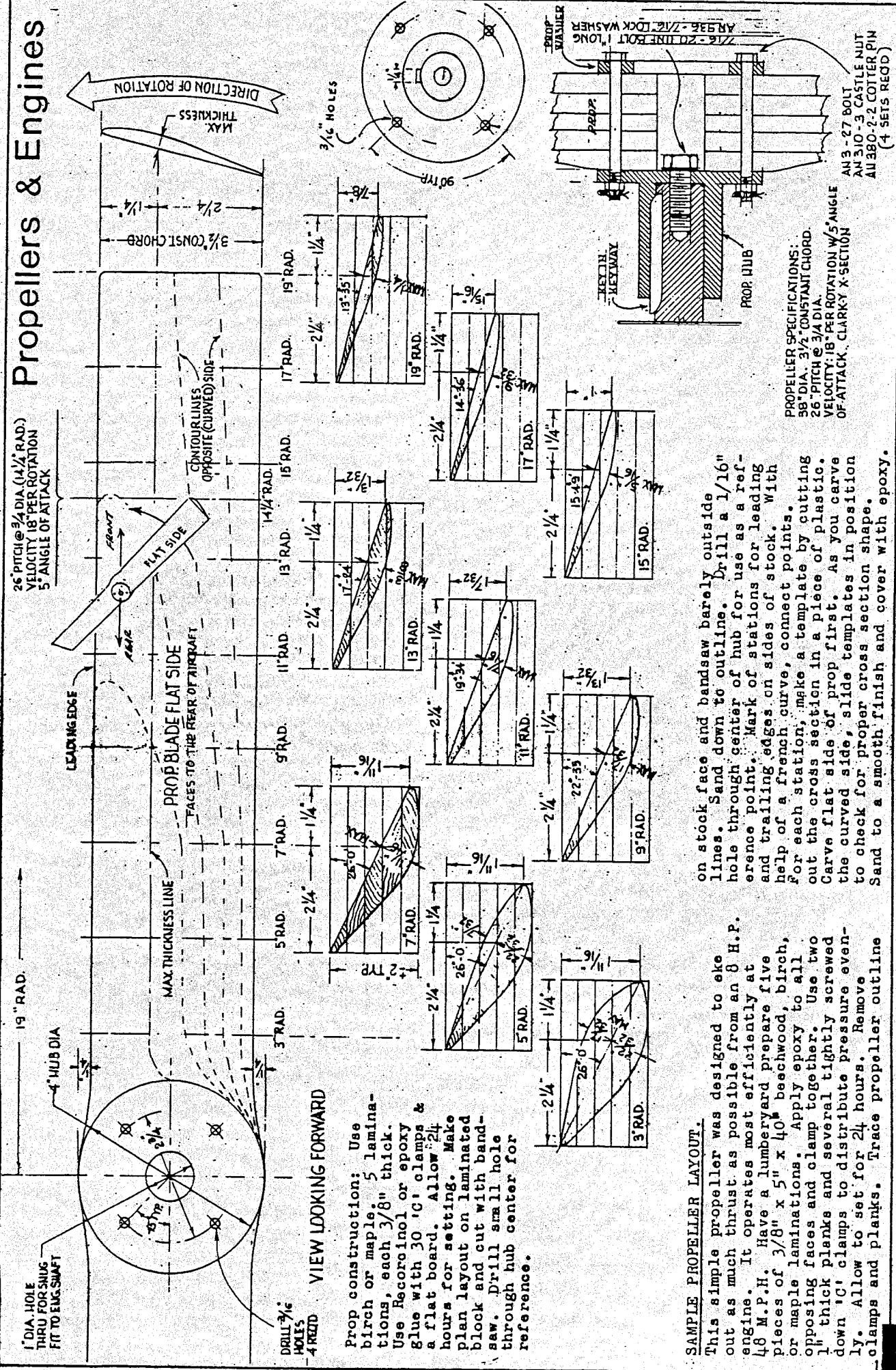
PROPELLER EFFICIENCY VERSUS DIAMETER  
Applicable to most ultralight aircraft

24" Dia. - .33	54" Dia. - .65
30" Dia. - .43	60" Dia. - .68
36" Dia. - .50	66" Dia. - .71
42" Dia. - .57	72" Dia. - .73
48" Dia. - .61	

The right diameter prop will work efficiently within the best horse-power and RPM combination available from a given engine.

Example: Find the prop diameter for a two stroke producing 20 BHP at 4000 RPM. Find 20 BHP at the bottom of the graph at right, follow vertically to the 4000 RPM line, then go left to your prop diameter of 45 inches.

# Propellers & Engines



## SAMPLE PROPELLER LAYOUT.

Prop construction: Use birch or maple 5 laminations, each  $\frac{3}{8}$ " thick. Use Recordinoil or epoxy glue with 30°C clamps & a flat board. Allow  $\frac{21}{4}$  hours for setting. Make plan layout on laminated block and cut with bandsaw. Drill small hole through hub center for reference.

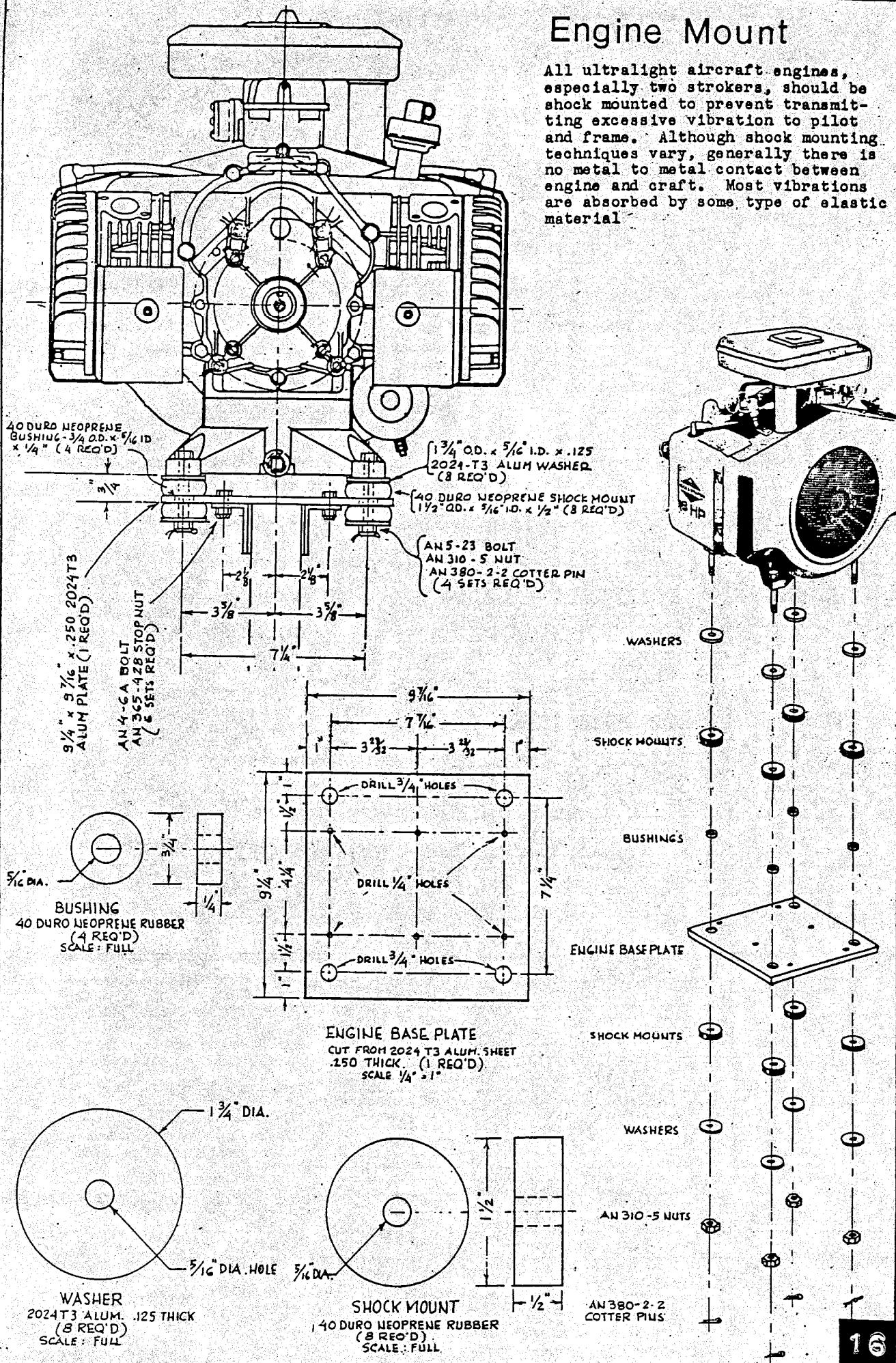
SAMPLE PROPELLER LAYOUT.

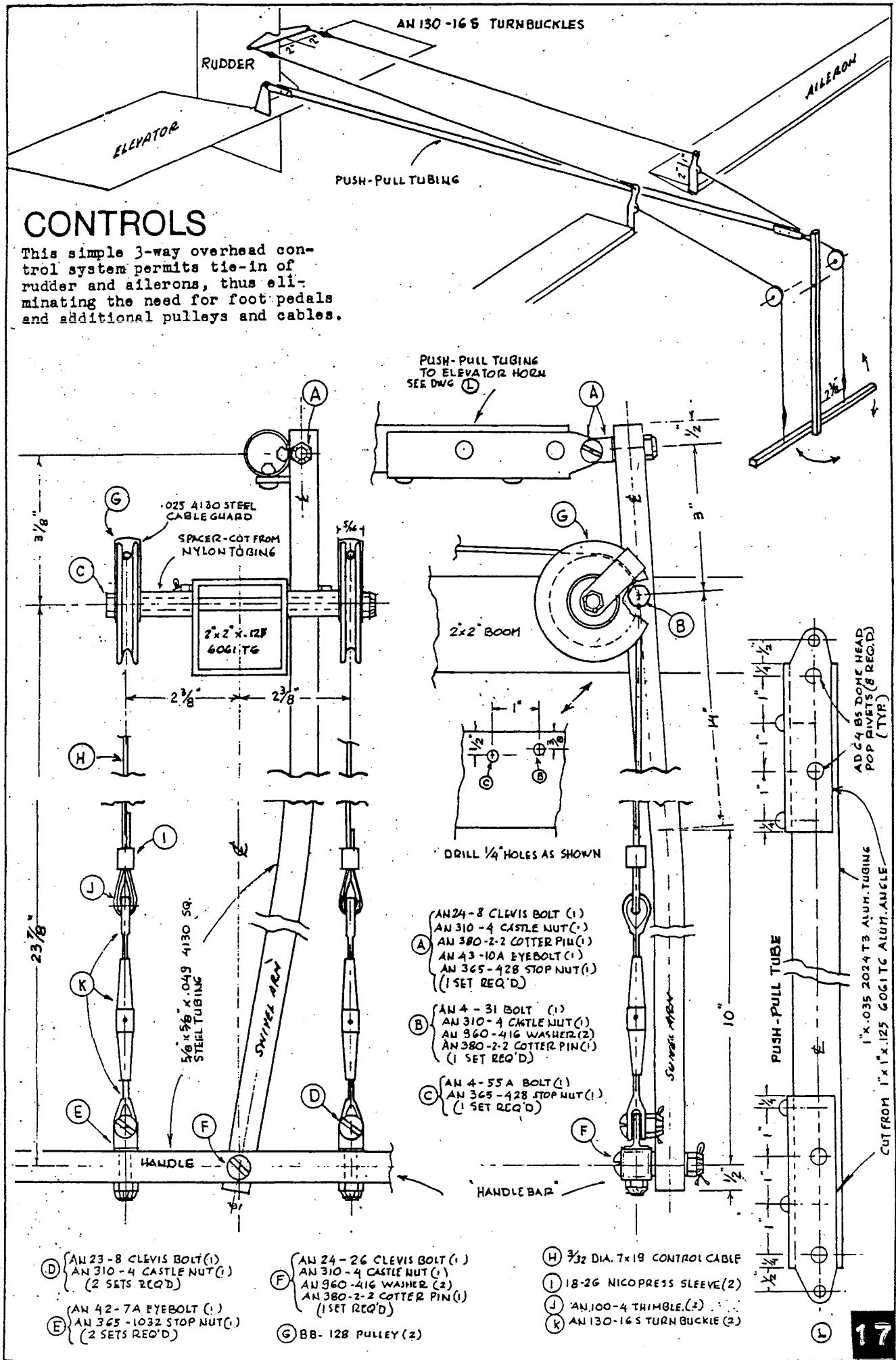
This simple propeller was designed to ~~be~~ out as much thrust as possible from an 8 H.P. engine. It operates most efficiently at 48 M.P.H. Have a lumber yard prepare five pieces of  $\frac{3}{8}$ " x 5" x 40" beechwood, birch, or maple laminations. Apply epoxy to all opposing faces and clamp together. Use two thick planks and several tightly screwed down 1" clamps to distribute pressure evenly. Allow to set for 24 hours. Remove clamps and planks. Trace propeller outline

on stock face and bandsaw barely outside lines. Sand down to outline. Drill a 1/16" hole through center of hub for use as a reference point. Mark off stations for leading and trailing edges on sides of stock. With help of a french curve, connect points. For each station, make a template by cutting out the cross section in a piece of plastic. Carve flat side of prop first. As you carve the curved side, slide template in position to check for proper cross section shape. Sand to a smooth finish and cover with epoxy.

# Engine Mount

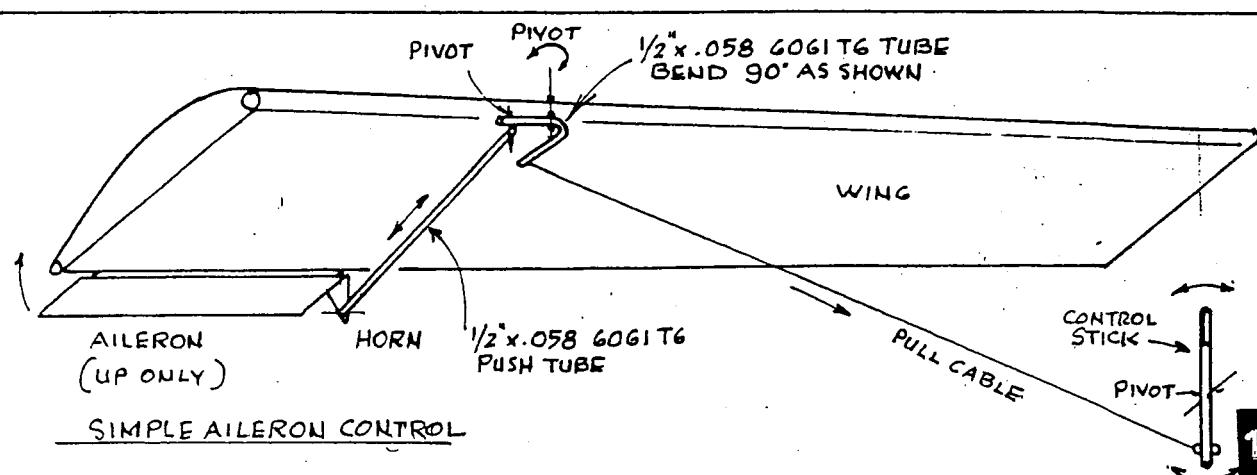
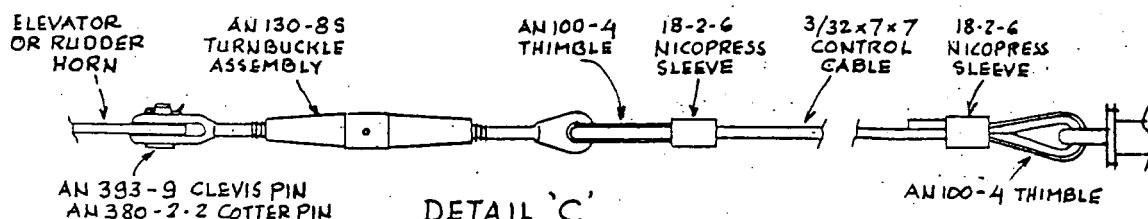
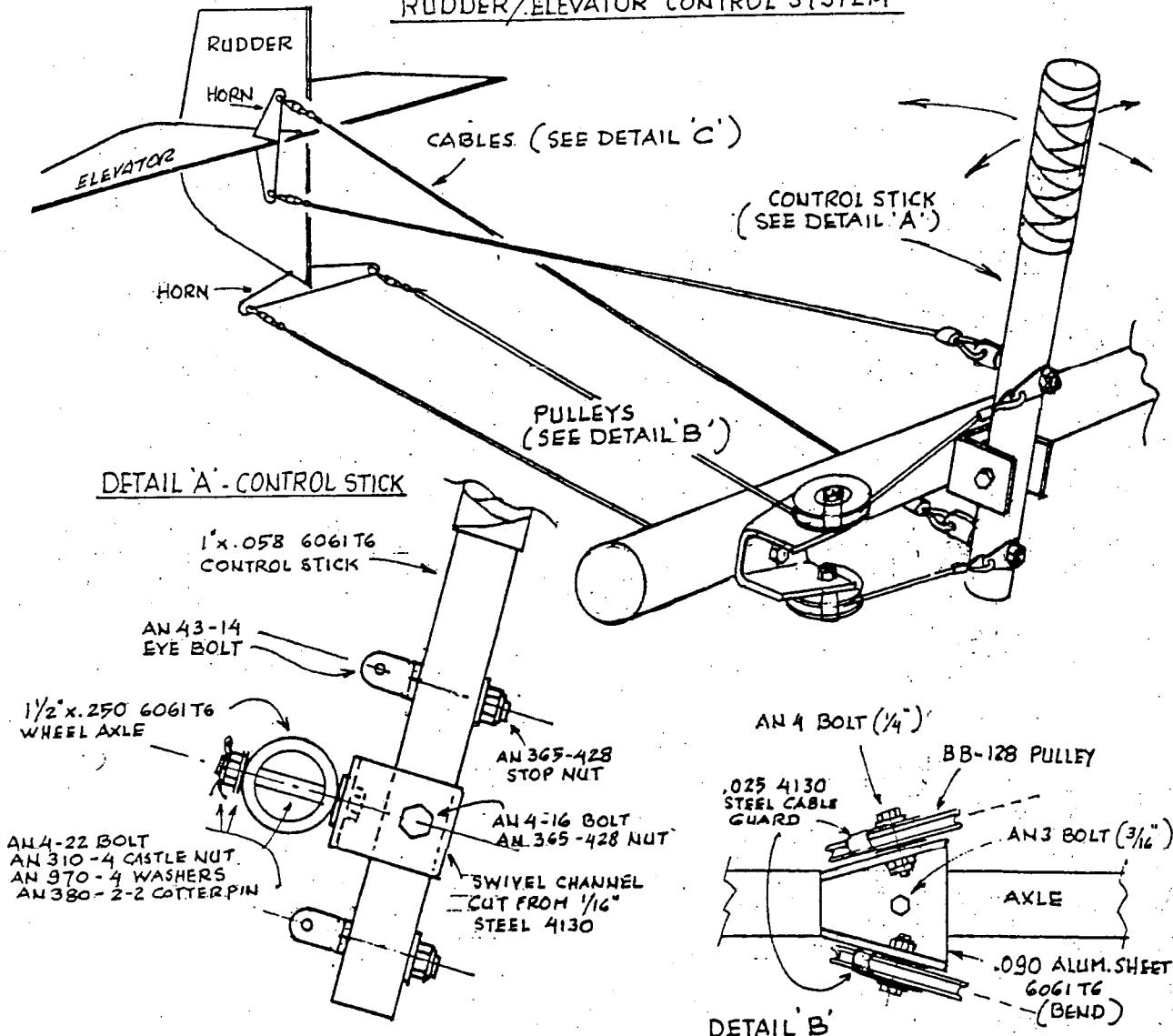
All ultralight aircraft engines, especially two strokes, should be shock mounted to prevent transmitting excessive vibration to pilot and frame. Although shock mounting techniques vary, generally there is no metal to metal contact between engine and craft. Most vibrations are absorbed by some type of elastic material.





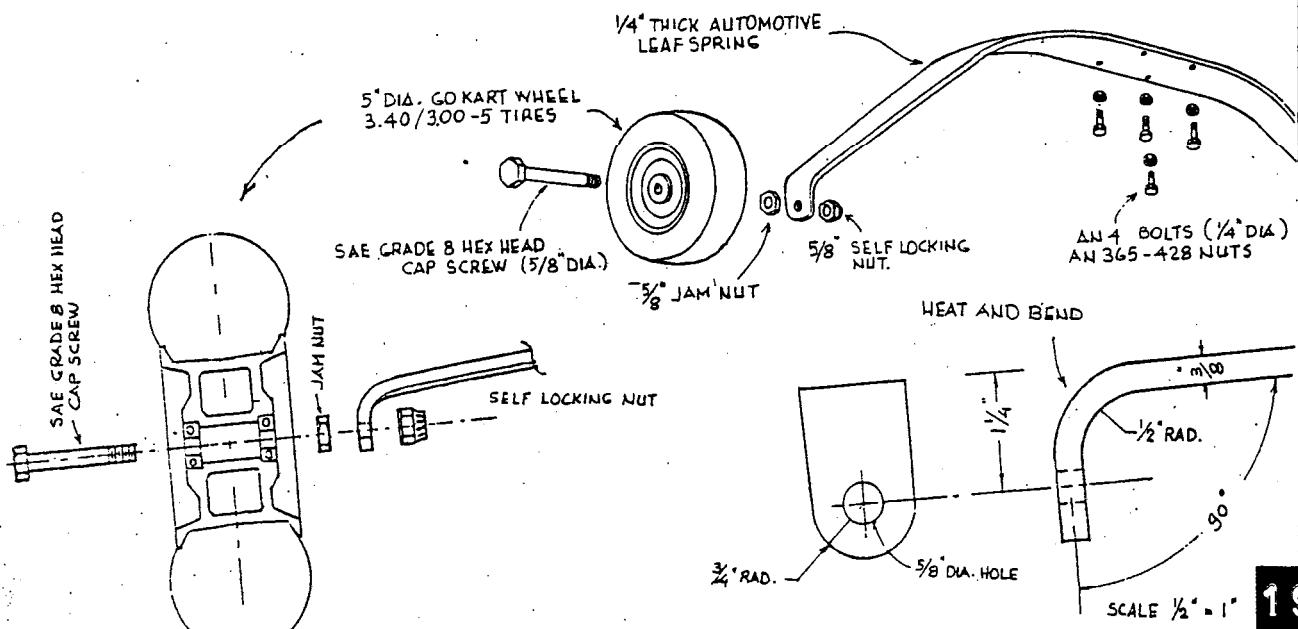
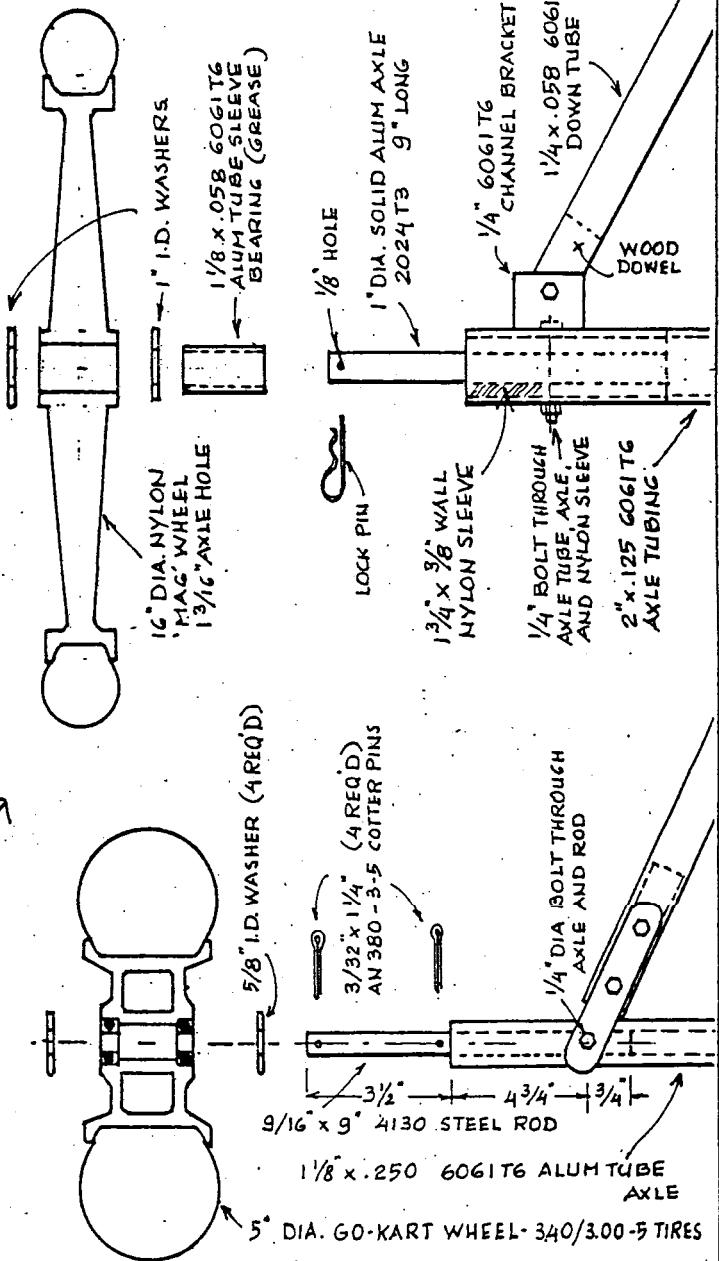
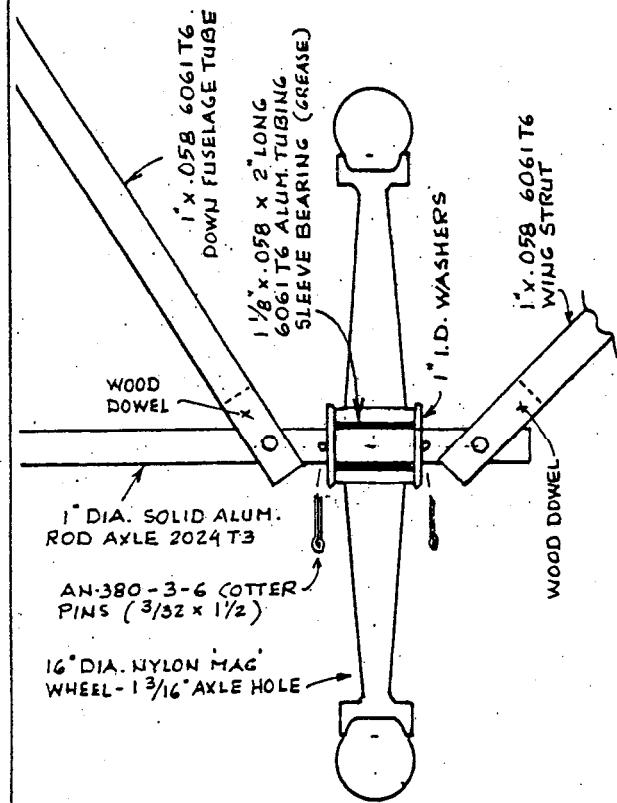
# CONTROLS

## RUDDER/ELEVATOR CONTROL SYSTEM



# Landing Gear Assemblies

The following four main wheel assemblies have many varieties. The 16 inch bicycle 'Mag' wheel is becoming very popular because it offers low drag and high axle ground clearance for rough landing strips. Having no ball bearings, the Mag wheel tends to bind, unless high temperature graphite grease is applied periodically.



# Tubing Connections

## NOTE:

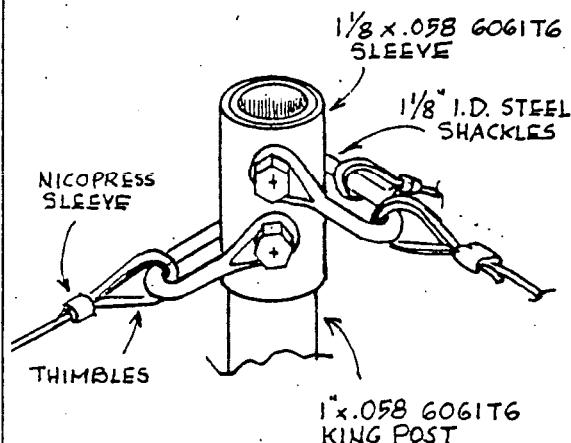
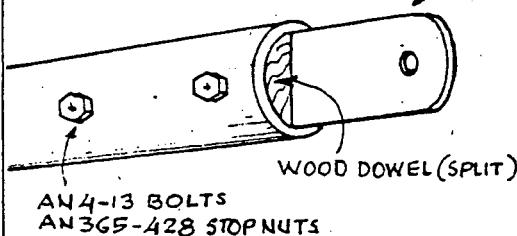
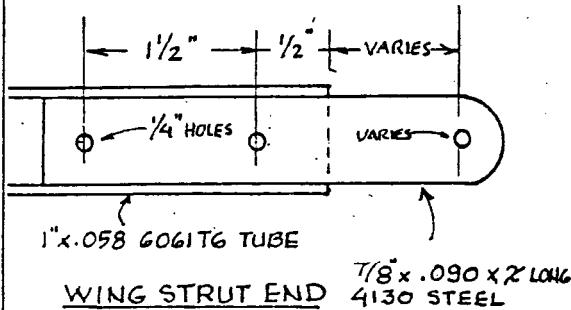
Aluminum tubing is generally sold in 12 foot lengths. Any length longer than 12 feet is referred to as Mill Length, and is difficult to locate. Furthermore, few delivery services will handle packets longer than 12 feet.

Since many ultralight aircraft tube parts are longer than 12 feet, knowledge of tube splicing becomes a necessity.

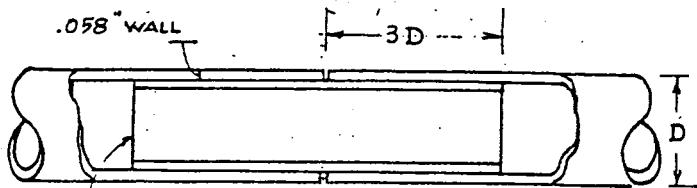
The spliced point between two tubes should be at least as strong as the weakest point along the entire tubing length.

ANY TUBING WILL SNUGGLY FIT INSIDE ANOTHER TUBING THAT HAS A 1/8 INCH LARGER OUTSIDE DIAMETER AND A WALL THICKNESS OF .058 INCHES.

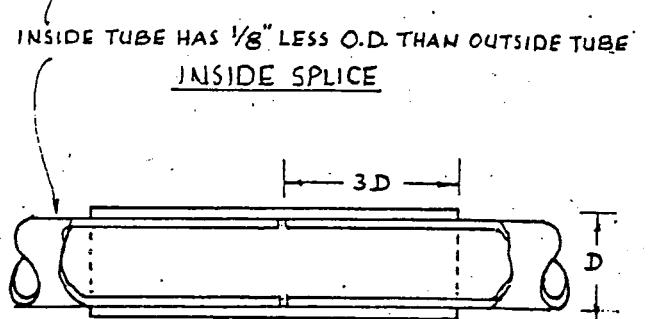
Example: A 1 1/8" O.D. x .058" wall tubing will fit tightly over a 1" O.D. tubing.



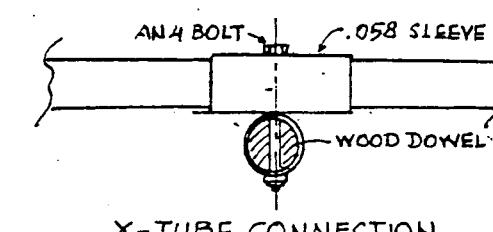
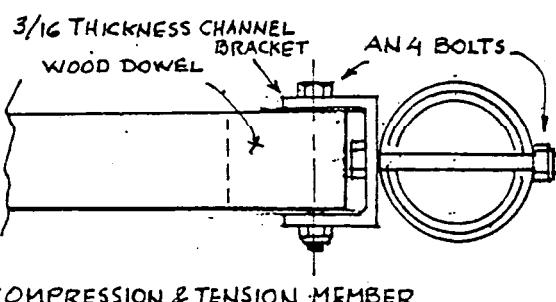
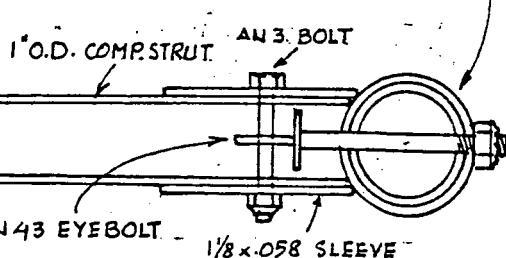
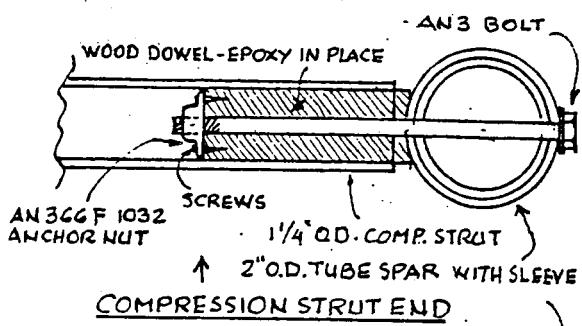
MULTI-CABLE ATTACHMENT



INSIDE TUBE HAS 1/8" LESS O.D. THAN OUTSIDE TUBE  
INSIDE SPLICE



OUTSIDE SPLICE



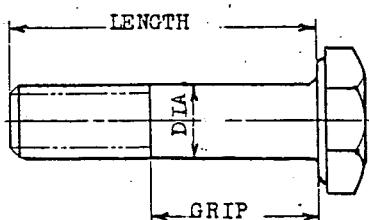
X-TUBE CONNECTION

# Hardware

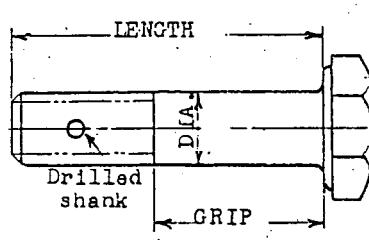
AN3 to AN6 hex head bolts are the most utilized bolts in the ultralight aircraft industry. These bolts can be fitted with AN 365 elastic stop nuts, AN 350 wing nuts, AN 310 castle nuts, AN 366F anchor nuts, and AN 380 cotter pins.

When ordering AN3 to AN6 bolts with undrilled shanks, add the letter A behind the dash number.

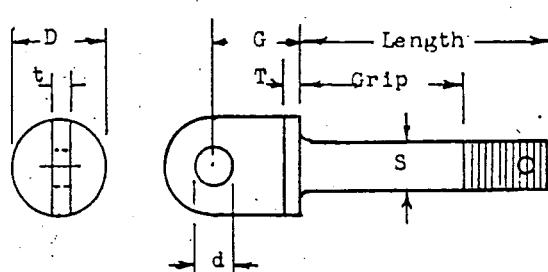
Example: AN4-7A



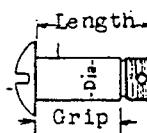
Example: AN4-7



**EYE BOLTS** - Used in tension. Ideal for control surface hinges, cables. Tensile strength 125,000 lbs/sq/in.



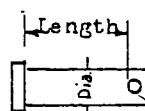
AN part No.	Length	Grip	S	d	D	G	T	t
AN42B-	For dash No. length & grip use AN3 bolt chart above	3/16	3/16	7/16	13/32	1/16	3/32	
AN43B-	For dash No. length & grip use AN4 bolt chart above	1/4	3/16	1/2	15/32	5/64	1/8	



## CLEVIS BOLTS AN23 - AN24

For shear stress, never for tension. Used as a hinge pin with eyebolts or other hinged surfaces.

Dash No.	AN23		AN24	
	3/16 Dia.	Length	1/4 Dia.	Length
8	3/16	17/32	3/16	17/32
9	1/4	19/32	1/4	19/32
10	5/16	21/32	5/16	21/32
11	3/8	23/32	3/8	23/32
12	7/16	25/32	7/16	25/32
13	1/2	27/32	1/2	27/32
14	9/16	29/32	9/16	29/32
15	5/8	31/32	5/8	31/32

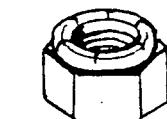


## CLEVIS PINS AN392 - AN394

Used with clevis forks. Shear stresses only. A secondary hinge pin.

Dash No.	AN392 1/8 Dia.		
	AN393 3/16 Dia.	AN394 1/4 Dia.	Length
7			7/32
9			9/32
11			11/32
13			12/32
15			13/32
17			17/32

# Hardware

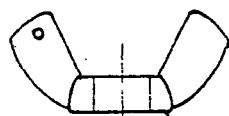


AN365  
Elastic stop nut

## ELASTIC STOP NUT AN365

A red or green nylon collar prevents this nut from loosening.

Dash No.	Hole Dia.
-1032	3/16
4	1/4



AN350  
Wing Nut

## AN350 Wing Nut

Has no fibre insert. must be lockwired for safety.

Dash No.	Hole Dia.
1032	3/16
4	1/4



## AN960 Flat Washers

Used with hex nuts to provide load surface, or as shims to correct bolt grip length.

Dash No.	I.D.	O.D.	Thickness
10	3/16	7/16	1/16
416	1/4	1/2	1/16



## AN970 Flat Washers

Used on wood surfaces.

Dash No.	I.D.	O.D.	Thickness
3	3/16	7/8	1/16
4	1/4	1 1/8	1/16

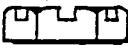


AN310 Castle

AN310 Castle nut  
AN320 Shear nut

Use with cotter pin

Dash No.	Hole Dia.
-1032	3/16
4	1/4



AN320 Shear

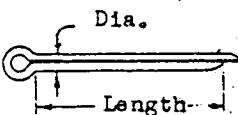
## AN366F Anchor nut

Can be pop riveted into blind spots. Has fibre insert.



AN366F  
Anchor nut

Dash No.	Hole Dia.
1032	3/16
428	1/4



## AN380 Cotter Pin

Use with castle nuts, drilled nuts, etc.

Dash No.	Dis.	Length
2-4	1/16	1"
3-4	3/32	1
4-6	1/8	1 1/2

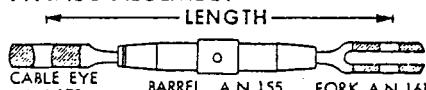


Lock Washer AN936 Type A  
Good locking action, especially on rounded surfaces ( tubing ).

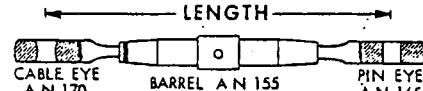
Dash No.	I.D.
A10	3/16
A416	1/4

**TURNBUCKLES** A complete turnbuckle assembly consists of a brass barrel and two steel ends. One end is threaded left and the other end is threaded right. Order by AN number and dash number.

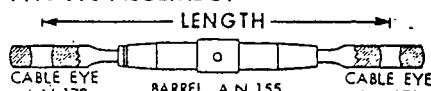
### AN 130 ASSEMBLY



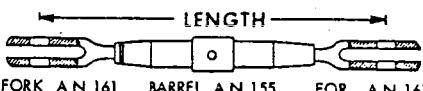
### AN 135 ASSEMBLY



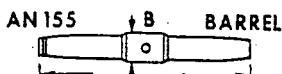
### AN 140 ASSEMBLY



### AN 150 ASSEMBLY



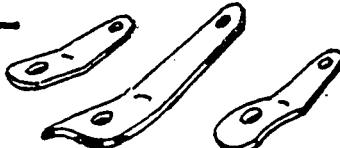
### TURNBUCKLE PARTS



Complete assemblies					Strength
Dash No.	Length in inches				
	AN130	AN135	AN140	AN150	Lbs.
-8S	4 1/2	4 1/2	4 1/2	4 1/2	800
-16S	4 1/2	4 1/2	4 1/2	4 1/2	1600
-22S	4 17/32	4 17/32	4 1/2	4 17/32	2200

Dash No.	Thread Size	AN155 Barrel L	AN161 Fork B	AN165 Pin eye G	AN170 Cable eye D	AN170 Cable eye A	AN170 Cable eye J
-8S	6-40	2 1/4	.250	.109	.188	.125	.188
-16S	10-32	2 1/4	.344	.156	.188	.188	.188
-22S	1-28			.187	.188	.188	.219

# Hardware

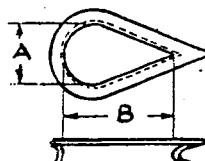
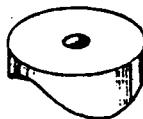


TANGS These allow cable connections to round or square tubing.

Straight tang - 1/4" & 5/16" hole  
 Flat angle tang - 1/4" hole  
 Saddle tang - 1/4" & 5/16" hole  
 Double flat tang - 5/16" hole  
 Double saddle tang - 5/16" hole  
 Double angle tang - 5/16" hole

## SADDLES AND STANDOFFS

Used to bolt together round tubing or tubing to tang.  
 Sizes vary considerably.



AN100 Cable thimbles  
 Forms eye end to control cables. Pass cable around thimble and secure with Nicopress sleeves.

Dash No.	Cable size
3	1/16"
4	3/32", 1/8"
5	5/32"

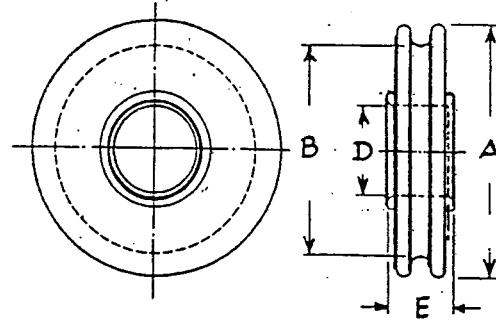


CABLES -  
 7 x 7 flexible cable has seven strands of 7 wires each.



7 x 19 extra flexible cable has seven strands of 19 wires each.

Dia. inches	Construction	Breaking strength galvanized	Breaking strength stainless
1/16	7 x 7	480 lbs	480 lbs
3/32	7 x 7	920 lbs	920 lbs
3/32	7 x 19	1000 lbs	920 lbs
1/8	7 x 19	2000 lbs	1760 lbs



AN210 Control pulleys - Made from fabric reinforced phenolic, with sealed ball bearings.

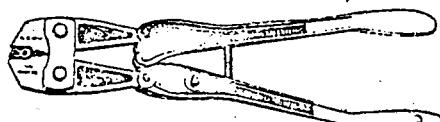
AN part No.	Cable size	A Dia.	B Dia.	D Hole	E	Load lbs
210-1A	1/16 3/32	1.25 2.50	.972 2.222	3/16	.297	185
210-2A	1/16 3/32	2.50 1.80	2.222 1.510	3/16	.297	500
210-3A	1/8 3/16	2.00 1.510	1.510 1.484	1/4	.484	450



## NICOPRESS SLEEVES

Part number	Cable dia.
18-1-C	1/16
18-2-G	3/32
18-3-M	1/8

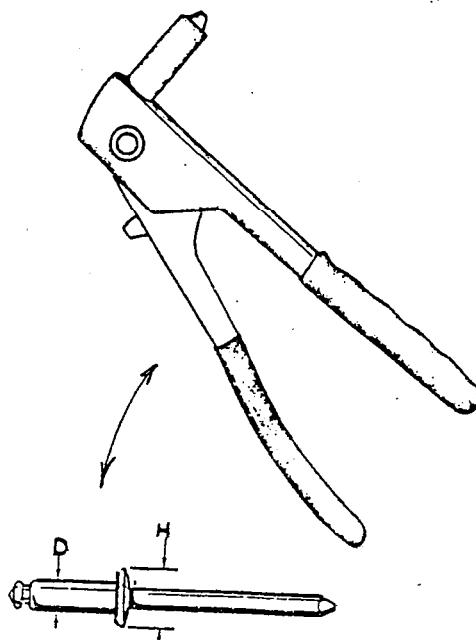
Nicopress hand squeezer



## POP RIVETS

Common pop rivets are available at your hardware store. These come in lengths of 1/8", 1/4", 1/2", 3/4", and 1", and are generally open ended. Use only the ones with steel mandrels.

Head Dia. H	Rivet Dia. D	Alum. body - Shear strength	Steel Mandrel Tensile Strength
3/16	3/32	120 lbs	170 lbs
1/4	1/8	200	320
5/16	5/32	330	480
1/2	3/16	440	700



# STRESSES in framed structures

A line may be used to represent direction and magnitude of a given force or stress. The magnitude of a straight line is measured in weight per given length, or commonly in pounds per inch of length. In Fig. 1, induced drag can be measured when the angle of attack (providing resultant) and lift (weight of aircraft acting vertically) are known. In Fig. 2, 3, 4, & 5, a force triangle is formed by following the force directions in a clockwise manner. Fig. 6 and 8, are extensions of the force triangle into a force polygon showing method of measuring the resultant force needed for equilibrium.

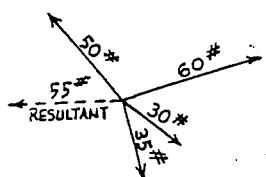
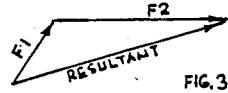
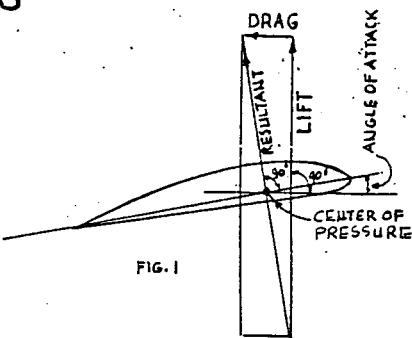


FIG. 6

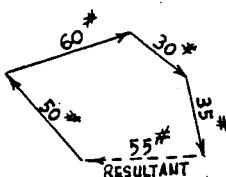


FIG. 7

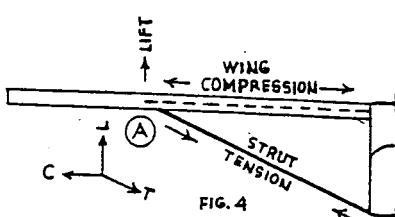
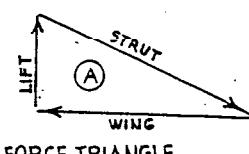


FIG. 4



FORCE TRIANGLE

FIG. 5

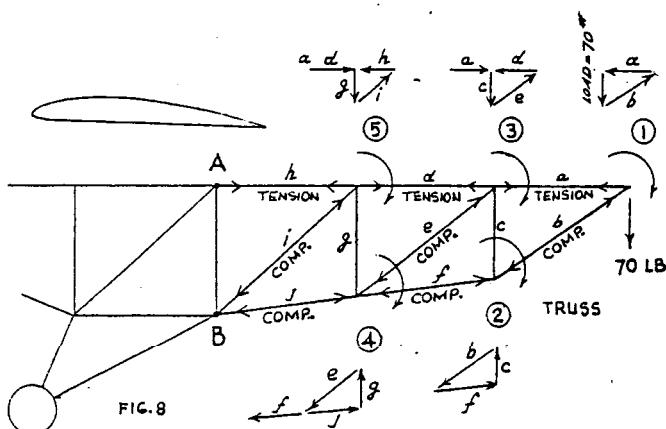


FIG. 8

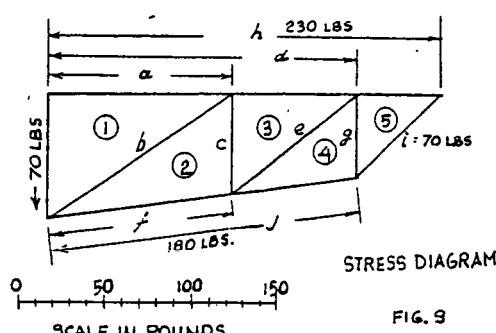


FIG. 9

Given: The truss shown in fig. 8, with an end load of 70 pounds.

Find: The tension load acting at point A. The compression loads acting at point B.

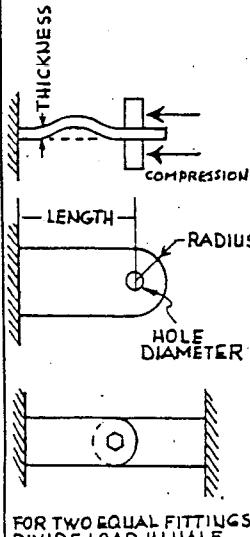
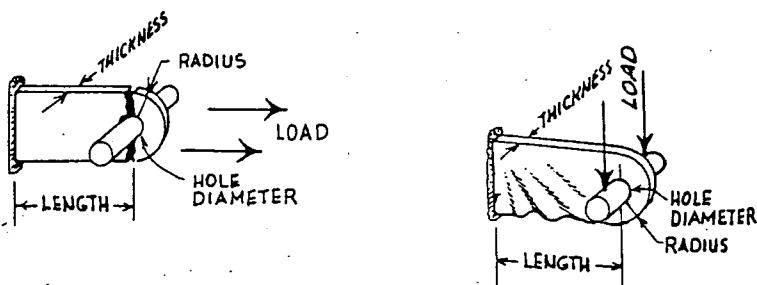
Compression loads act into a joint. Tension loads act away from a joint.

Starting at junction 1, fig. 8, form a force triangle as indicated by the small sketch shown immediately above. Always measure load directions in a clockwise direction. Using the scale shown, mark

a vertical distance of 70 pounds in fig. 9. Your force triangle at 1, fig. 8, is drawn in fig. 9 as the force triangle shown by lines 70 pounds, a, and b. Junction 2, fig. 8, is drawn in fig. 9 as the force triangle b, c, f. Follow through, remembering that no single force may be extended beyond itself. All your graphic forces 1, 2, 3, 4, 5, should fit together to form the complete force frame in fig. 9. The tension at A, fig. 8, is equal to the measured length of line h, fig. 9, or 230 pounds. By the same token, the compression loads at B are 70 pounds and 180 pounds. ( i, j )

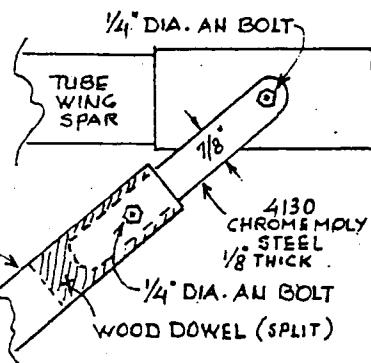
# Strength of Fittings

MAXIMUM TENSILE STRENGTH OF FITTINGS				
THICKNESS	HOLE DIA.	RADIUS	BREAK AREA	4130 CHROMEMOLY      2024-T3 ALUMINUM
.040	3/16"	1/4"	.012"	830 LBS.      580 LBS.
.040	1/4"	3/8"	.02"	1350 "      950 "
.040	1/4"	1/2"	.03"	2000 "      1400 "
.063	3/16"	1/4"	.02"	1300 "      900 "
.063	1/4"	3/8"	.032"	2100 "      1480 "
.063	1/4"	1/2"	.047"	3100 "      2200 "
.090	1/4"	3/8"	.045"	3000 "      2100 "
.090	1/4"	1/2"	.067"	4150 "      2900 "

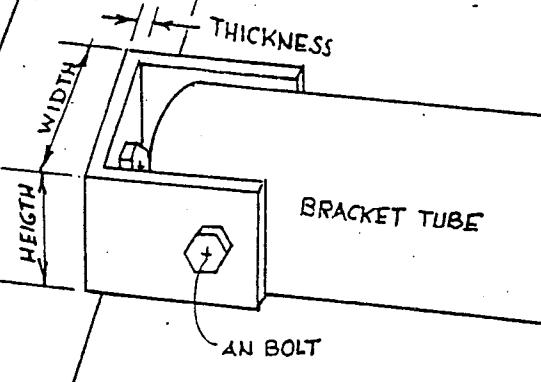


MAXIMUM COMPRESSION OF FITTINGS					
THICKNESS	HOLE DIA.	RAD.	LENGN	4130 CHROMEMOLY LBS.	2024-T3 ALUMINUM LBS.
.040	3/16"	1/4"	1/2"	770	540
			3/4"	600	420
			1"	420	290
.040	1/4"	3/8"	1/2"	1100	770
			3/4"	900	630
			1"	630	440
.063	3/16"	1/4"	1/2"	1260	880
			3/4"	1220	850
			1"	1120	780
.063	1/4"	3/8"	1/2"	1900	1320
			3/4"	1820	1270
			1"	1640	1140
.063	1/4"	1/2"	1/2"	2500	1750
			3/4"	2350	1640
			1"	2150	1500
.090	1/4"	3/8"	1/2"	2800	1960
			3/4"	2700	1900
			1"	2600	1800
.090	1/4"	1/2"	1/2"	3700	2600
			3/4"	3600	2500
			1"	3450	2400

MAXIMUM BENDING LOADS OF FITTINGS					
THICKNESS	HOLE DIA.	RADIUS	LENGTH	4130 CHROMEMOLY	2024-T3 ALUMINUM
.063	3/16"	1/4"	1/2"	450	315
			3/4"	320	223
			1"	250	175
.063	1/4"	3/8"	1/2"	160	110
			3/4"	1100	770
			1"	800	560
.063	1/4"	1/2"	1/2"	600	420
			3/4"	400	280
			1"	1700	1200
.063	1/4"	1/2"	1/2"	1300	900
			3/4"	950	670
			1"	650	420
.090	1/4"	3/8"	1/2"	1400	980
			3/4"	1100	770
			1"	820	570
.090	1/4"	1/2"	1/2"	550	380
			3/4"	2700	1900
			1"	2100	1480
.090	1/4"	1/2"	1/2"	1600	1120
			3/4"	1100	770
			1"	3500	2450
.090	1/4"	5/8"	1/2"	2700	1780
			3/4"	2100	1480
			1"	1400	980

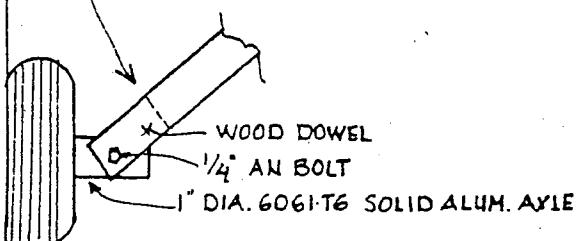


This typical strut arrangement will support a maximum tension load of 800 pounds. The weakest point is below, at the wheel, where the bolt will shear the bolt hole in the strut at the contact area between the axle and the strut.



STRENGTH OF 6061 T6 ALUMINUM CHANNEL BRACKETS - Permissible maximum tension loads in pounds.

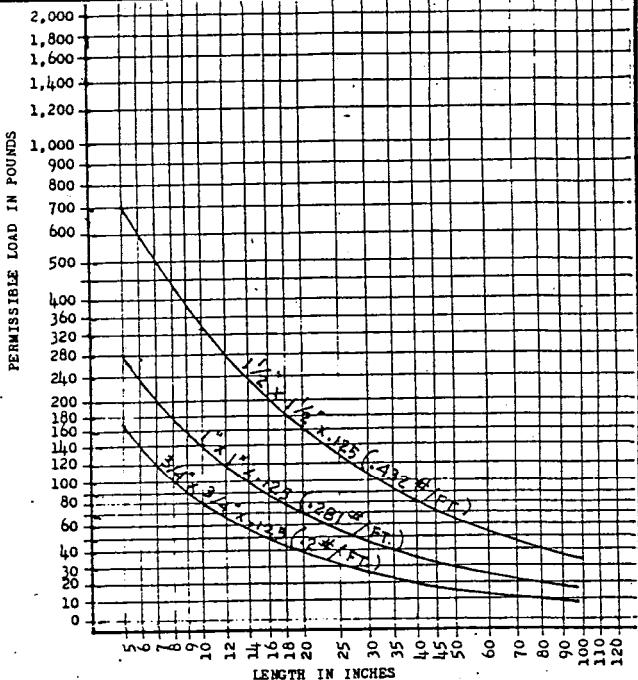
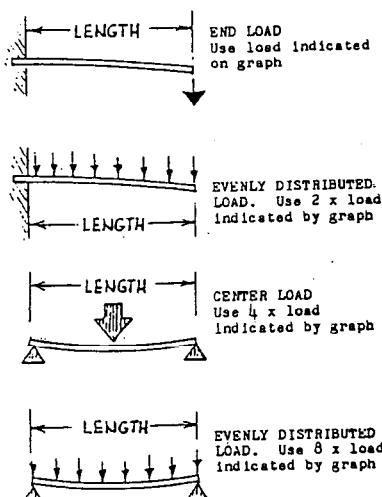
Bolt Dia.	Tube Dia.	Thickness	Width	Length	Maximum load.
3/16	3/4	1/8	1	3/4	220 lbs.
1/4	1	1/8	1 1/4	1	220 lbs.
1/4	1	3/16	1 3/8	1	540 lbs.
1/4	1 1/2	1/8	1 3/4	1 1/2	216 lbs.
1/4	1 1/2	3/16	1 7/8	1 1/2	540 lbs.
1/4	1 1/2	1/4	2	1 1/2	930 lbs.
1/4	2	1/4	2 1/2	2	940 lbs.



6061-T6 ALUMINUM ANGLE

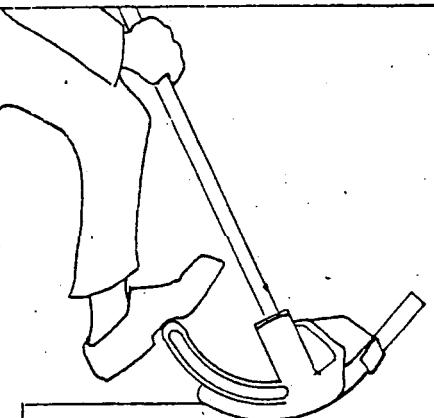
(2)

BENDING LOADS



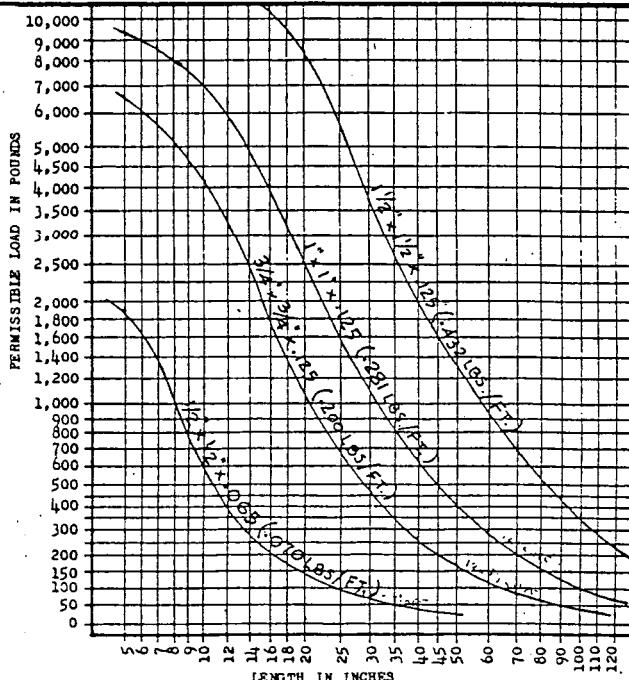
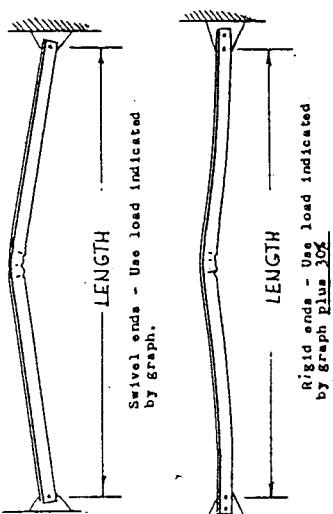
MINIMUM RADII FOR 90 DEGREE COLD BEND - Tubing.

Tube O.D.	6061 T6 Alum.	4130 Chrome-Moly Steel Tubing
1/4"	1 1/8" Rad.	7/8" Rad.
3/8"	2"	1 5/16"
1/2"	2 1/2"	1 3/4"
3/4"	3 1/2"	2 5/8"
1"	6"	3 1/2"
1 1/4"	7 1/2"	4 3/8"
1 1/2"	10"	5 1/4"
1 3/4"	11"	6 1/8"
2"	16"	7"



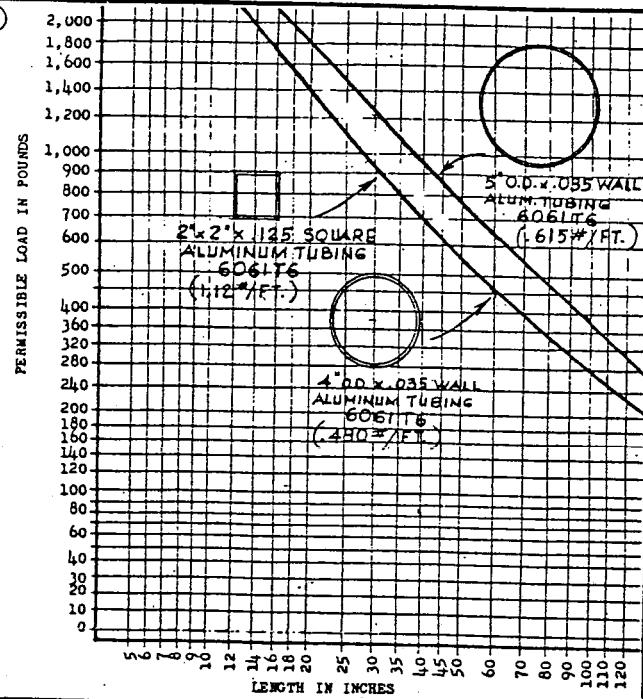
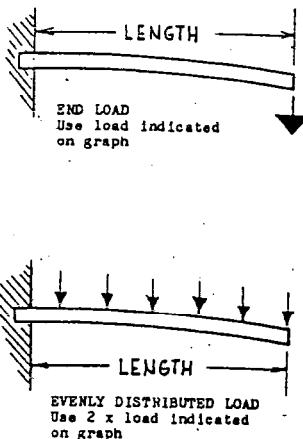
6061 ALUMINUM ANGLE  
COMPRESSION LOADS

(2)



6061-T6 ALUMINUM TUBING ④

BENDING LOADS



⑦

WALL 2024-T3 ROUND ALUMINUM TUBING

1/4" O.D. x .035 wall	.0281 lbs./ft.
3/8 .. x .035 ..	.0449 ..
1/2 .. x .035 ..	.0612 ..
5/8 .. x .035 ..	.0775 ..
5/8 .. x .049 ..	.1060 ..
3/4 .. x .049 ..	.1288 ..
3/4 .. x .065 ..	.1670 ..
1 .. x .035 ..	.1250 ..
1 .. x .049 ..	.1754 ..
1 .. x .065 ..	.2295 ..
1 1/4 .. x .049 ..	.2213 ..
1 1/2 .. x .049 ..	.2683 ..

⑨

2024-T3 ALUMINUM ANGLE

1/2" x 1/2" x .062" thick	.070 lbs./ft.
5/8 x 5/8 x .062 ..	.095 ..
3/4 x 3/4 x .062 ..	.109 ..
1 x 1 x .062 ..	.154 ..
1 1/2 x 1 1/2 x .125 ..	.432 ..

⑩

2024-T3 ALCLAD ALUMINUM SHEET

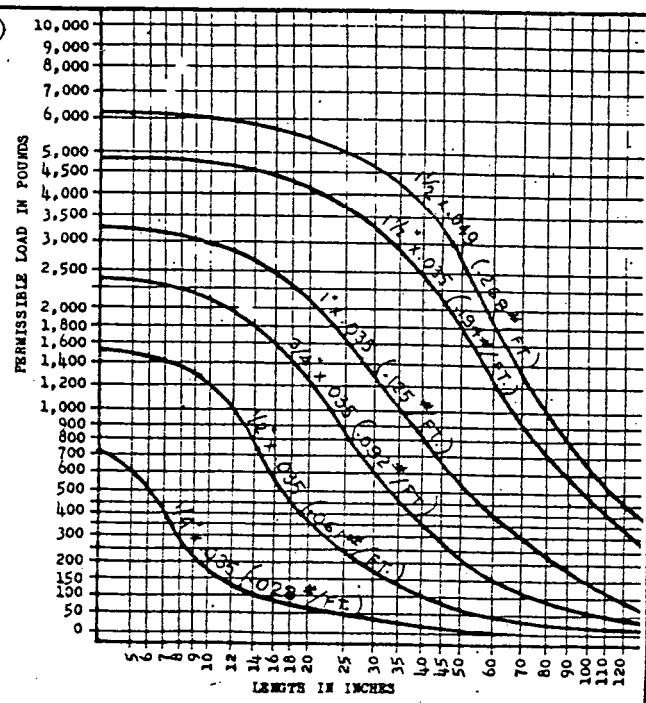
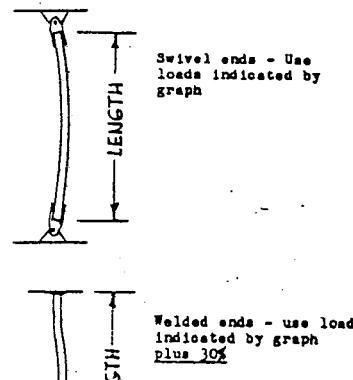
.016" thick	.230 lbs./sq. ft.
.025 ..	.360 ..
.032 ..	.461 ..
.063 ..	.907 ..
.090 ..	1.300 ..
.125 ..	1.800 ..

⑧

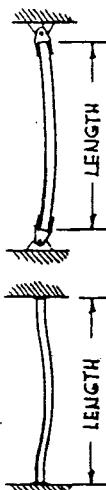
6061-T6 SQUARE ALUMINUM TUBING

2" x 2" x .125" wall	1.120 lbs./ft.
----------------------	----------------

6061 ALUMINUM TUBING  
COMPRESSION LOADS

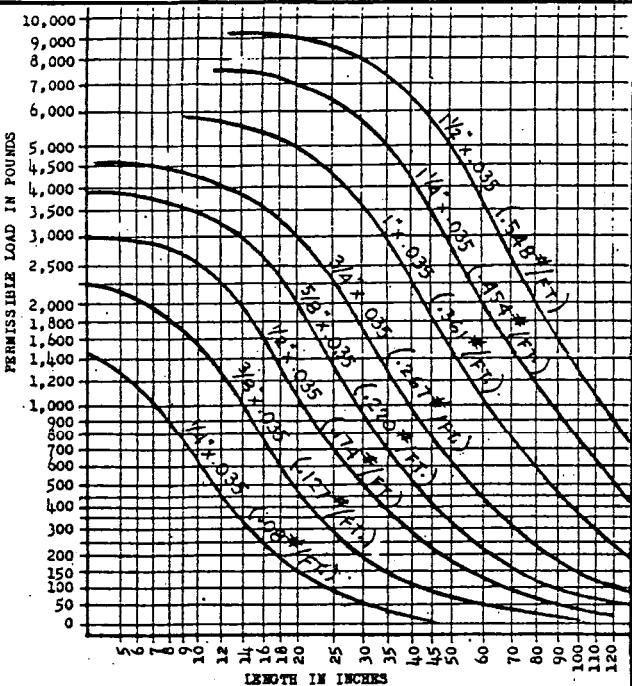


**4130 CHROME MOLY  
SEAMLESS STEEL TUBING  
COMPRESSION LOADS**



Swivel ends - Use load indicated by graph

Welded ends - use load indicated by graph plus 10%



THICKNESS

4130 CHROME MOLY ROUND  
STEEL TUBING

1/4" O.D. x .028 wall	.0664 lbs./ft.
1/4" x .035 ..	.0804 ..
3/8" x .028 ..	.1038 ..
3/8" x .035 ..	.1271 ..
1/2" x .028 ..	.1411 ..
1/2" x .035 ..	.1738 ..
5/8" x .028 ..	.1785 ..
5/8" x .035 ..	.2205 ..
3/4" x .035 ..	.2673 ..
3/4" x .065 ..	.4755 ..
1" x .035 ..	.3607 ..
1" x .065 ..	.6491 ..
1 1/4" x .035 ..	.4542 ..
1 1/4" x .065 ..	.8226 ..
1 1/2" x .035 ..	.5476 ..

THICKNESS

4130 CHROME MOLY SQUARE  
STEEL TUBING

1/2" x 1/2" x .035 wall	.2213 lbs./ft.
5/8" x 5/8" x .035 ..	.2808 ..
3/4" x 3/4" x .035 ..	.3403 ..
7/8" x 7/8" x .035 ..	.3998 ..

4130 CHROME MOLY  
STEEL SHEETS

.025" thick	1.00 lbs./sq. ft.
.036 ..	1.45 lbs./sq. ft.
.063 ..	2.55 ..
.090 ..	3.66 ..
.125 ..	5.10 ..

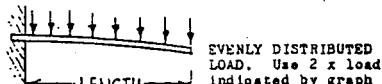
EQUIVALENTS IN MEASURING (1)

Fraction of inch	Decimal equivalent	Gauge equivalent
1/64	.015625	28
1/32	.03125	20
3/64	.046875	18
1/16	.0625	16
5/64	.078125	14
3/32	.09375	13
7/64	.109375	12
1/8	.125	11
9/64	.140625	10
5/32	.15625	9
11/64	.171875	8
3/16	.1875	7
13/64	.203125	6
7/32	.21875	5
15/64	.234375	4
1/4	.25	3

**4130 CHROME MOLY  
SEAMLESS STEEL TUBING  
BENDING LOADS**



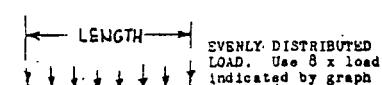
END LOAD  
Use load indicated on graph



EVENLY DISTRIBUTED  
LOAD. Use 2 x load indicated by graph

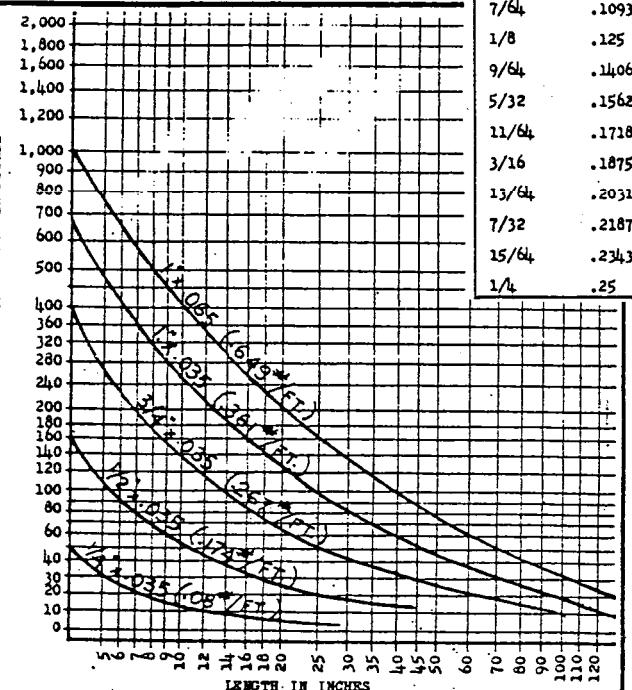


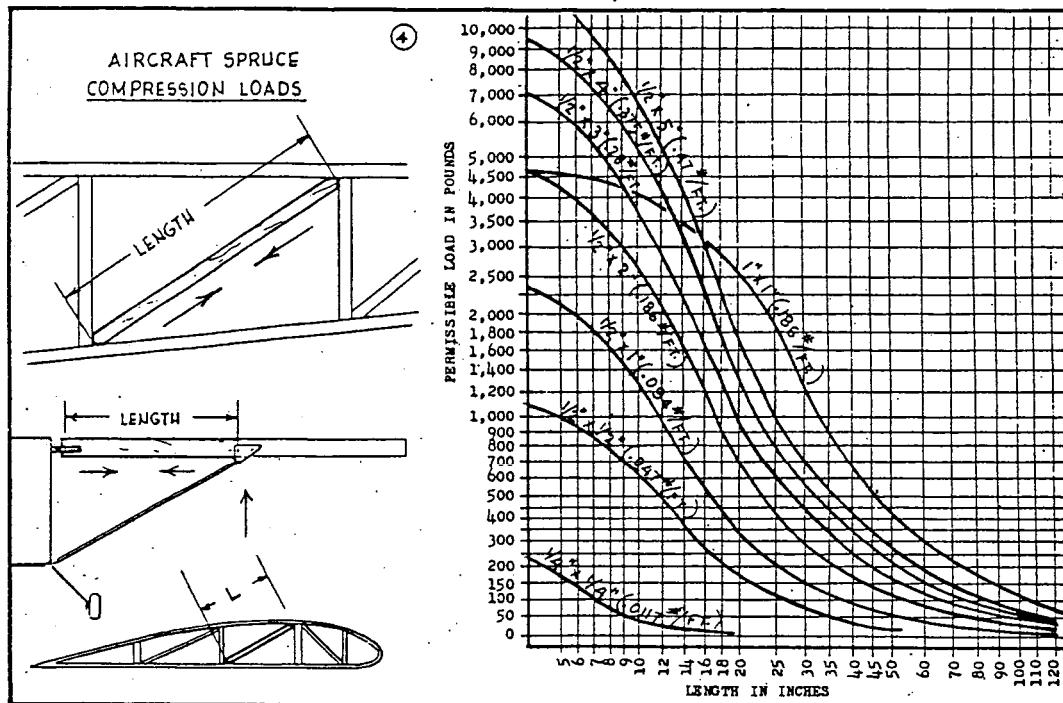
CENTER LOAD  
Use 4 x load indicated by graph



EVENLY DISTRIBUTED  
LOAD. Use 8 x load indicated by graph

PERMISSIBLE LOAD IN POUNDS





(14) GLUES AND EPOXIES

**RECORCINOL - FORMALDEHYDE GLUES.** Most highly recommended. Use on wood. Completely waterproof. Withstands high temperatures. Marketed under various trade names such as Amberlite, Cascophen, Wildwood, etc. Hardens through catalytic action of resin and hardener. Do not use on foams, as it will shrink and crack.

**UREA - FORMALDEHYDE GLUES.** Waterproof. Excellent for wood. Sensitive to high moisture content of wood. Marketed as Aerolite, LaPages Panite, Casco, Plaskon, etc. Hardens through catalytic action of resin and hardener. Never use on foam.

**EPOXIES.** Excellent for almost all materials. Does not shrink. Recommended for foam. Hardens through curing action of resin and hardener. Does not lose weight during curing. Varies from liquid to paste. Marketed under many trade names, including Flyte Bond, Epon 815, Loctite, etc.

(2) WOOD

Sitka Spruce	.016 lbs./cu. in.
Pine	.016 lbs./cu. in.
Birch	.025 lbs./cu. in.
Balsa	.006 lbs./cu. in.
1/32" Birch Plywood	.156 lbs./sq. ft.
1/32" Mahogany Plywood	.125 lbs./sq. ft.
1/16" Birch Plywood	.225 lbs./sq. ft.
1/16" Mahogany Plywood	.180 lbs./sq. ft.
1/8" Birch Plywood	.470 lbs./sq. ft.
1/8" Mahogany Plywood	.375 lbs./sq. ft.
1/4" Birch Plywood	.98 lbs./sq. ft.
1/4" Mahogany Plywood	.78 lbs./sq. ft.



PLEXIGLAS SHEETS

.060" thick	.37 lbs./sq. ft.
.080 ,,	.49 ,,
.125 ,,	.62 ,,

(16) FLUIDS

Gasoline	6.0 lbs./gal.
Oil	7.5 lbs./gal.
water	62.5 lbs./cu. ft.

PROPERTIES OF AIRCRAFT WOOD

**SPRUCE**, red or white  
27 lbs./Cu. Ft.

The most popular wood for aircraft construction. 10,000 lbs./Sq. in. tensile strength. 5,000 lbs./Sq. in. compression strength. Excellent for wing spars. Grain deviation must be less than 1 : 15.

**DOUGLAS FIR**  
28 lbs./Cu. Ft.

Slightly stronger than spruce, but hard to shape. May be used as substitute for spruce (with care).

**NORTHERN WHITE PINE**  
27 lbs./Cu. Ft.

About 85% as strong as spruce. Easy to work. Not a substitute for spruce.

**BIRCH**, yellow  
44 lbs./Cu. Ft.

Very dense wood. Excellent for propellers. Tensile strength - 17,000 lbs./Sq. In.

**MAHOGANY**  
34 lbs./Cu. Ft.

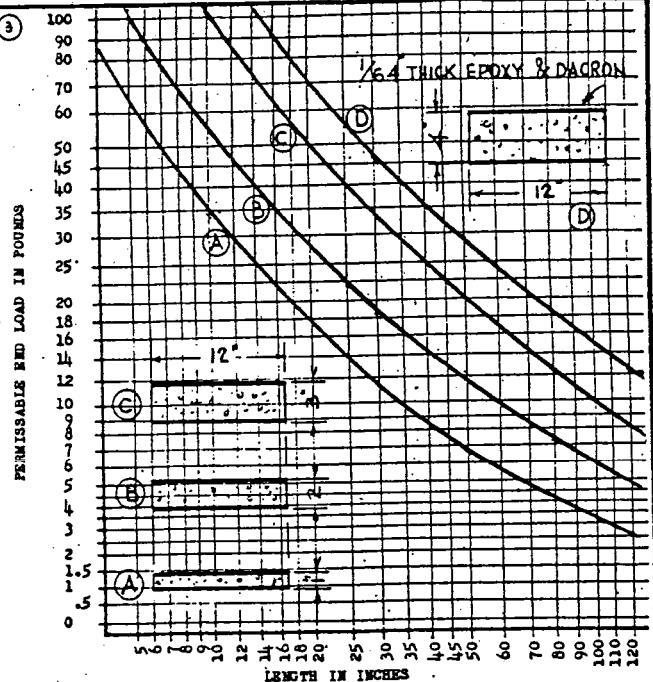
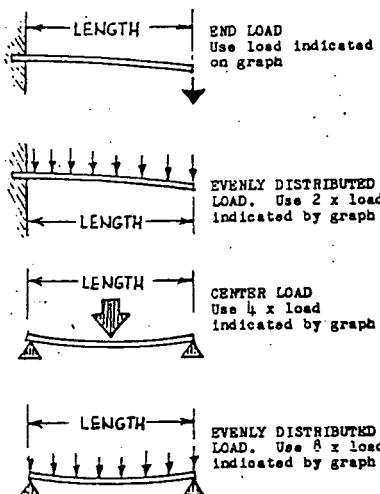
Used in aircraft plywoods.

**BALSA**  
10 lbs./Cu. Ft.

Has about 1/3 the strength of spruce. Not very popular anymore. Foams taking it's place.

**EXTRUDED FOAM (BLUE)**  
**1/64" EPOXY/DACRON COVER TOP**  
**AND BOTTOM**

Foam in aircraft is considered highly experimental. These figures should not be used for structural loads.



**FOAMS**

Urethane foam ( tan )	2 lbs./sq. ft.	sizes: 1/2" x 2' x 4' 1" x 2' x 4' 2" x 2' x 4'
Extruded foam ( blue )	2.2 lbs./sq. ft.	sizes: 1/2" x 2' x 4' 1" x 2' x 4' 2" x 2' x 4'

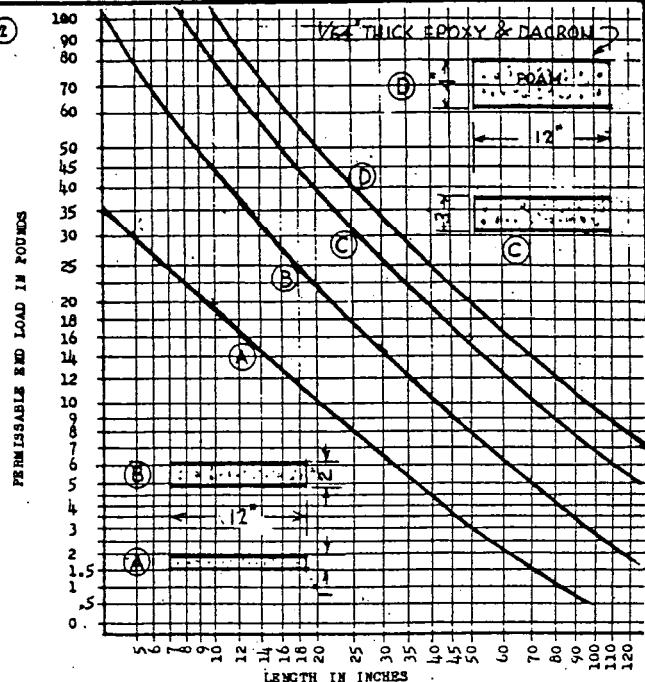
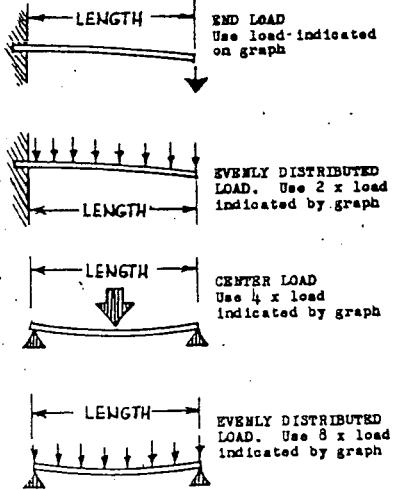
**FABRICS**

Dacron Greige, 66" wide	1.8 oz./sq. yard or .0125 lbs./sq. ft.
" "	2.7 " " " " ,0186 " " "
" "	3.7 " " " " ,0255 " " "
Grade "A" cotton, 60" wide	4.4 oz./sq. yard or .030 lbs./sq. ft.
Dynel, 39" wide	6.0 oz./sq. yard or .028 lbs./sq. ft.

Layer of epoxy/ 1.8 dacron/ epoxy .....approx. .06 lbs./sq. ft.  
Single layer epoxy over foam..... approx. .04 lbs./sq. ft.  
Single layer epoxy over plywood.....approx. .03 lbs./sq. ft.

**POLYURETHANE FOAM (TAN)**  
**1/64" EPOXY/DACRON COVER TOP**  
**AND BOTTOM**

Foam in aircraft is considered highly experimental. These figures should not be used for structural loads



# Aircraft Material

## FOAM

Take a piece of  $\frac{1}{8}$  inch thick plywood, 10 inches wide, and 4 feet long. Set one end on the ground and press down the plywood strip. Now, spay blue this side of the plywood band and break the plywood strip. Now, spay blue this side of the plywood band and break the plywood strip. After the epoxy has hardened, compress the plywood strip as before. You cannot break it. It will easily support two men.

To the other side of the foam block, place the foam sandwich across a cement block. Place two men on either side of the foam. The foam sandwich will barely bend.

The above illustrations cover the basic principle used in foam aircraft construction. Foam is never used as a load bearing structural member, but rather as a shear body for load carrying surfaces which would otherwise buckle, or as a shear body for load carrying surfaces which would otherwise fail.

Here are some of the most popular foams....

**BLUE STYROFOAM OR EXTRUDED FOAM ( Poly-Styrene ).** Most highly recommended for ultralight aircraft. Weighs 2.2 lbs. per cubic foot. Dissolves easily in fuel, solvents, contact cement, and polyester resins. Compressive strength about 10 lbs./sq. in. Does not dissolve in benzene.

Really out with hot wire. Does not give off poison gases when heated.

**TAN OR GREEN URETHANE ( Polyurethane ).** The tan variety is most commonly used. Weighs 2 lbs. per cubic foot. Resistant to gasoline, solvents, acetone, epoxy, and polyester resins. Compressive strength: 20-25 lbs./sq. in. Do not hot wire out, gives off poison gas. Often used where fuel is present.

**PVC ( Polyvinyl Chloride ).** Hard to find. No longer made in U.S.A. Very expensive, but very good. Used in sailplane construction. Resistant to most chemicals.

**ACRYLIC FOAM.** Extremely strong and expensive. Made in Germany. For the rich who can afford high performance sailplanes.

**WHITE STYROFOAM ( Expanded Poly-Styrene ).** The worst of the lot. Looks like a bunch of foam balls squashed together. Weighs only 1 lb. per cu. ft. Virtually disappears in the presence of heat or gasoline. Has been involved in airplane accidents in solid form, but only as a stiffener with no shear involved. Deteriorates in sunlight. Must be painted a very light color. Used in making molds.

Not all types of foam are practical for aircraft use. White styrofoam is used in cups, picnic coolers, packing boxes, etc. Its use in aircraft construction is reserved for the experts. Placed in solid form between wing or tail spar, it acts as a mild stiffener where all load bearing members are in contact with each other. Unlike the better foams, white styrofoam is considered to have no shear capabilities. For long lasting results, the finished aircraft must be painted a highly reflective color ( white is best ) to keep ultra violet rays from disintegrating the foam. Gasoline striking down a pinhole in the styrofoam covering will create a big empty hole where the whole styrofoam once was. As a medium for breaking molds, it has few equals. Carve it into the desired shape, then coat with dycne / epoxy. After the epoxy has set, wash out the white styrofoam with gasoline, leaving a perfect shell.

Blue styrofoam is best all around - price and strength wise. It must be used with epoxy. Polyester resins will slowly dissolve it.

Second best - in the same category - is tan urethane. Green urethane is seldom used. Urethane foam can be covered with either epoxy or polyester resin. It is more resistant to most chemicals than blue styrofoam, but has only half the shear and compressive strength. Its use should be restricted to areas where fuel spillage could occur.

Always wear a mask whenever sanding foam. An aromatic sander can create a real ranastorm.

## POLYESTER

Polyester resins come with a Hardener ( catalyst ) which does not become part of the final cured product. One gallon of polyester resin requires about two ounces of hardener.

There are two types of polyester resins commonly used in aircraft construction. Bonding polyester resin hardens with a tacky surface, permitting additional layers to be applied without sanding.

Surfacing polyester resin hardens with a dry, hard surface. Before additional layers can be applied it must be thoroughly sanded.

As with epoxy resin, polyester resin is used with fibrocloth, dycne, dacron, or just about any kind of loosely woven material. Maximum strength is reached with fiber glass cloth.

Although polyester weighs less and costs less than epoxy, there are some penalties involved. Polyester resin shrinks as it hardens. It will break away from any material that it does not give, such as metal and glass.

If not properly applied, polyester resin can cause deformation in flexible materials. It may only be used on certain foams ( urethane, for example ). Never use it on styrofoam.

## EPOXY

Because there are so many different types of epoxies on the market, we shall cover only the general characteristics.

A typical epoxy kit will contain a large can of resin and a small can of hardener. Resin and hardener are thoroughly mixed in ratios varying from three to six parts resin for each part hardener. Since the hardener is a curing agent, it enters into the reaction and becomes part of the final solid. A quart of resin mixed with a quart of hardener will give 1.4 quarts of cured resin. Most epoxies have a working life of 20 minutes to 2 hours. The complete cure takes about 24 hours.

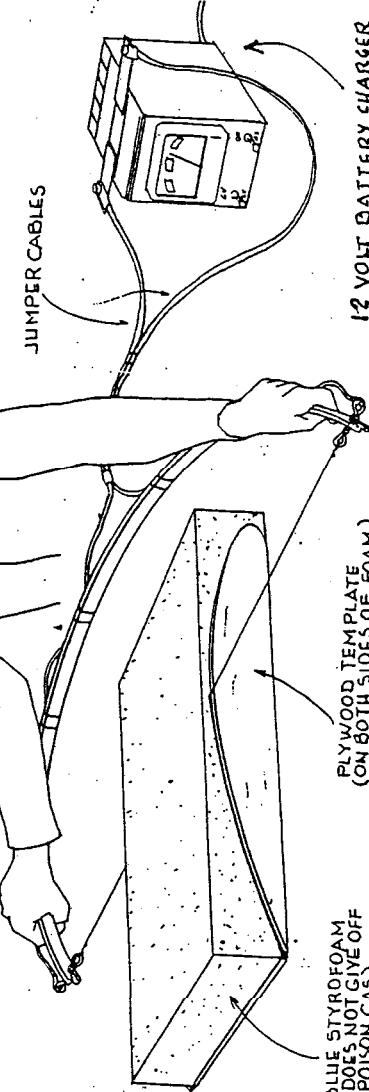
Viscosity of the epoxy resin will vary from syrupy to pasty. The less viscous variety is used for applying dycne, dacron, or fibrocloth to foam. The thicker epoxies are best for creating strong bonds between smaller contact areas.

Epoxy shrinks very little, and can thus be used to bond slick surfaces of hard materials ( glass, metal ). Epoxy will stick to polyester, but from hard smooth materials. Polyester shrinks and pulls away from hard smooth materials.

Epoxy is expensive - about twice as much as polyester.

## HOT WIRE CUTTING BOW

Use an actual plastic bow from a toy bow and arrow set. Form connecting ends from heavy gauge copper wire, twisted as shown into double eyelets in which to notch the notches of the bow. The cutting wire may be stainless steel, safety wire or nichrome wire. Nichrome wire is used in toasters, heaters, etc., and available at your electrical hardware store. Your copper eyelets, connect jumper cables leading to a 12 volt battery, 12 volt battery charger, or a model train transformer. The cutting wire must be barely hot enough to melt the foam away from the cutting plane. The cut edges of the foam must be smooth.



12 VOLT BATTERY CHARGER

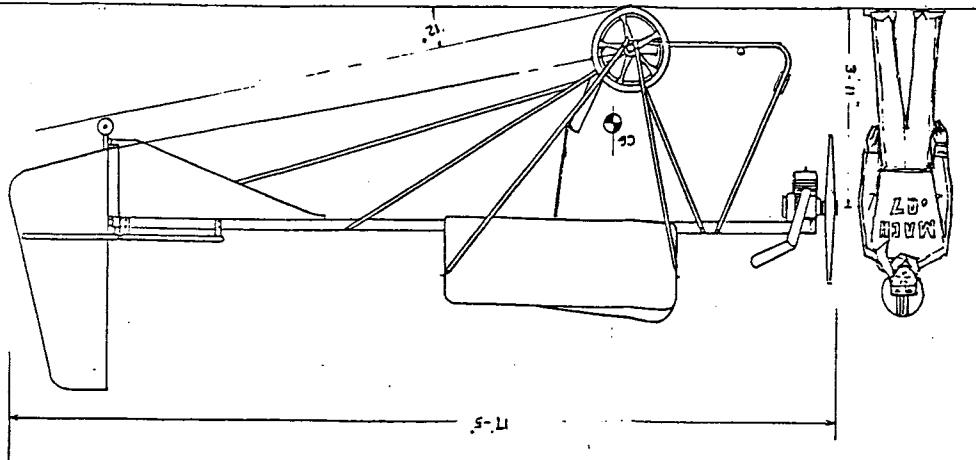
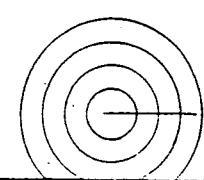
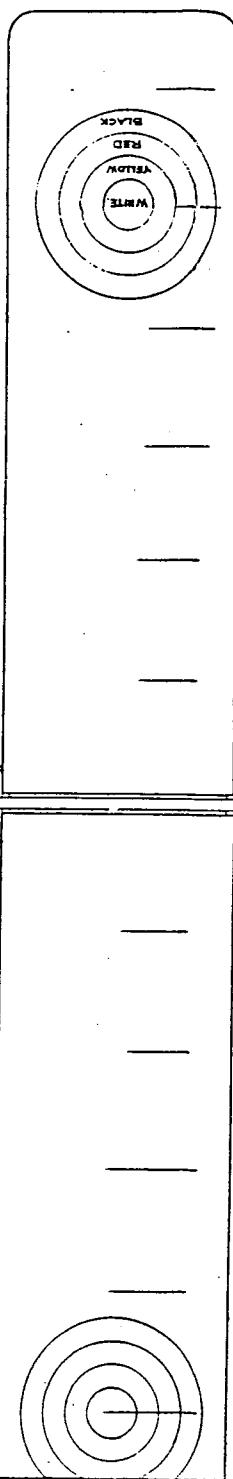
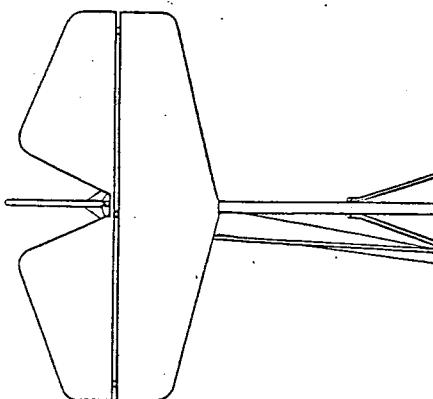
PLYWOOD TEMPLATES  
(ON BOTH SIDES OF FOAM)



# REFERENCE PLANS

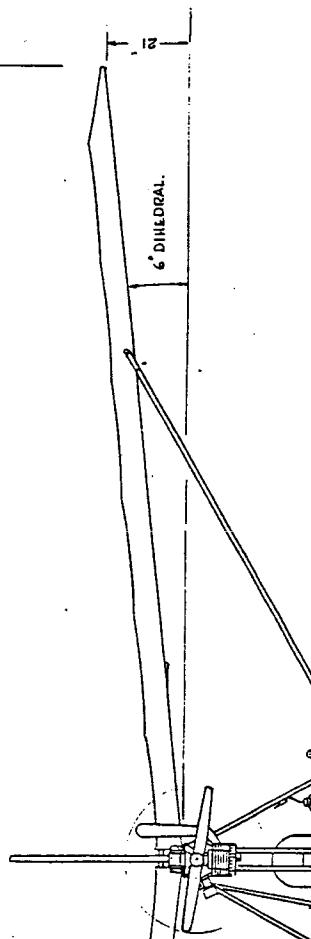
## SPECIFICATIONS

POWER 250CC 2 CYLINDER 6.25:1 ENGINE  
 PROPRIOR 20 HP / 6200 RPM.  
 LENGTH 17'-5"  
 HEIGHT 42.5 FT  
 WEIGHT 165 LB.  
 GROSS WEIGHT 400 LB.  
 CRUISE LOAD 160 LB.  
 WING LOAD 2.25 LB/SF  
 ROLL RATE 2.4 R/S  
 P.D. 2.5 OAT.  
 ROLL Damping 1.5 OAT.  
 MAX. THRUST 40-50 MPH/MIN.  
 TIME TO 70 MPH 10 SECONDS.



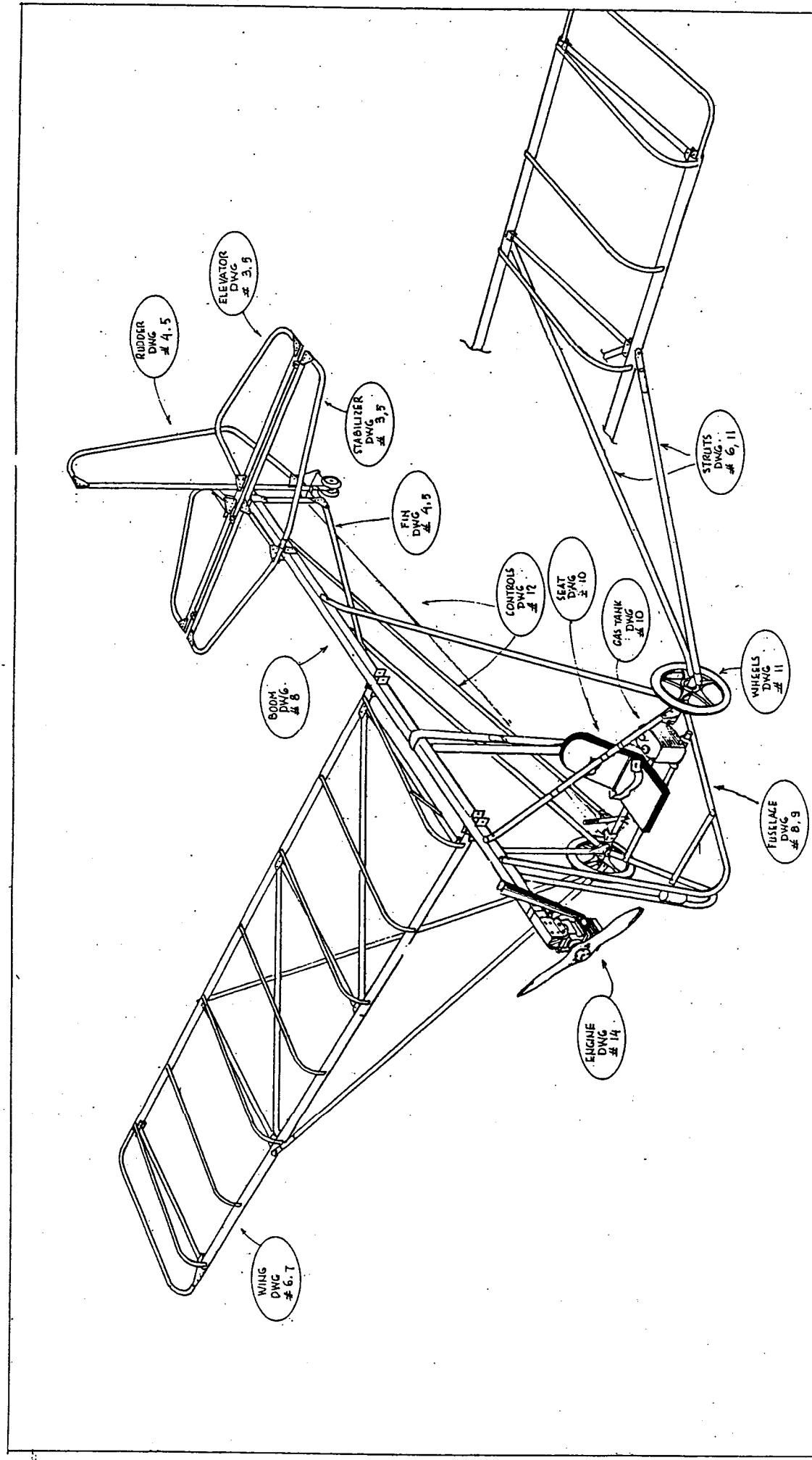
## PERFORMANCE

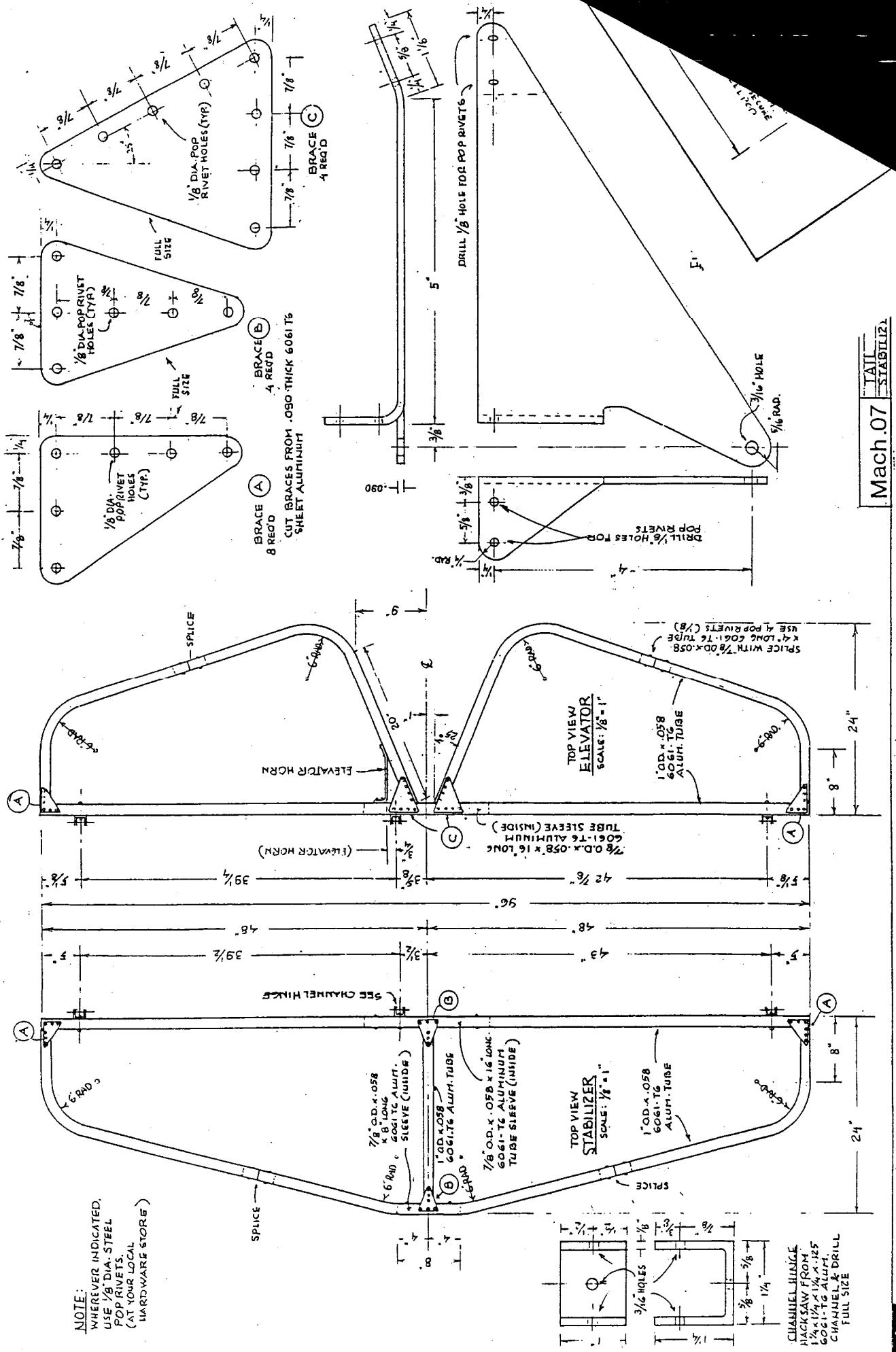
TOP SPEED 18 MPH  
 CRUISE SPEED 38 MPH  
 STALL SPEED 20 MPH  
 SEA LEVEL CLIMB 350 FPM  
 TAKE OFF ROLL 220 FT  
 80 FT.  
 (1400 FT)  
 CLIMB 210 FT  
 RANGE 60 MI.  
 SINK RATE 300 FT/MIN.  
 L/D 8-1 @ 27 MPH  
 SET UP TIME (10 seconds) 10 MIN.

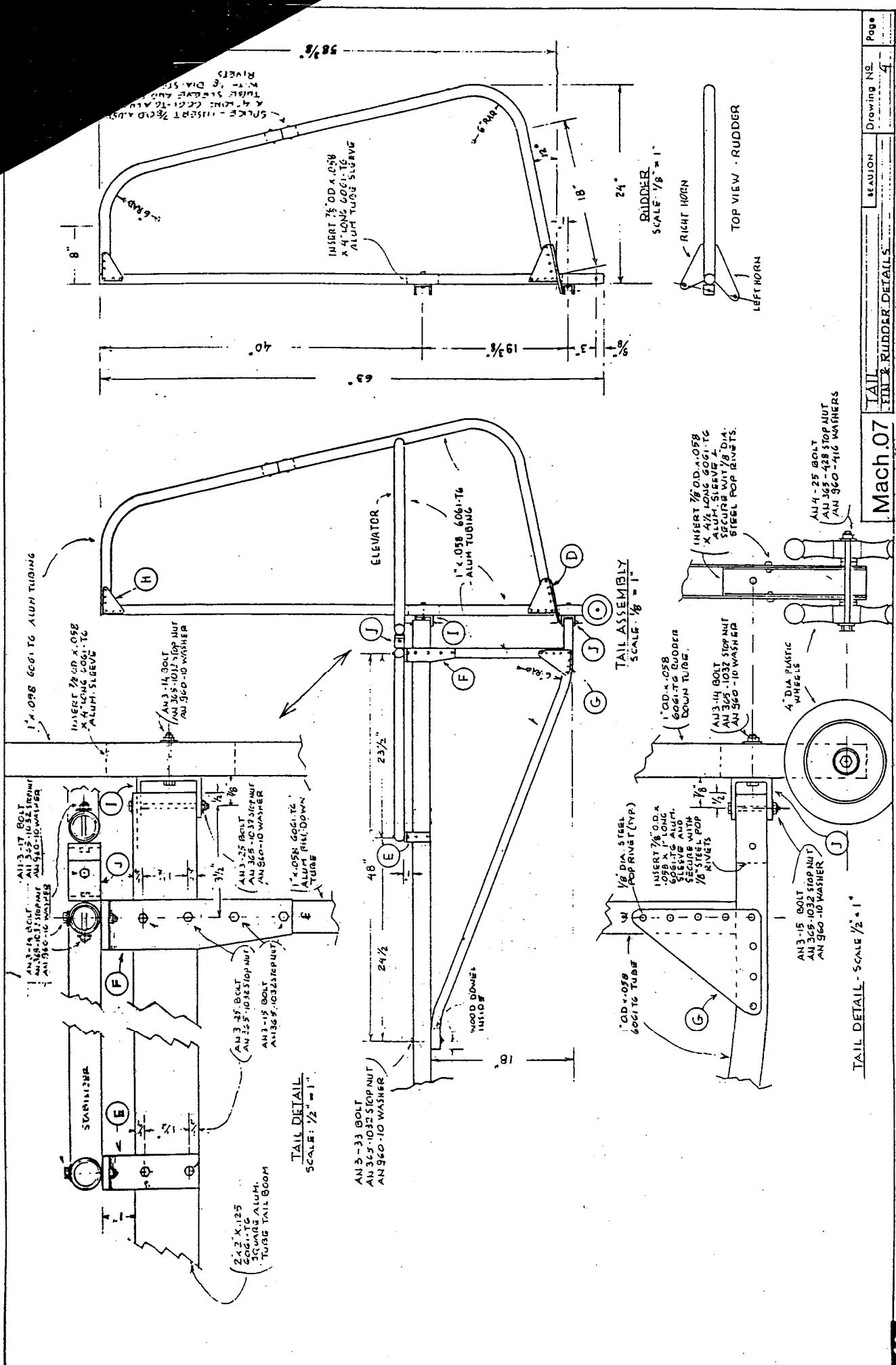


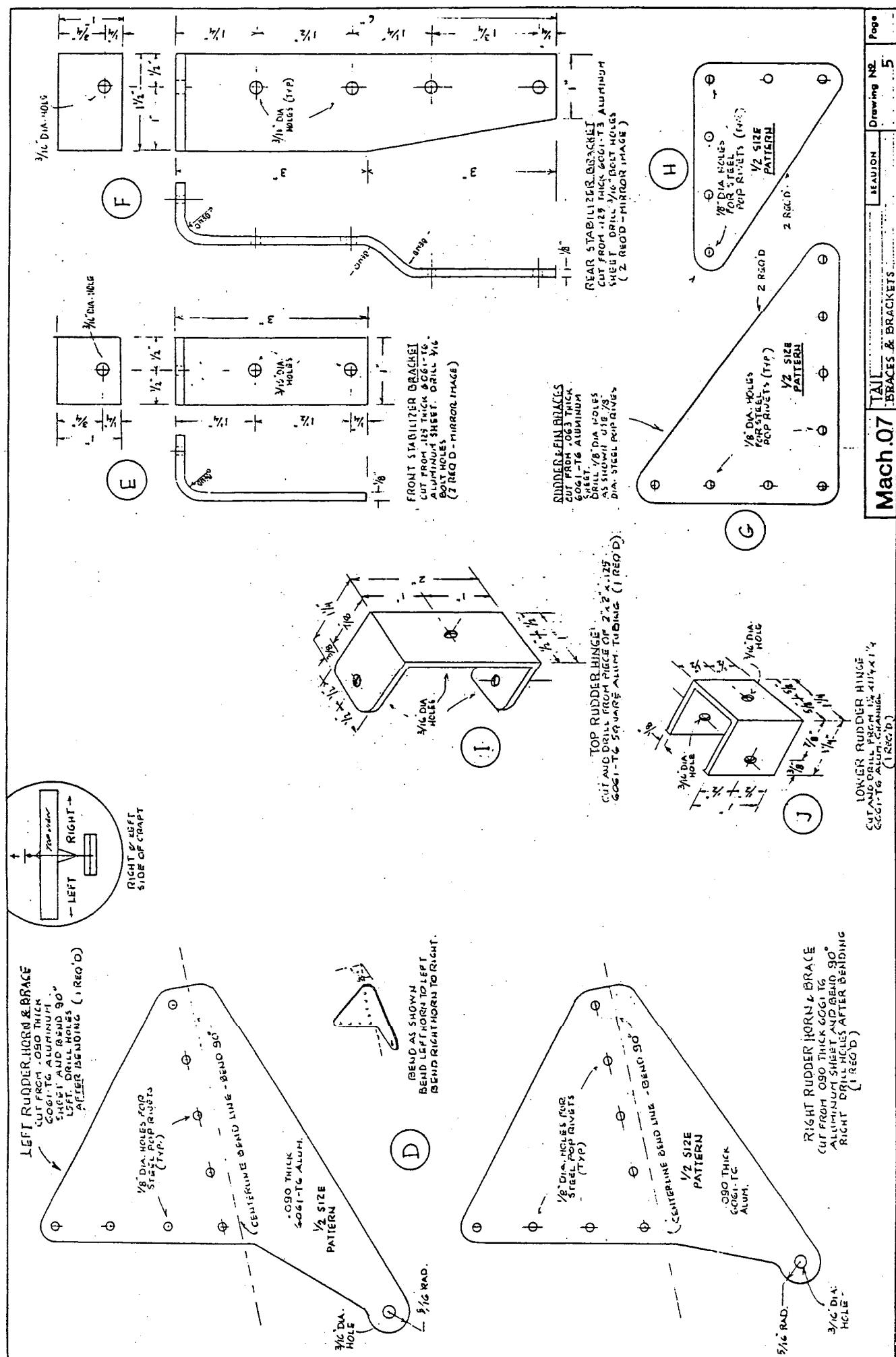
Mach.07	3-YIEW	LEAVION	Drawing №	Page
			1	1

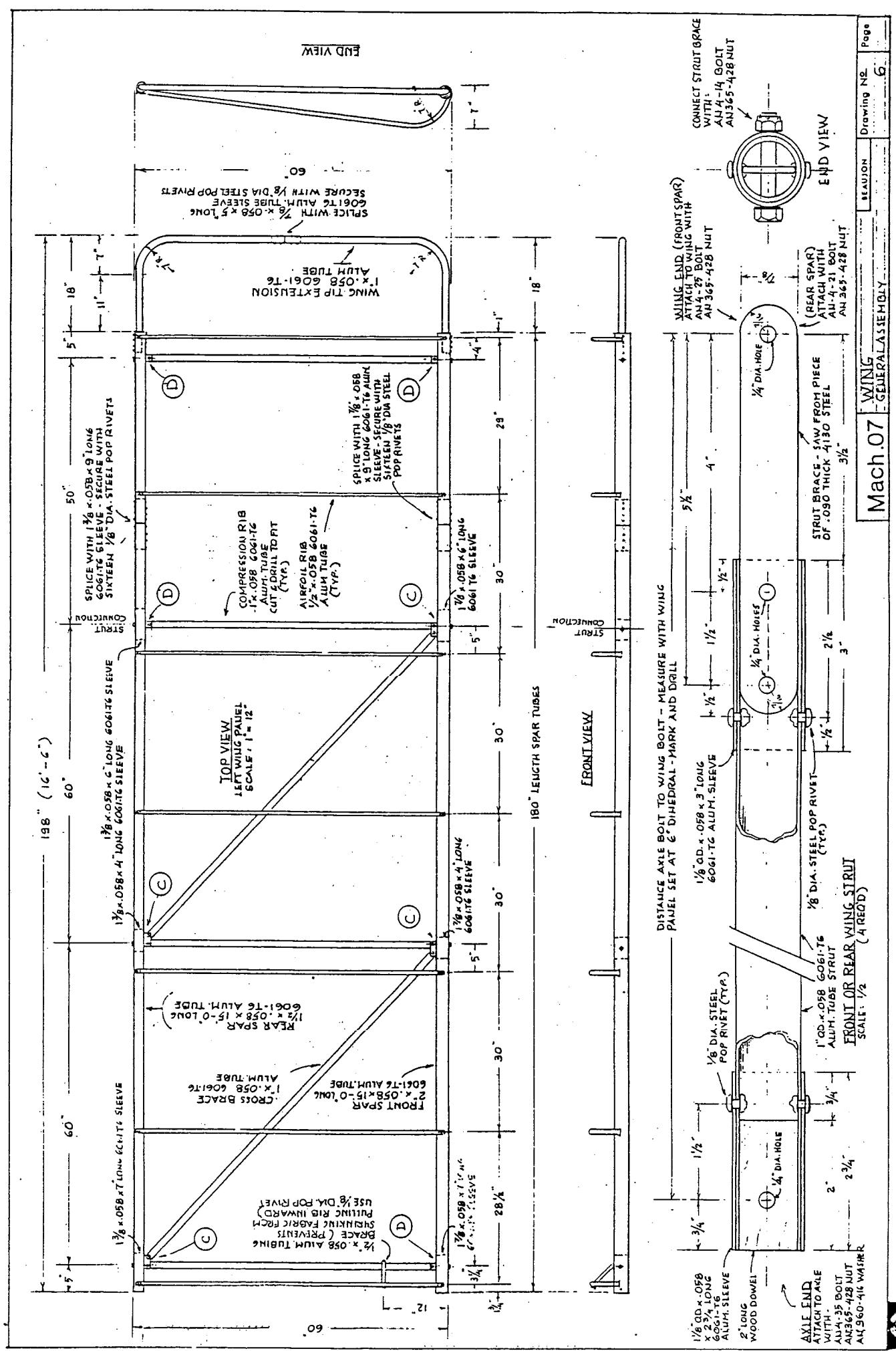
Mach.07 3-D & REFERENCE - LIAISON Drawing No. 2-  
Page

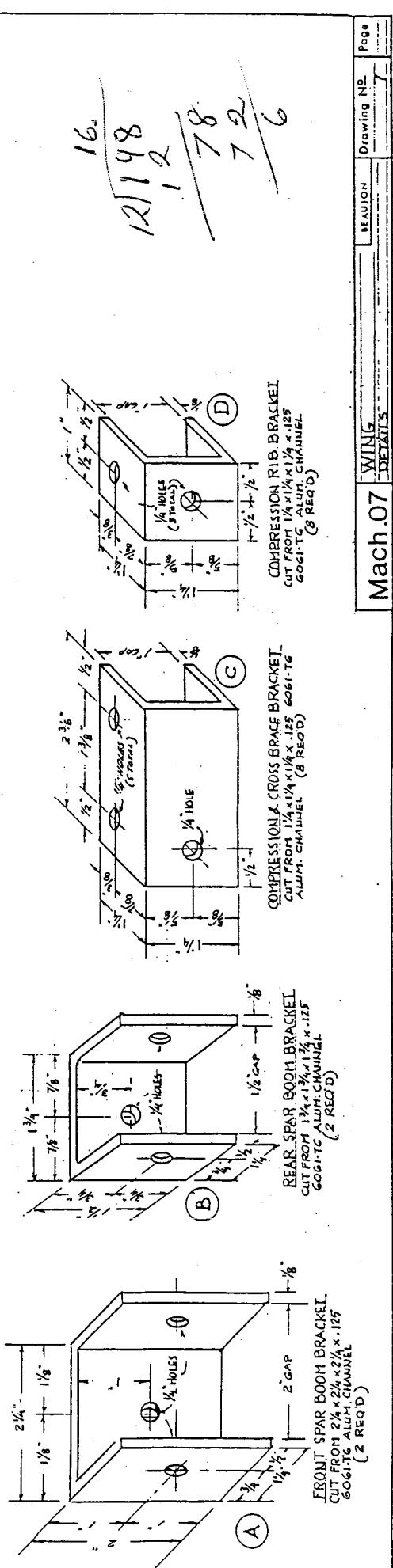
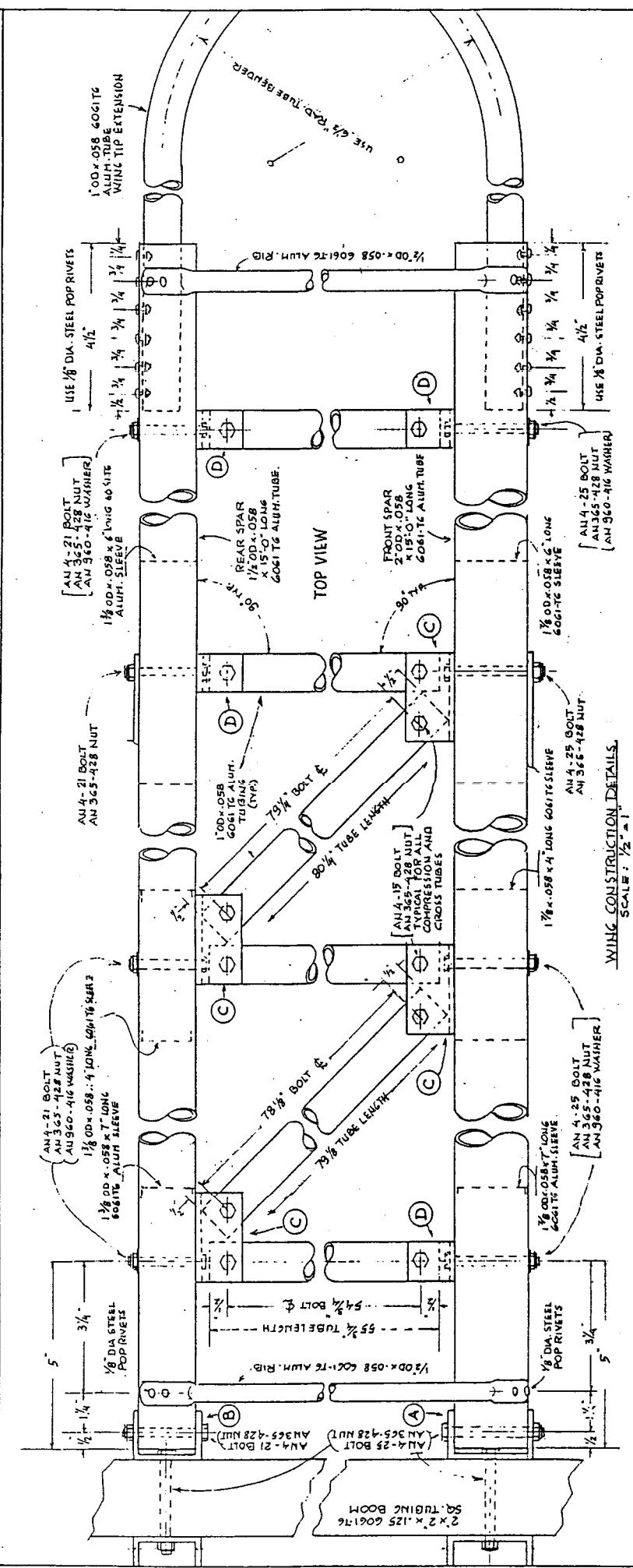


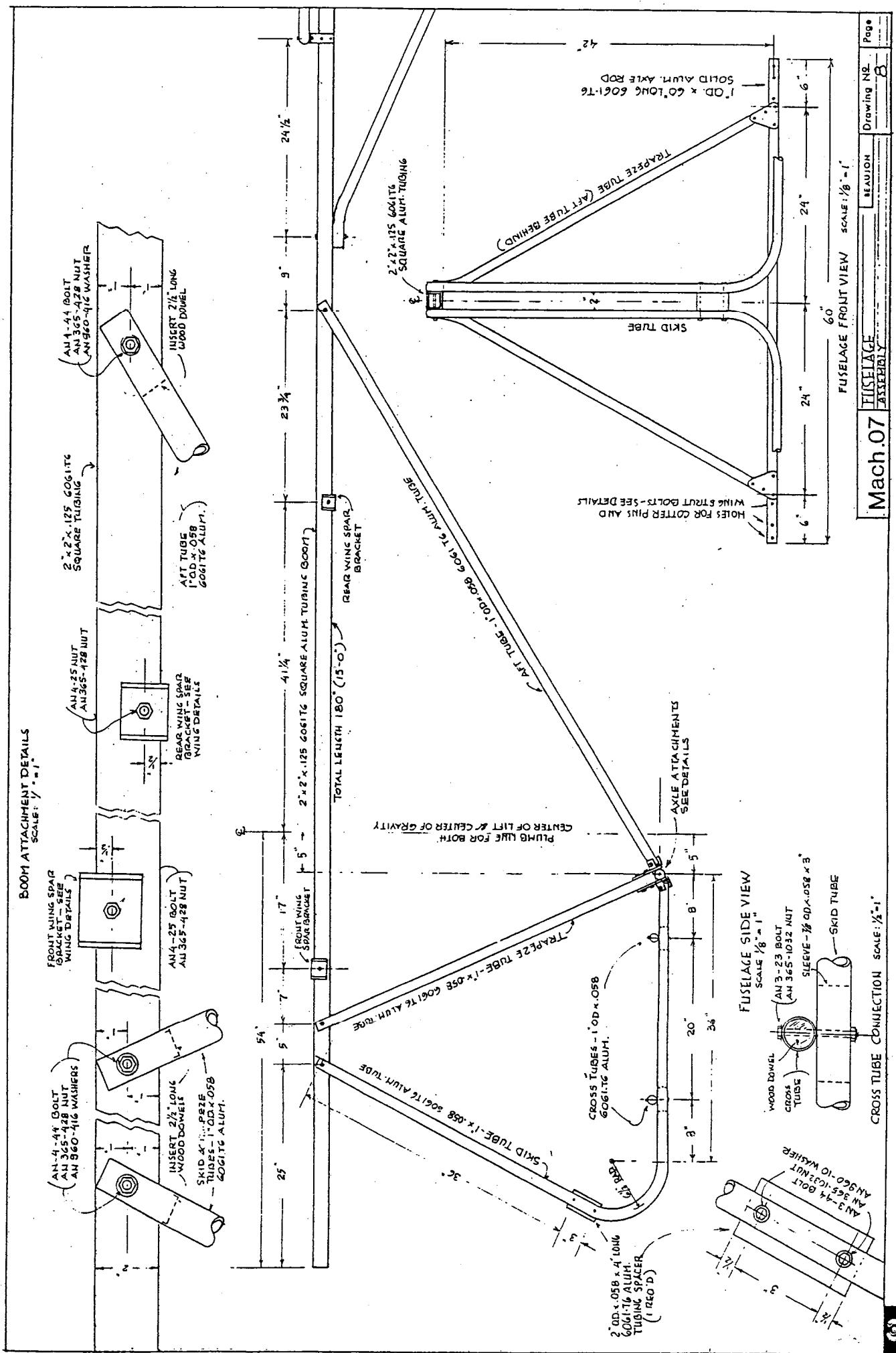




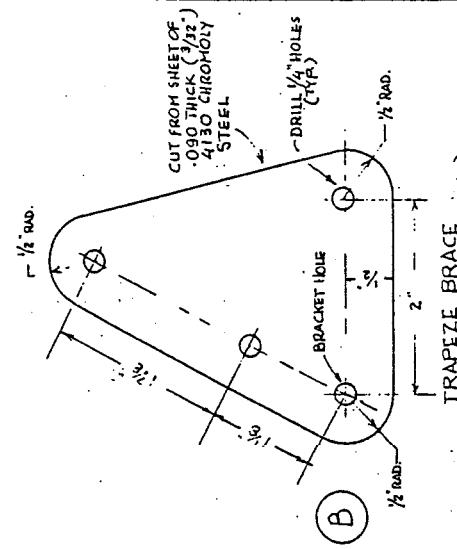
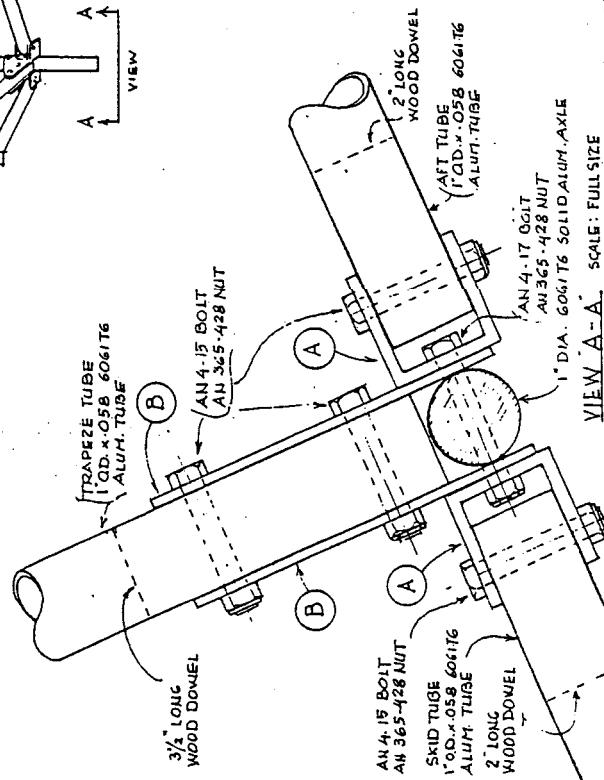
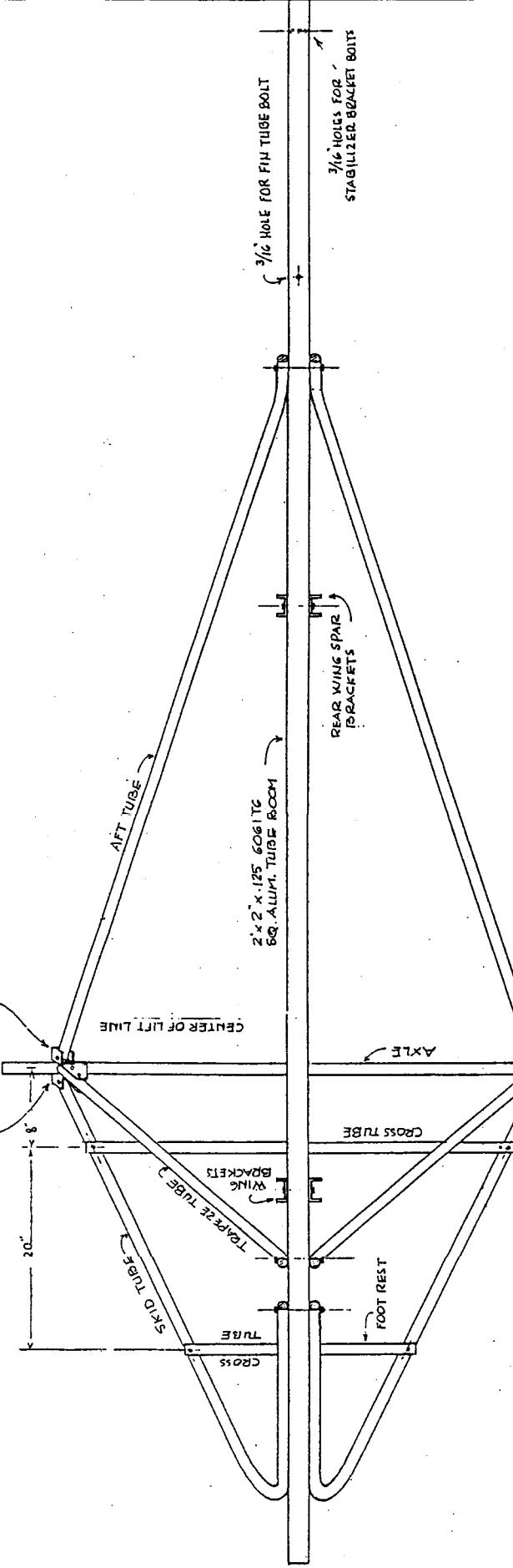






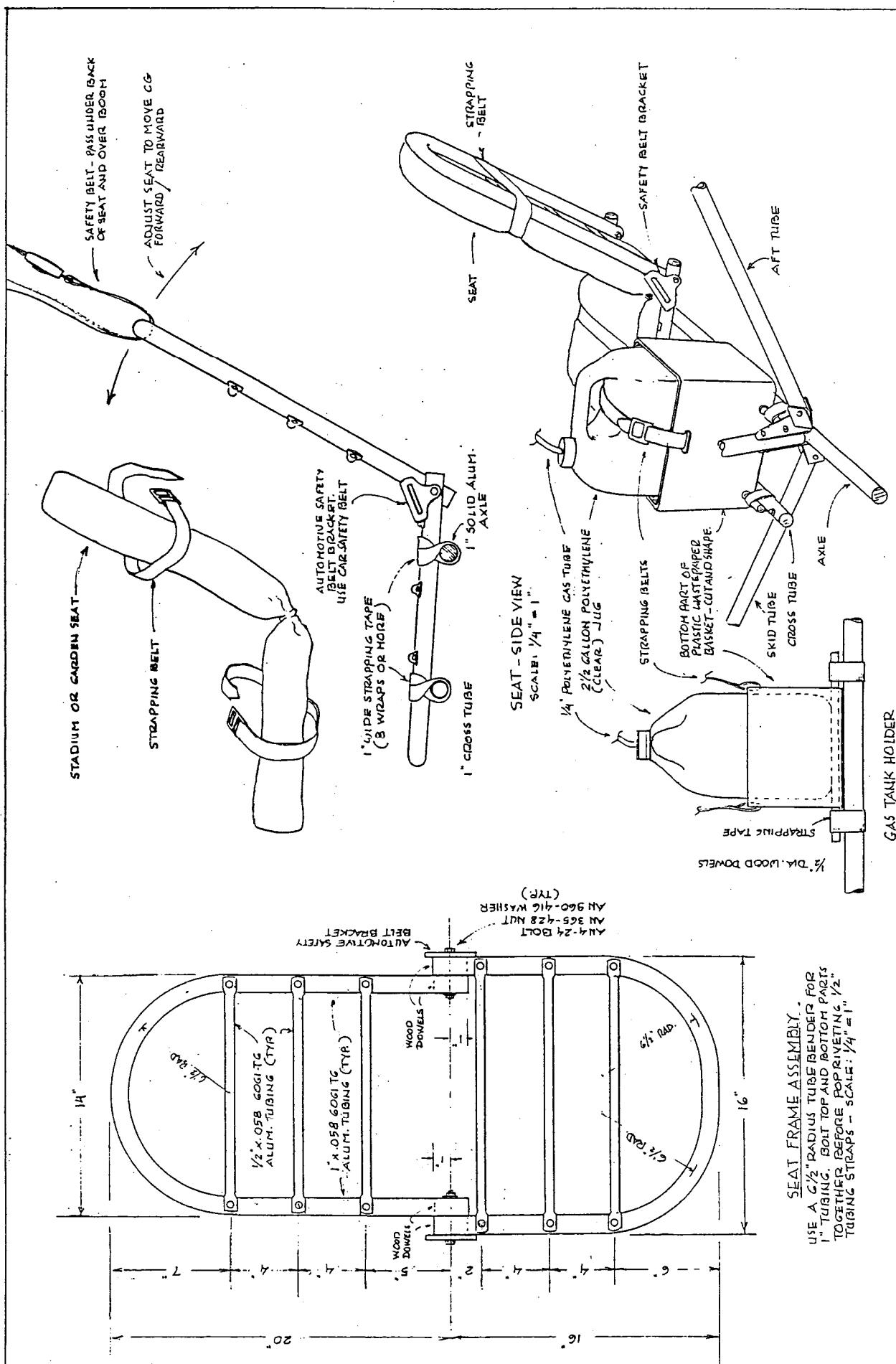


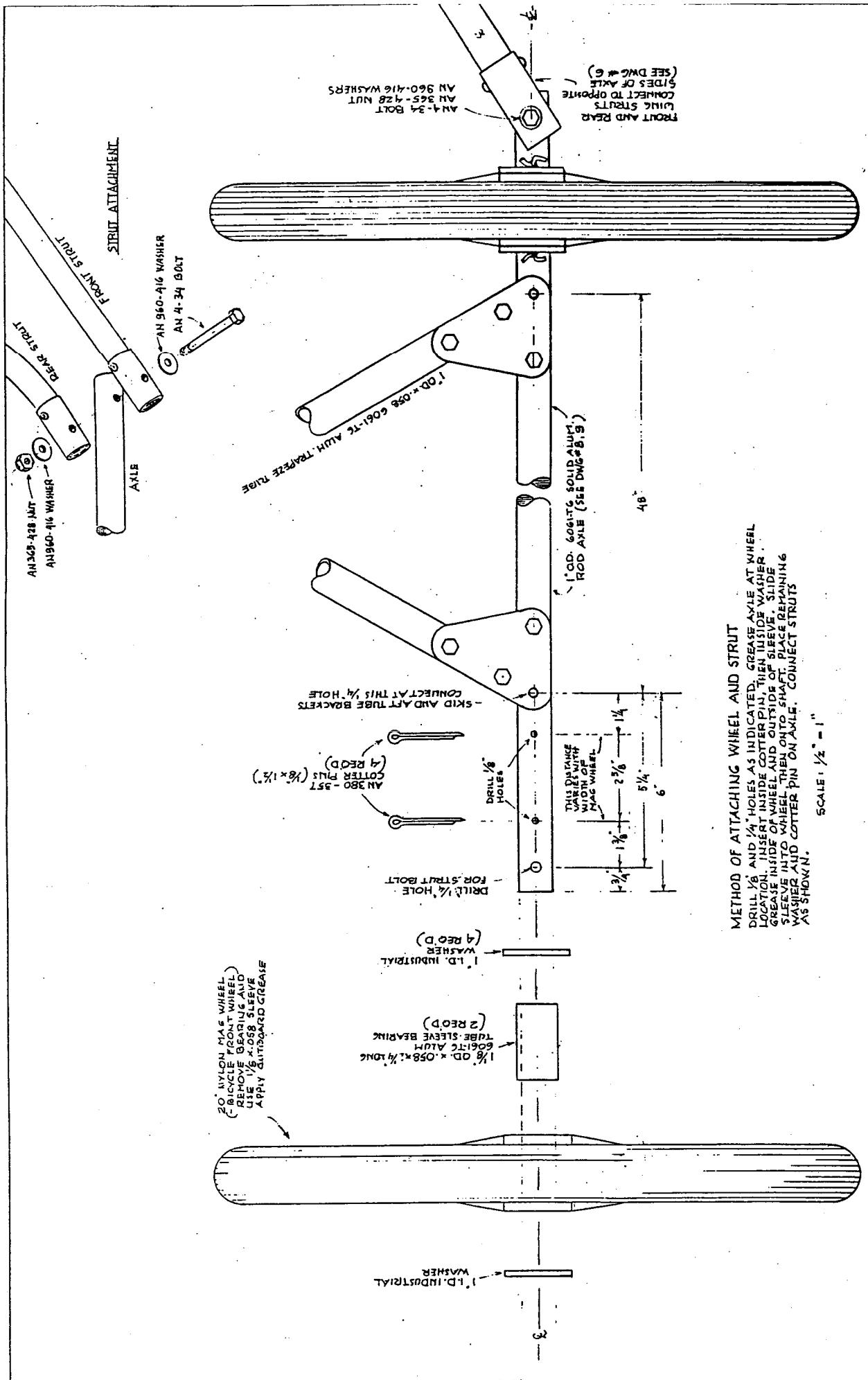
FUSELAGE BRACE (A) UNTIL SKID AND AFT TUBES ARE  
ALIGNED WITH PROPER HOLE POSITIONS - THEN TIGHTEN  
ALL BRACKET NUTS



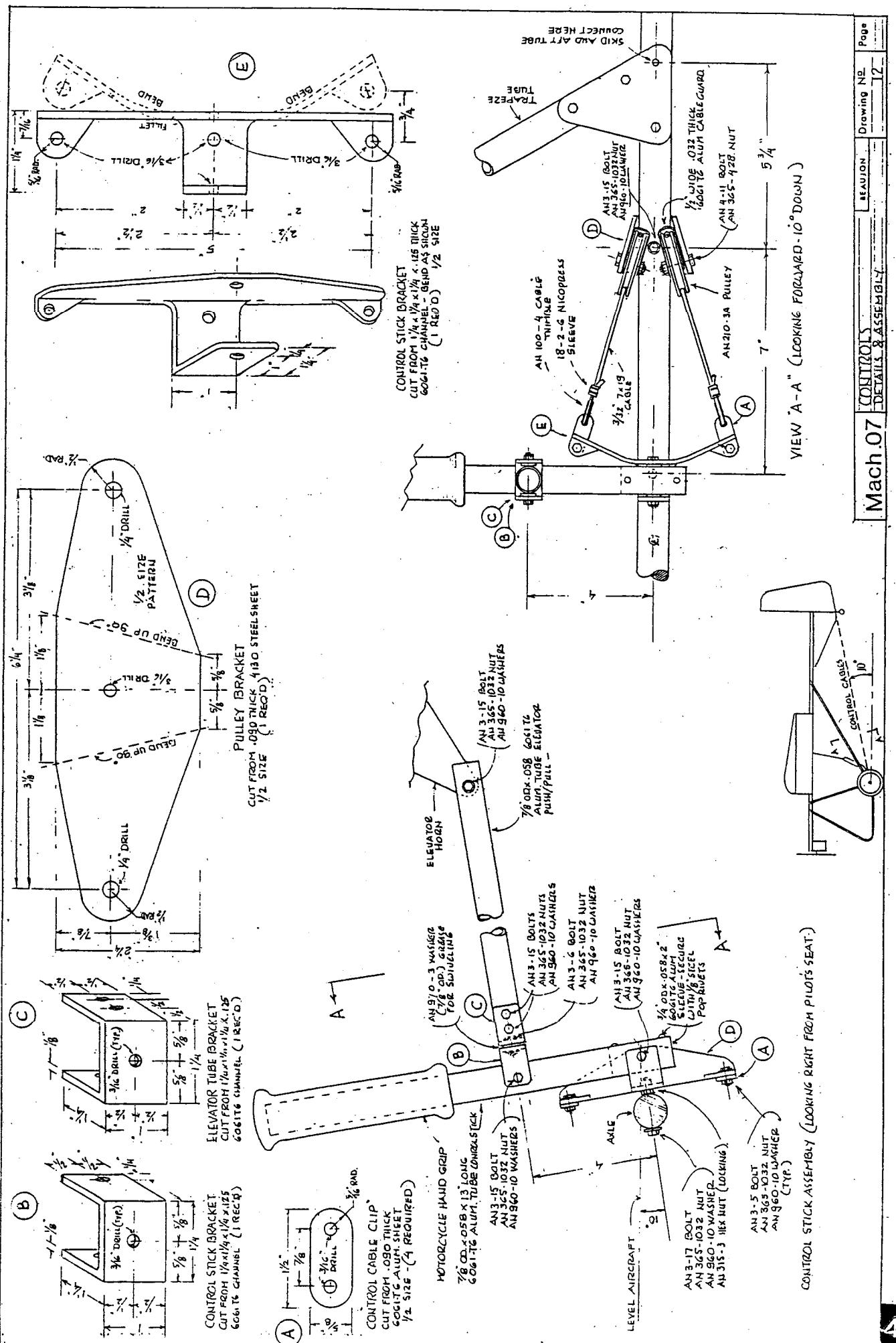
Mach.07	FUSELAGE DETAILS	DRAWING NO. 9	PO#
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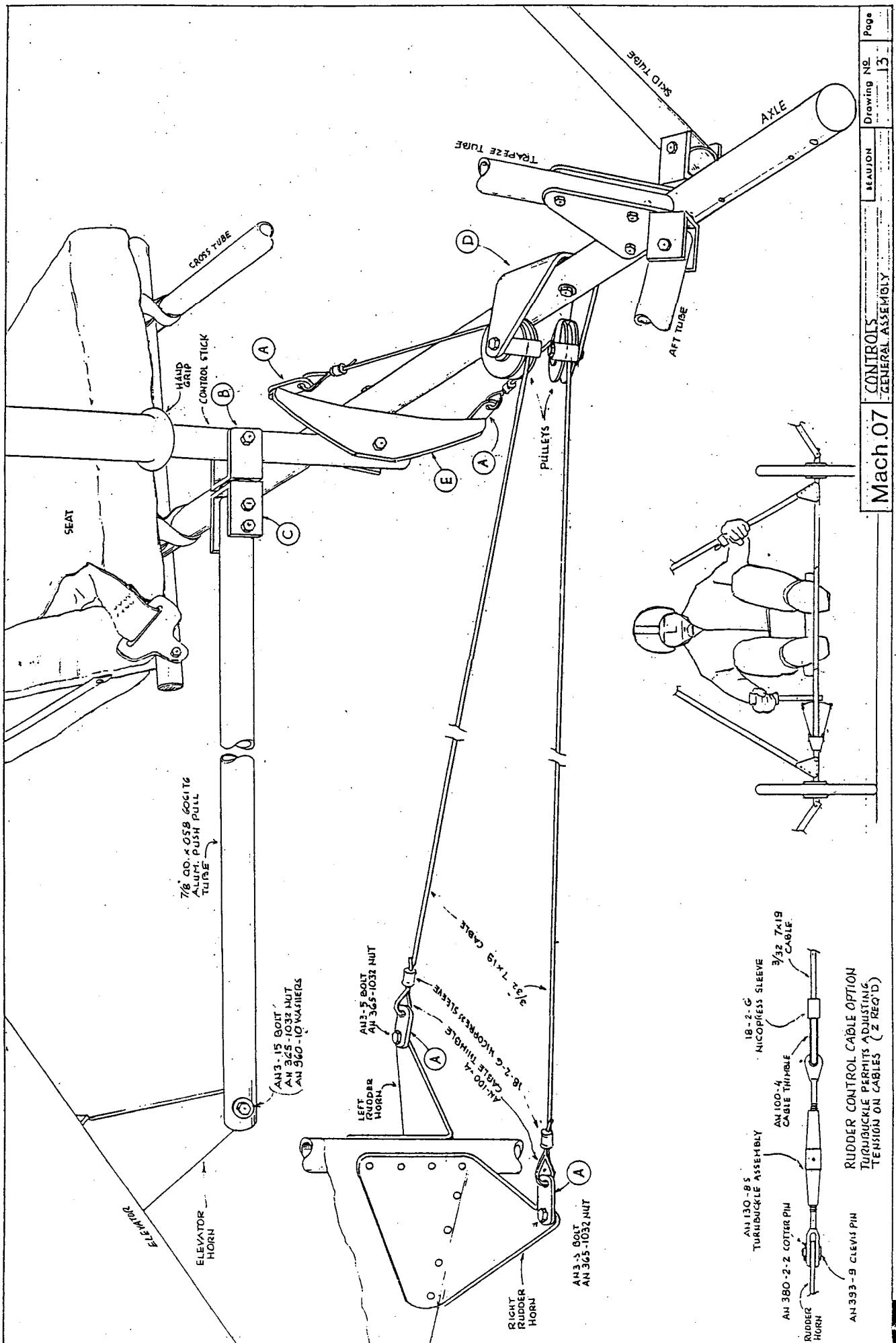
Mach.07 SEAT & GAS TANK Drawing No. 10 Page 10



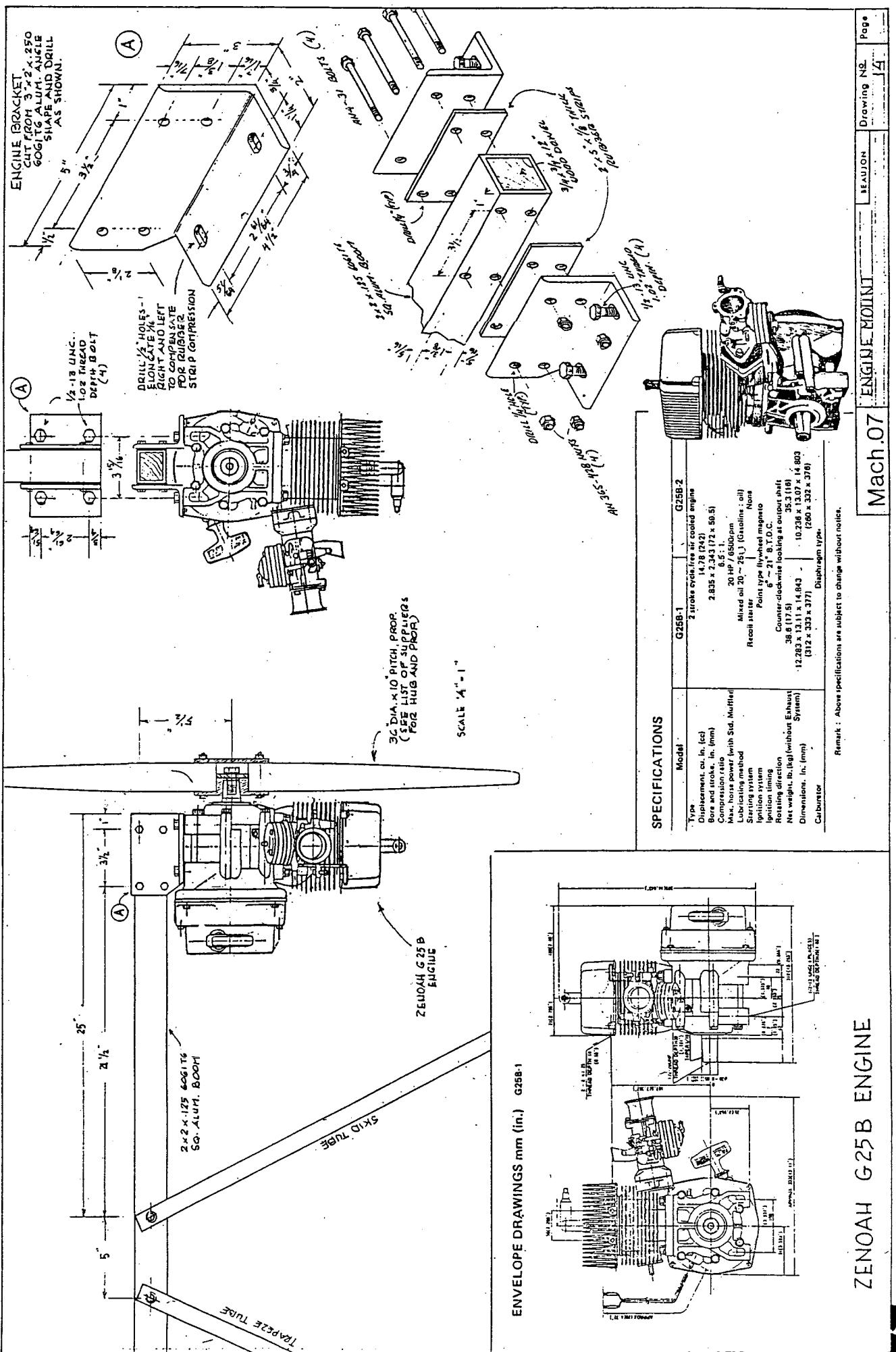


Mach 07	WHEEL STRUT ASSEMBLY
1	1
1	1
1	1
1	1





44

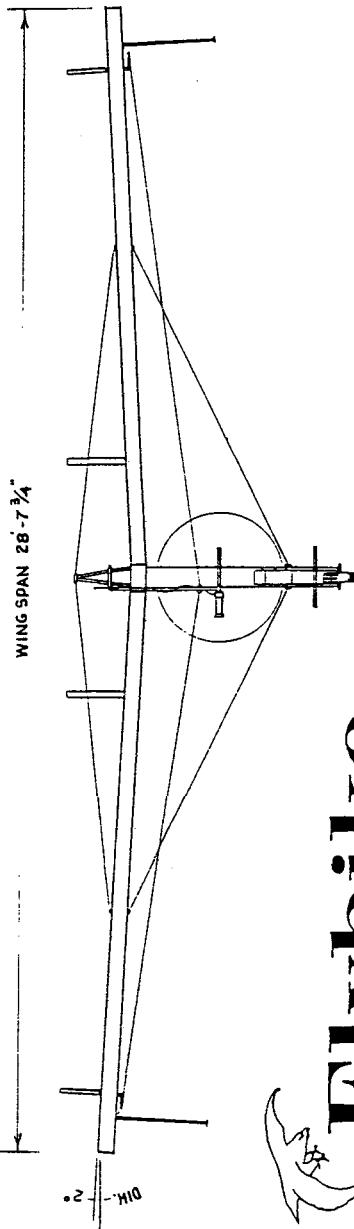


ZENOAH G25B ENGINE



## REFERENCE PLANS

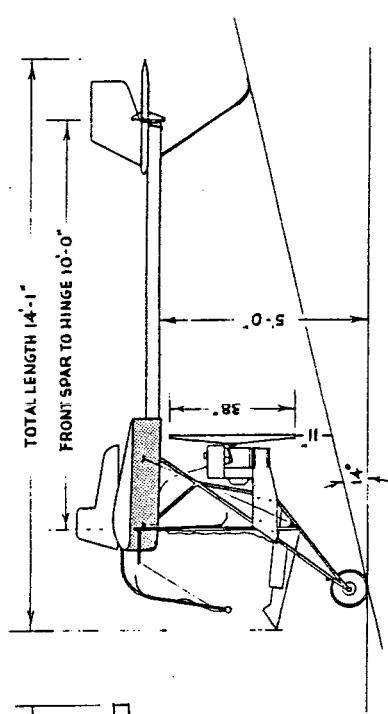
WING SPAN 28'-7 3/4"



# Flybike

**A DIFFERENT FLIGHT SENSATION**  
CONTROLS ARE BOTH A SIMPLE AND PROVIDE A TRUE FEELING OF FLIGHT. ARM MOVEMENTS ARE SIMILAR TO WING MOVEMENTS OF A SOARING BIRD. FORWARD WING MOTION CAUSES ASCENT, REARWARD MOTION CAUSES DESCENT. TO TURN RIGHT, EXTEND LEFT WING, PULL IN RIGHT WING; AND YOU GET TWO HOURS OF JONATHAN LIVINGSTON MANEUVERING ON ONE GALLON OF REGULAR GAS. TWIST GRIP GAS THROTTLE ON RIGHT HANDLEBAR PROVIDES INSTANT CONTROL.

**UNIQUE CONSTRUCTION**  
WING PANEL IS MADE UP OF FRONT SPAR, REAR SPAR, AND SOLID STYROFOAM. ENTIRE PANEL IS MIRROR FINISHED WITH EPOXYD FABRIC. SIMPLE, LIGHT, AND EXTREMELY STRONG. BOTH PANELS WEIGH 50 LBS. 4" X .035 ALUMINUM BOOM IS INTERNALLY BRACED WITH A DOWEL AND SPAR ARRANGEMENT. TAIL GROUP IS OF SOLID STYROFOAM WITH WOOD SPARS. FRAME IS 5/8" X .035 STEELTUBING. GO-KART WHEEL USED. SEAT AND ENGINE MOUNT ARE OF SPRUCE.

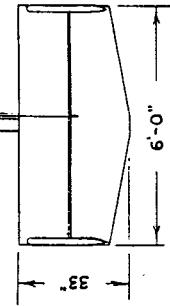


DIMENSIONS -	
WINGSPAN	28'-7 3/4"
WING CHORD (CONSTANT)	28'-7 3/4"
ASPECT RATIO	3.3
WING AREA	.8.8
WING LOADING	.92.0 SQ.FT.
STAB. - ELEV. CHORD (MEAN)	2'-6"
TOTAL ELEV. AREA	15 SQ. FT.
TOTAL FIN AREA	4.50. FT.
C/L TO HINGE	9'-9"
AIRFOIL	CLARK Y
ENGINE	BRIGGS & STRATTON 190-400
HORSEPOWER	8 HP @ 3600 RPM.
MAX. B.L.P.	7.25 @ 3000 RPM.
MAX. TORQUE	12.1 FT/LB @ 5600 RPM.
DISPLACEMENT	19.44 CUMIN(320 CC)
BORE & STROKE	.71 X .237 IN.
DOORER LOADING	4 LB/H.P.
FUEL CAP.	1 GAL. REG
FLIGHT DURATION	2 HRS
WEIGHT	45 LBS.

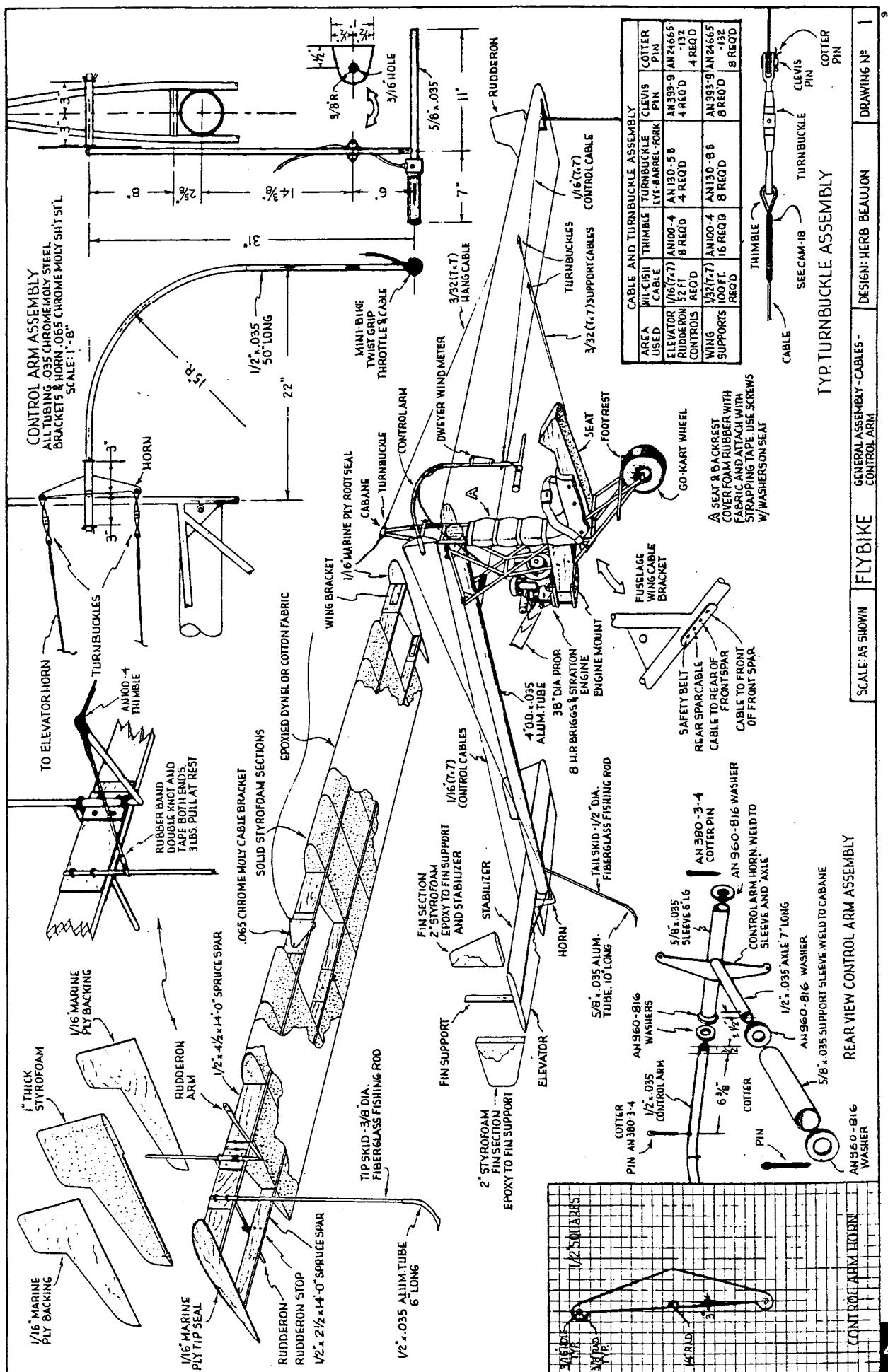
WEIGHTS -	
GROSS	350 LBS.
EMPTY	145 LBS.
MAX. PILOT WT	230 LBS.

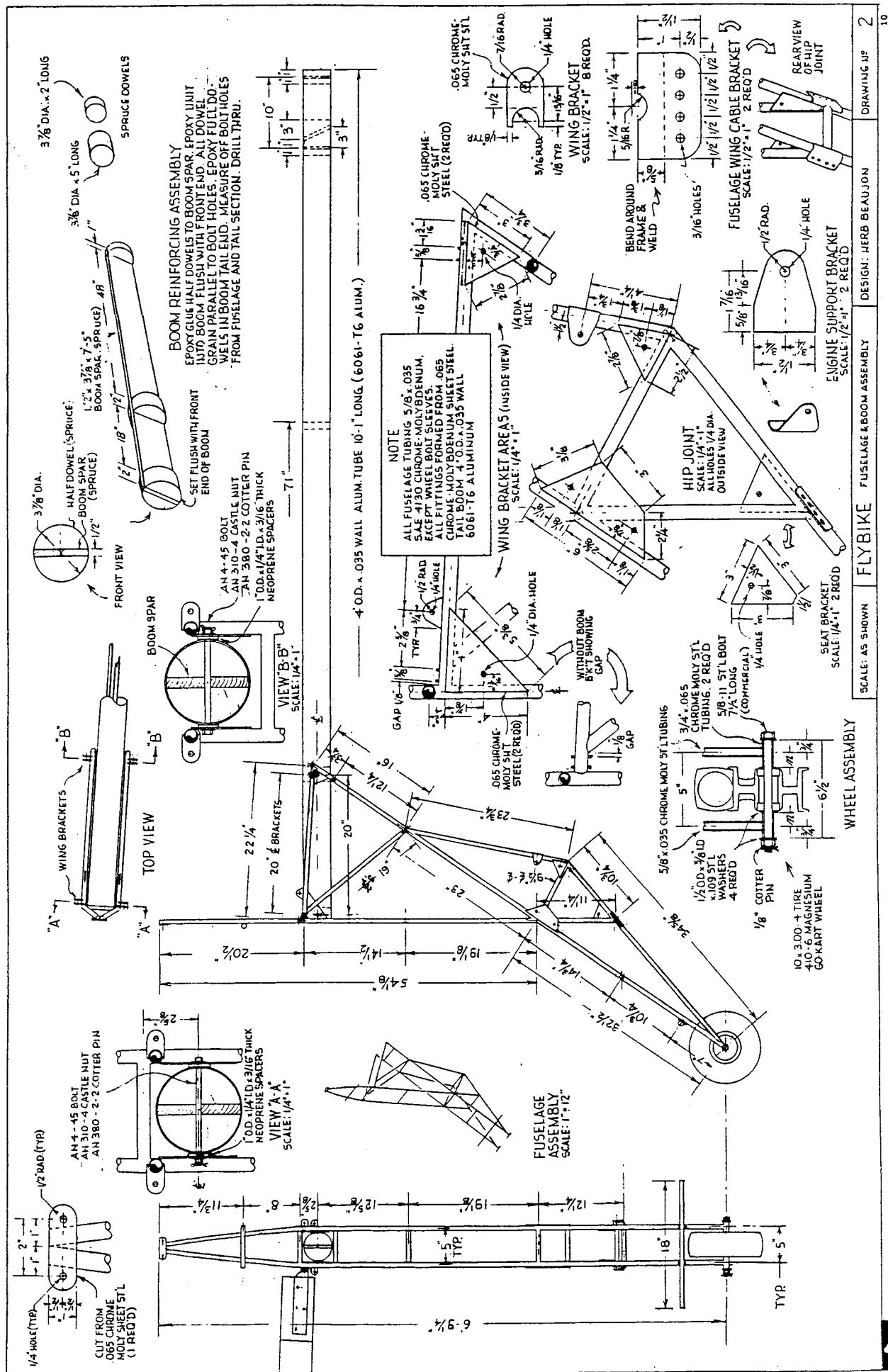
PERFORMANCE -	
CRUISE SPEED	45 MPH
MAX SPEED	54 MPH
STALL (POWER OFF)	23 MPH
STALL (POWER ON)	20 MPH
BEST GLIDE SPEED	33 MPH
GLIDE RATIO	12.1
TAKOFF OVER 50' OBSTACLE	650 FT.
RATE OF CLIMB	250 FT./MIN.

YOUR 8 HP BRIGGS & STRATTON  
ENGINE COMES COMPLETE WITH  
GAS TANK, MUFFLER, AIR FILTER, ETC.  
... AND COSTS \$150.00

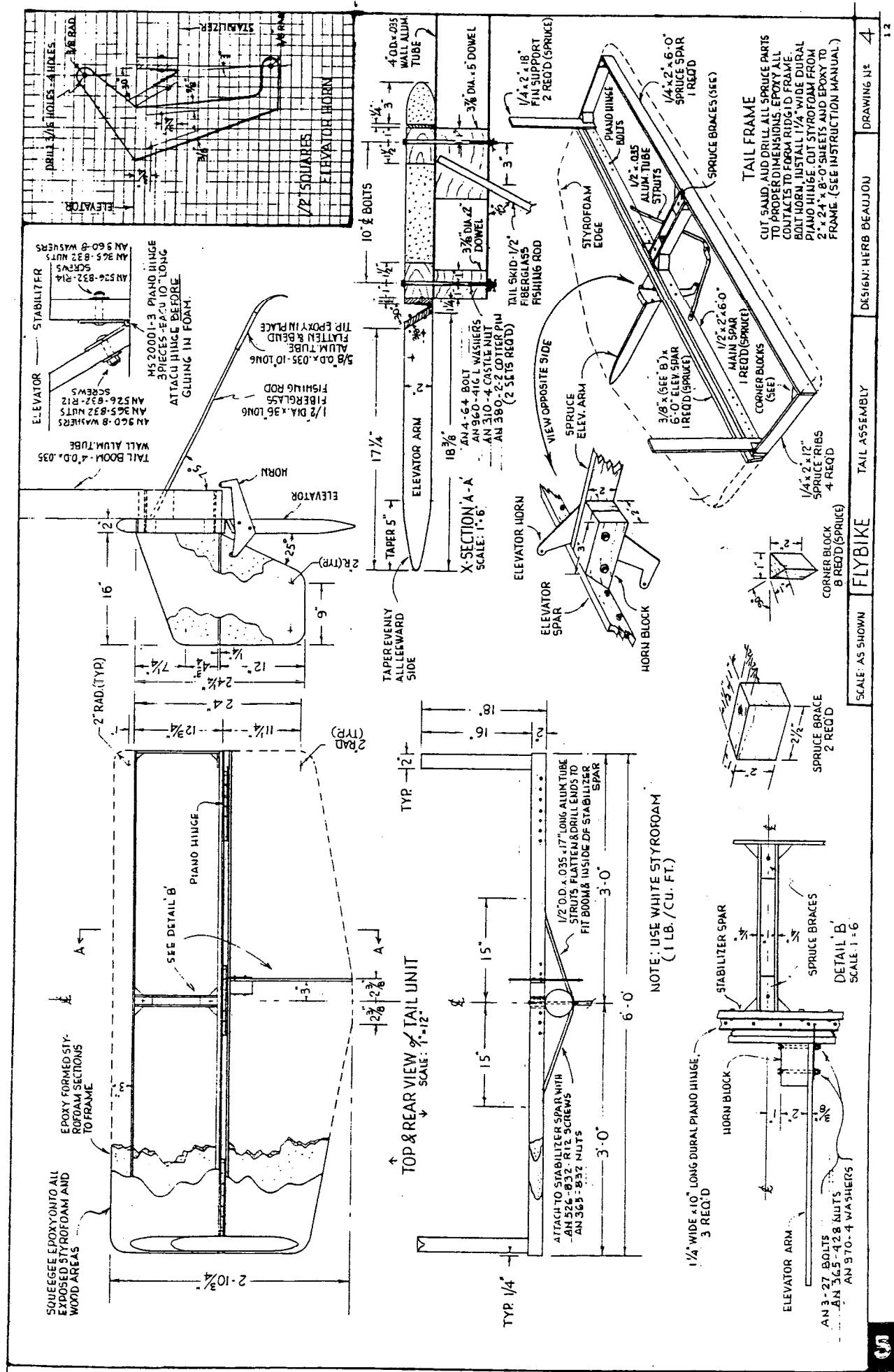


H. BEAUJON  
1119 12<sup>th</sup> AVE N.E.  
ARDMORE, OKLA. 73401











Flybikes

1



#### LEGAL NOTE

Herbert Beale and his estate, author and designer of Flybikes, submit the enclosed balloon and related information for your reference only and do not guarantee, offer assurance, or accept liability for actions which may result from its use thereof. Copyrights pending.

#### CONSTRUCTION

In order for all parts of Flybikes to fit perfectly, construct sections in the numerical order shown below.

- RUDIMENTS. Plans 1 & 3. These pivoting vanes act as spoilers and rudder. By both causing reduced lift and drag. Fit and weld all parts as indicated before constructing vane. Vane is made of  $\frac{1}{8}$ " thick aluminum cut from a standard  $1 \times 20 \times 60$  sheet. Cut grooves, ridges and to proper size, then spray to  $1/2$ " tubing. Allow to set for two hours. Apply epoxy soaked cotton tape to  $1/2$ " tubing - tubing area to further ensure hold. Sandwich tape to vane faces and contact areas of  $1/16$ -ply bearing. Sandwhich tape to vane faces and contact areas of  $1/16$ -ply bearing. Without breaking film, mark out and apply pressure with three cement mortar cement blocks. Sand surface to approximate flatness. Then remove layer of epoxy over wax surface. See Plan No. 7, "Allison Support, Assembly for idea on how to obtain tight bearing inside the  $5/8$ " tubing sleeve.

- WHEELS. Plan 7. Optional. Instead of rudders, you may want to use the more efficient drag-alleron. These are somewhat more difficult to construct, but will provide better ground handling. Complete instructions with Plan 7.

- WING PLATES. Plans 1, 3, 6, 9, 10. Wing panels are super strong. Without safety factor considered they will stand  $13 \text{ G's}$ . With the safety factors included they will stand  $5 \text{ G's}$ . This is well beyond the range of a utility aircraft. Panels are detachable. Cut and shape the aircraft quality aircraft spars according to the dimensions shown on Plans 3, 6 & 10. If applicable, add a rib to each side of the top spar. Make sure to fair out to the leading edge. On all panels, add a vertical rib to support the top spar. Add a vertical rib to each panel. Apply  $1/8$ " on all vertical ribs. Sand down to their exact positions. Bend a standard  $12 \times 20 \times 60$ -inch block as shown below in order to achieve longitudinal, lateral and a smooth lower surface. Make wing cross section template according to Plans 6, 9, 10. Mark off as shown below and hot wire cut one foot wide sections.



heaves are occupied by heave, buoy to buoy and to each other. Sand down to a smooth finish. Use sandpaper to check for uniformly, epoxy  $1/16$ -ply facing to ends of panels. If you are using drag-alleron, epoxy surfaces streamlined to outer and inner panels for wing to set. Apply aqueous epoxy to both upper and lower panel surfaces and poly grade A cotton or dycel cloth to upper surface. Smooth out any wrinkles. Apply a second coat of epoxy to upper surface. Squeeze down very thin and smooth. Trim and fill rough spots.

- TAIL GROUP. Plans 1 & 4. Cut and sand all spars parts to proper dimensions and epoxy together to form frame. Bolt in horn, piano hinge, and  $1/2$ " aluminum tube struts. Cut a spruce saddle to support the tail boom. Sand down to a smooth finish. Apply epoxy to both upper and lower surfaces for a smooth finish.

Drill holes for boom attachment.

#### CONTROLS

The author suggests that the first flight be made by a licensed pilot who has had some real-life experience. Controls on Flybikes require some skill of control and steering. If you have a perfectly flat cement floor, you can attach flat wood moulding directly to floor with small cement nails. Cut tubing to proper size and lay in the tank weld, remove, and complete welding. Cut  $24 \times 1$ " lumber into exact  $1/8$ " lengths. You'll need ten pieces. Match left and right side of fuselage frame using these  $2 \times 1\frac{1}{8} \times 1\frac{1}{8}$ "  $\times \frac{3}{8}$ " spacers and strappling tape for a perfect alignment. Cut cross tubing to size and weld at proper locations. Weld wheel sleeves in place using the  $5/8$ " wheel bolt to maintain alignment. Heat and bend cable "horn" inward until tight. Remove spacers. Cut out all braces and brackets. Drill all necessary holes. Weld all hardware washers to prevent any play along bolt. Although a sagging seat is OK, a seat is preferred, you may use any similar seat capable of supporting the weight.

5. FUSILAGE. Plans 2. Two sets of fuselage frame are constructed separately, joined into one with cross-tubing. Build a simple tail frame. Cut out and striping of  $1/8$ " wood available. If you have a perfectly flat cement floor, you can attach flat wood moulding directly to floor with small cement nails. Cut tubing to proper size and lay in the tank weld, remove, and complete welding. Cut  $24 \times 1$ " lumber into exact  $1/8$ " lengths. You'll need ten pieces. Match left and right side of fuselage frame, using these  $2 \times 1\frac{1}{8} \times 1\frac{1}{8}$ "  $\times \frac{3}{8}$ " spacers and strappling tape for a perfect alignment. Cut cross tubing to size and weld at proper locations. Weld wheel sleeves in place using the  $5/8$ " wheel bolt to maintain alignment. Heat and bend cable "horn" inward until tight. Remove spacers. Cut out all braces and brackets. Drill all necessary holes. Weld all hardware washers to prevent any play along bolt. Although a sagging seat is OK, a seat is preferred, you may use any similar seat capable of supporting the weight.

6. TAIL SKID. Plans 2 & 4. Welded to hold up and load of 100 lbs. Without the tail skid arrangement, the load capacity would only be 200 lbs. The reinforced boom also provides control when flying. The reinforced boom also provides control when flying. Cut out boom rear, half dowels and complete dowels. Epoxy half dowels to boom after. Use a small section of your  $1\frac{1}{8} \times .025$  aluminum tubing as a template to insure tight fitting assembly. epoxy dowel-dowel assembly into hole tube flush with front end. Epoxy cables inside in place at tail end. Allow to set for 24 hours, then use frame and tail assembly to locate and mark holes. Drill.

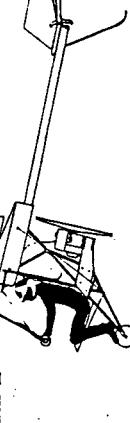
7. ENGINE MOUNT. Plans 1 & 5. Cut spruce side panels, base plates, and front plate. epoxy together. Side unit into fuselage frame, marking off top front holes as indicated on plan. Drill holes marked and bolt to frame. Now install engine mount parallel to tail boom. Cut out base of remaining holes, drill, and take out with a hacksaw. Cut approximately to tightly fit between side panels. epoxy into place. Make of engine bolt holes on side plates. Drill. Install engine after rear of aircraft has been completed and assembled.

8. PLATE. Plan 1 & 5. Form seat plate and side panels. Epoxy together. Insert in frame. Mark off both holes from frame. Drill and insert bolts. Cut styrofoam to tightly fit between panels. Epoxy in place. Seat is supported by two bolts and a frame cross tube.

9. HOPIPLIER. Plan 6. This single propeller was specifically designed to fit out as much thrust as possible from the maximum 7.25 brake H.P. available. It operates most efficiently around  $15 \text{ M.P.H.}$  Have a lumberyard supply pieces of  $1\frac{1}{8} \times 5\frac{1}{2} \times 10^{\prime}$  basswood or birch laminations. Apply epoxy to all opposing faces and clamp together. Use two  $1\frac{1}{8}$ " thick plates and several tightly screwed down U-clamps to distribute pressure evenly. Allow to set for 24 hours. Remove clamps and plates. Trace propeller outline on stock face and bendwise barely outside lines. Sand down to outline. Drill  $1/16$  hole through center of hub and for use as a reference point. Mark off station for leading and trailing edge on sides of stock. With help of sandpaper, sand down to proper profile of section. Cut out a template of stock to proper profile. As soon as you have the curved side, slide template to position to check for proper cross section shape. Smooth further. Insert a  $1/16$ " pin through hub hole and check balance. Slide propeller hub until balance is achieved. Drill a  $1\frac{1}{8}$ " hole through hub. Drill. Squeeze thin layer of epoxy over entire prop surface. Add epoxy to lighter side until balanced. Author suggests that prop be built by expert.

WEIGHT AND BALANCE. These are located at the center of lift, at  $26\frac{1}{2}\%$  of the wing chord. With pilot and fuel, Flybikes should hang with tail boom perfectly horizontal. If tail heavy, add some styrofoam behind the front wing brakets. When completed and ready for flight testing, check for proper balance by having pilot fly from nose crum beam or from a strict children's swing frame and distance behind the front wing brakets. The tail boom must be balanced. When completed and ready for flight testing, check for proper balance by having pilot fly from nose crum beam or from a strict children's swing frame and distance behind the front wing brakets. The tail boom must be balanced. If tail heavy, add some styrofoam behind the front wing brakets. If no heavy screw lead strips to top of stabilizer between tail boom until aircraft returns to horizontal position. Flybikes was designed to balance without adjustments holding a 90 lb. person. Your finished version may vary. A single pound increase at the tail end necessitates a nine pound reduction in the pilot's seat.

NOTE: USE WHITE WITTY STYROFOAM (EMBALLOM) POLYSTYRENE - 1/8" (CU. FT.) THROUGHTHER



To turn left shift handles to right  
To turn right, shift handles to left

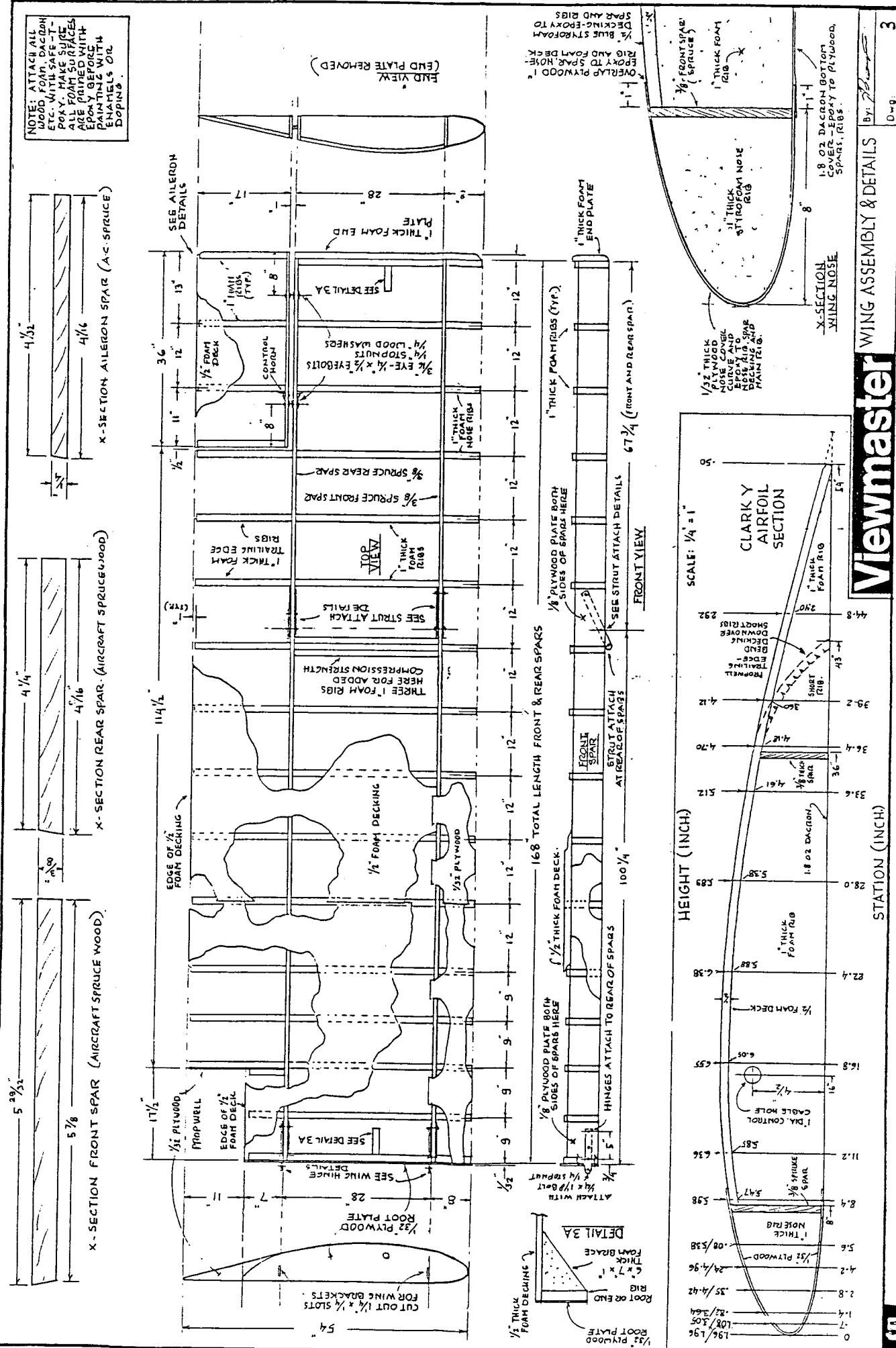
To go up, push handle forward  
To go down, pull handle in

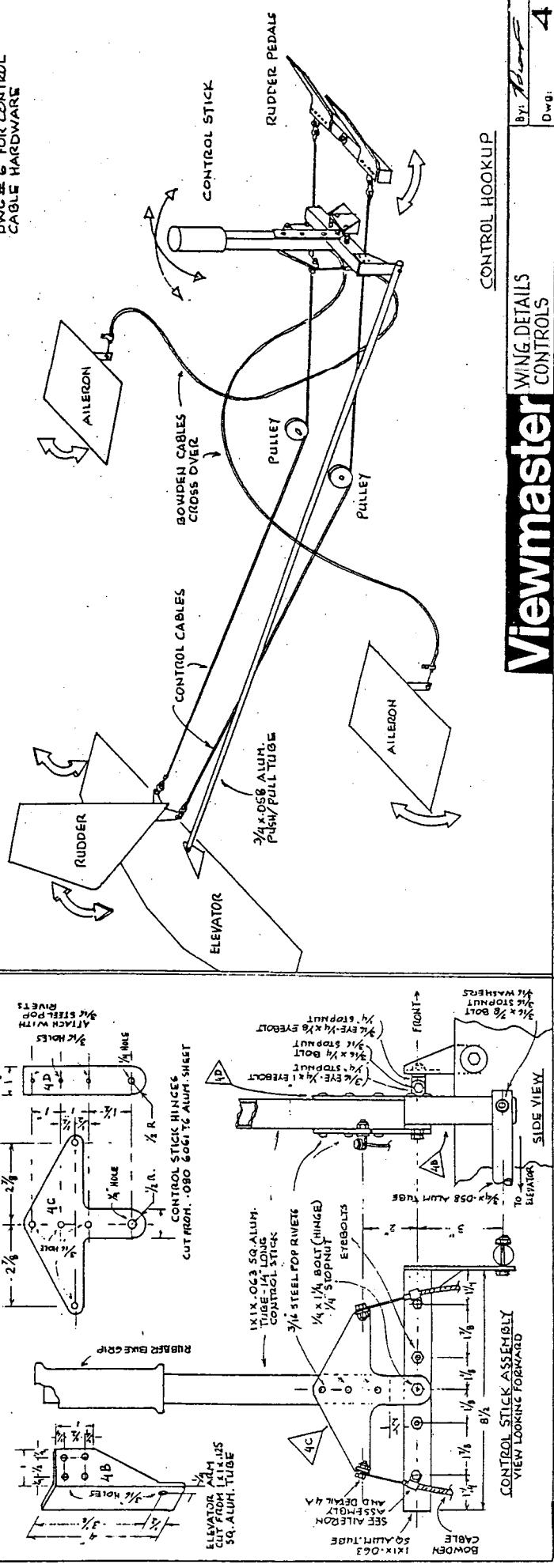
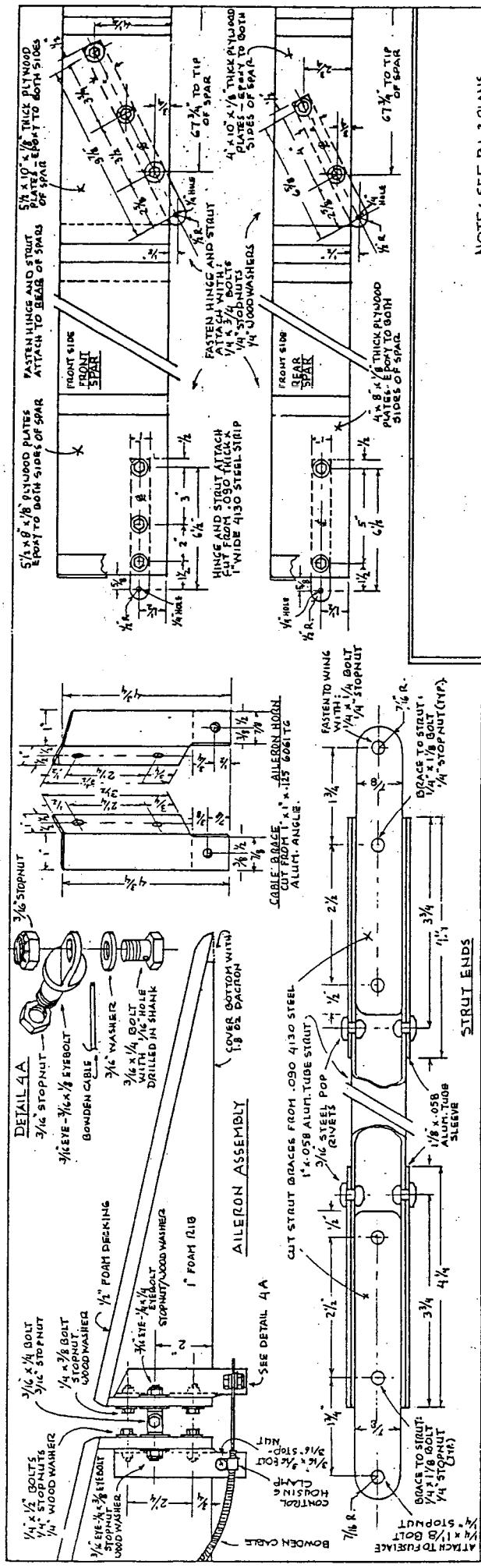




# **Viewmaster**

3





# Viewmaster

By: John Dwg: 4

viewmaster

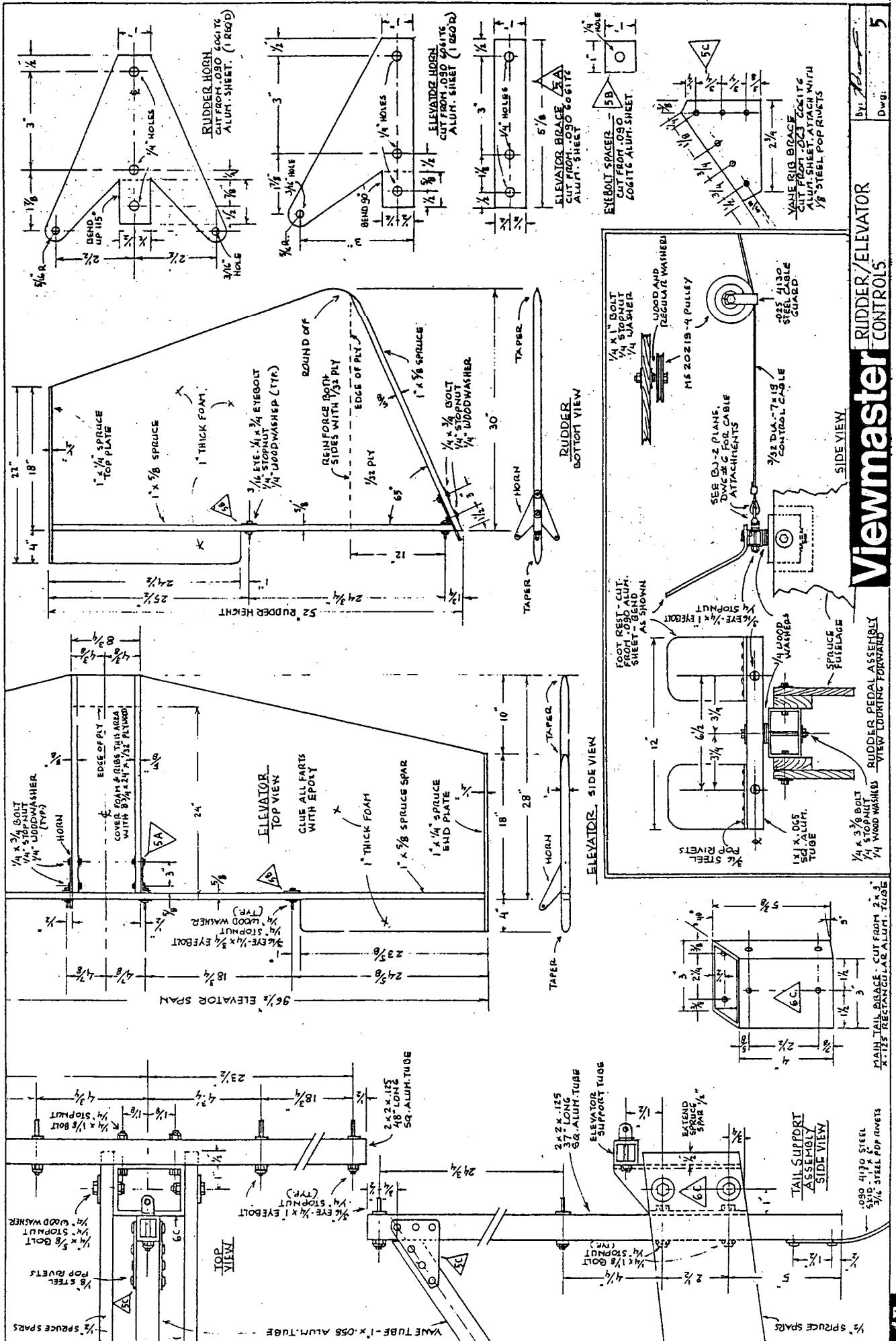
5

ELEVATOR  
DOLLS

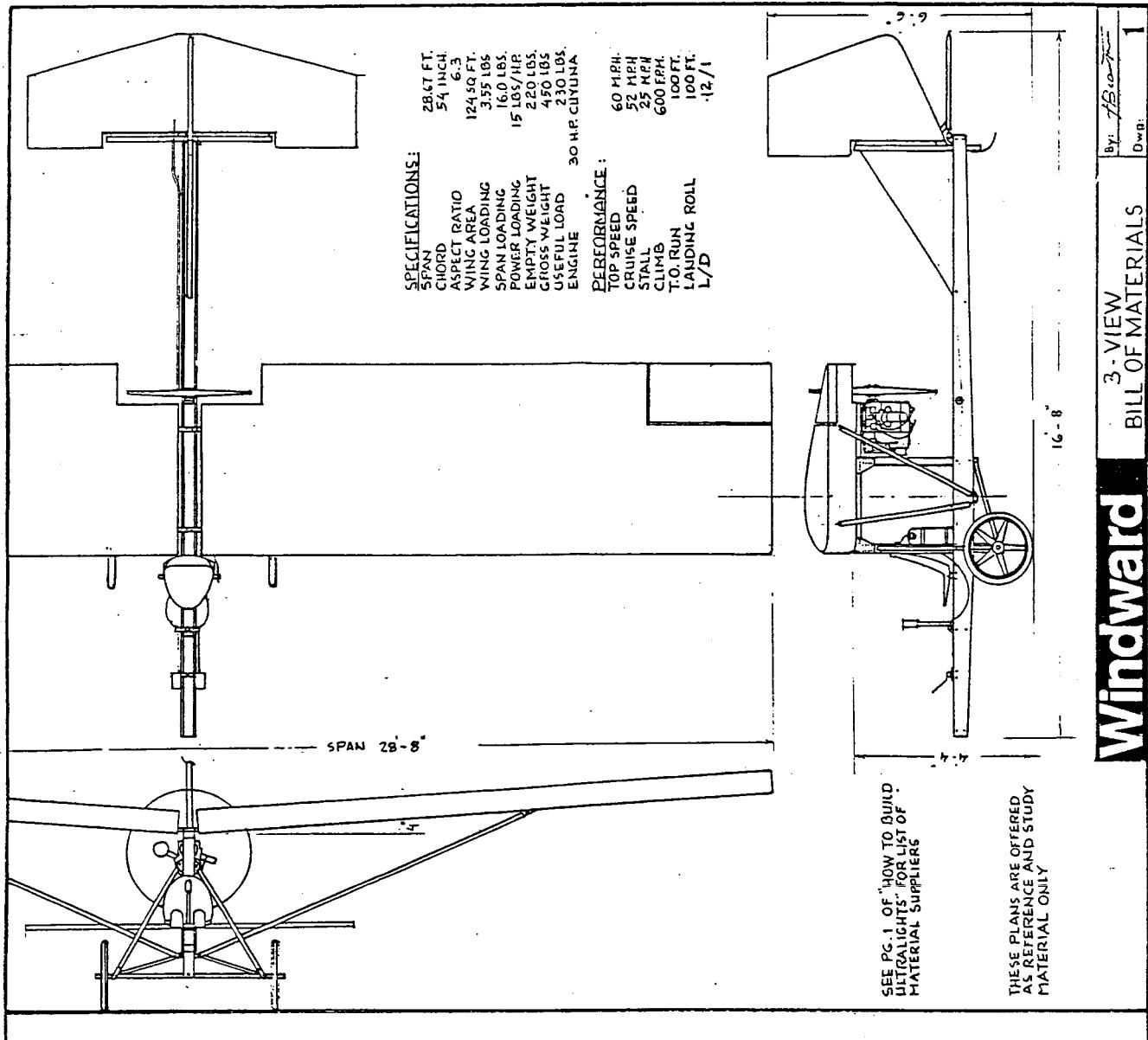
RUDDER PEDAL ASSEMBLY  
VIEW LOOKING FORWARD

MAIN TAIL BRACE - CUT FROM 2 X 3"  
X 12" RECTANGULAR ALUM. TUBE

0.090 4-1/2" X 6"  
SKID - 1/2" X 6"  
3/4" STEEL POP RIVETS



# REFERENCE PLANS



WINDWARD MATERIAL KIT			
BOLTS	ORDER	QUANTITY	ROUND ALUMINUM TUBING
Die x Grip			O.D. x Wall x L
3/16x1/4	AN3-5	26	3/4" x .065x 12 ft.
3/16x1/4	AN3-6	6	1" x .056x 12 ft.
3/16x1/4	AN3-12	4	1" x .095x 12 ft.
3/16x1/8	AN3-14	4	1" x .08x 6 ft.
3/16x1/8	AN3-14	4	1" x .08x 6 ft.
1/4" x 1/4	AN4-5	8	SQUARE ALUMINUM TUBING
1/4" x 1/4	AN4-6	16	O.D. x Wall x L
1/4" x 1/2	AN4-7	9	1" x .065x 8 ft.
1/4" x 1/2	AN4-8	16	1" x .065x 12 ft.
1/4" x 1/4	AN4-10	11	1" x .065x 12 ft.
1/4" x 1/4	AN4-11	11	1" x .065x 12 ft.
1/4" x 1/4	AN4-12	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-13	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-14	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-15	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-16	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-17	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-18	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-19	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-20	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-21	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-22	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-23	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-24	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-25	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-26	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-27	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-28	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-29	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-30	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-31	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-32	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-33	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-34	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-35	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-36	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-37	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-38	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-39	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-40	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-41	4	1" x .065x 12 ft.
1/4" x 1/4	AN4-42	4	1" x .065x 12 ft.
EYEBOLTS	Eye-Dia. x Grip	6	SPRUCE WOOD STRIPS
3/8" x 1 1/2	AN6-14	8	1 1/4" x 10 ft.
7/16-14 UNC 1 1/8 long		6	1 1/4" x 10 ft.
7/16-14 UNC 1 1/8 long		6	1 1/4" x 10 ft.
STOP NUTS		50	1 1/4" x 10 ft.
1/4	AN365-1032	250	1 1/4" x 10 ft.
1/4	AN365-1128	12	1 1/4" x 10 ft.
3/8	AN365-624	12	1 1/4" x 10 ft.
WASHERS			STRUCTURAL (BLUE OR ORANGE)
3/16	AN960-10	100	1 1/2" x 4 ft. x 4 ft. ....
1/4 Reg.	AN960-116	220	1" x 4 ft. x 4 ft. ....
1/4 Wood	AN970-4	200	SAFE-T-POXY 1 1/4 gal. Kit.
1" I.D. Industrial Washer	AN970-5	12	1.6 oz. diacon, 64" wide.....12 yards
COTTER PINS		10	20" Mag. Wheels .....2 req'd.
1/8 x 1 1/2	AN380-L4-6	.10	Plastic bucket seat Metal to metal seat belts 5 gal. plastic gas tank
Cable shuklon AN115-21		6	CUYUNA 4.10 R/D ENGINE, COMPLETE
Cable chimbles AN100-4		8	36" dia. x 16" pitch wood prop with hub, bolts, etc.
Hegress leaves 10-2-0		0	1/16 Steel top rivets
1/16 Steel top rivets		100	Cable pulley MS 20219-4
Cable pulley MS 20219-4		200	3/32 dia. x 19 Control cable 30 ft.
1/2x2x18 Neoprene rubber bar		2	

SEE PG. 1 OF "HOW TO BUILD  
WINDWARD" FOR LIST OF  
MATERIAL SUPPLIERS

THESE PLANS ARE OFFERED  
AS REFERENCE AND STUDY  
MATERIAL ONLY

**Windward**

3-VIEW  
BILL OF MATERIALS

By: J. B. G.  
Dwg. No. 1



Windward

FUSELAGE ASSEMBLY By: HB-0701 2  
Dwg:

FUSELAGE - SIDE VIEW

NOTE : THE WINDWARD USES THE SAME WING, TAIL AND CONTROL AS THE VIEWMASTER. - SEE VIEWMASTER PLANS, DRAWINGS - # 3.4.5.

DRILL  $\frac{3}{16}$ " HOLES FOR  $\frac{3}{16}$ " STEEL  
POP RIVETS - USE MAIN BRACE AS PATTERN

10

FUSELAGE - TOP VIEW

SEAT AND THROTTLE  
SUPPORT - 1" x .065 SQ.  
ALUM. TUBE

MAIN BRACE - CUT FROM  
3/16" THICK COATING ALUM.

REAR VERTICAL TUBE  
CUT FROM 2 x 3 x .125  
SODIUM RECT. ALUM.  
THIN

FRONT VERTICAL TUBE  
CUT FROM 2 x 3 x .125  
GALV. RECT. ALUM.  
TIGUE

BOLT SEAT  
TO CROSS TUBE

10

22

مکالمہ

$\frac{1}{4} \times \frac{5}{8}$  S  
 $\frac{1}{4} \times \frac{5}{8}$  TOP  
 $\frac{1}{4} \times \frac{5}{8}$  WOOD

-14-4 TOTAL WOOD SPAR LENGTH

EISENAGE FRONT VIEW

STENT CRACKER  
CUT FROM 2 X 2 X .125  
SQR. ALUM. TUBE

CUYUNA 430 R/D ENGINE  
3G DIA X 16 PITCH PROPELLER.  
WITH HUB, BOLTS, ETC.  
SEE G-2 PLANS. DRAWINGS  
FOR DETAILS.

**SEE VIEWMASTER  
DISC #5**

$\frac{1}{4}$  x  $\frac{3}{8}$  BOLTS  
 $\frac{1}{4}$  STOP PLATE  
 $\frac{1}{4}$  WOOD MANNER

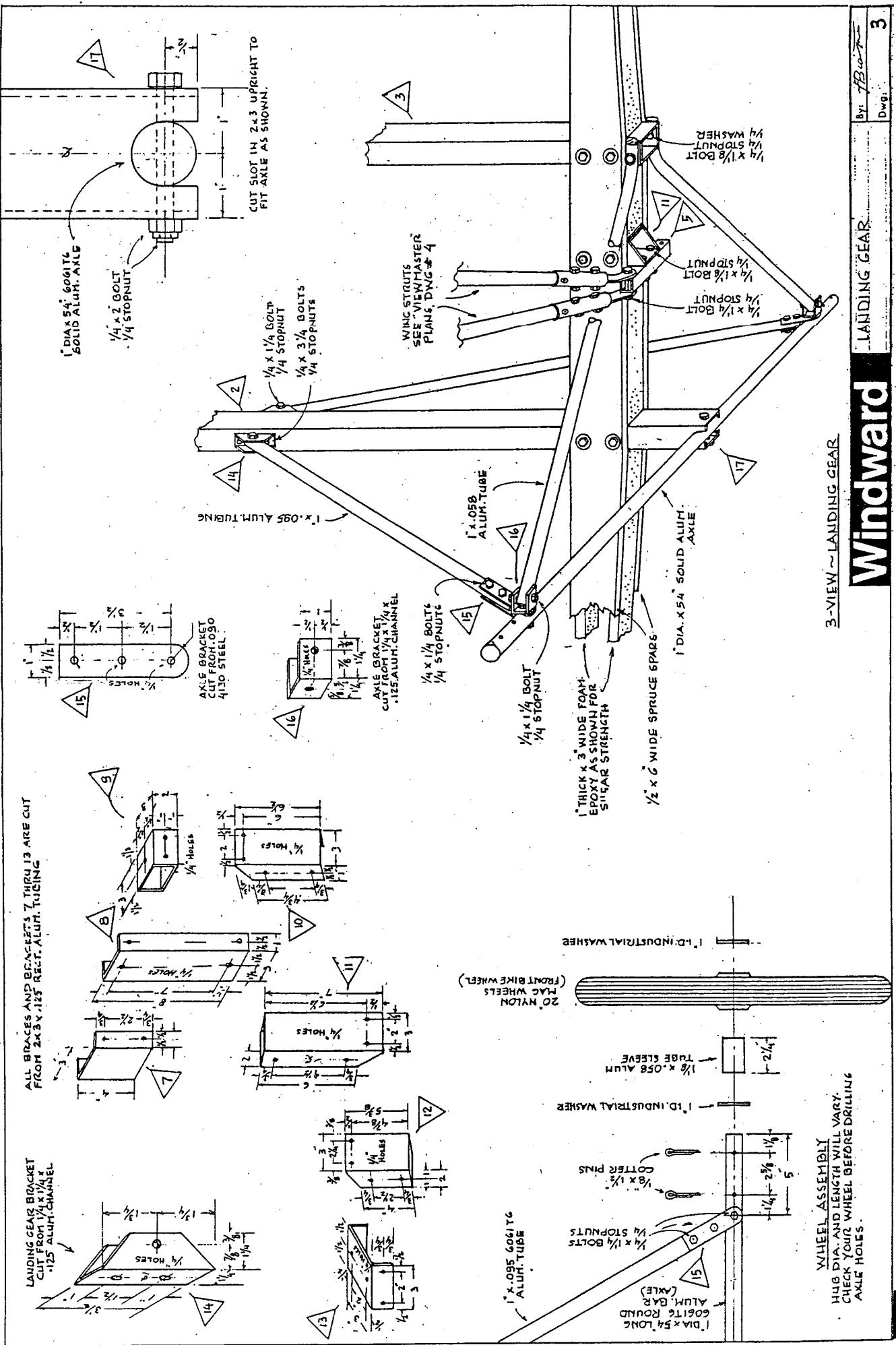
#### 14.4" TOTAL WOOD SPAR LENGTH

FUSELAGE - SIDE VIEW

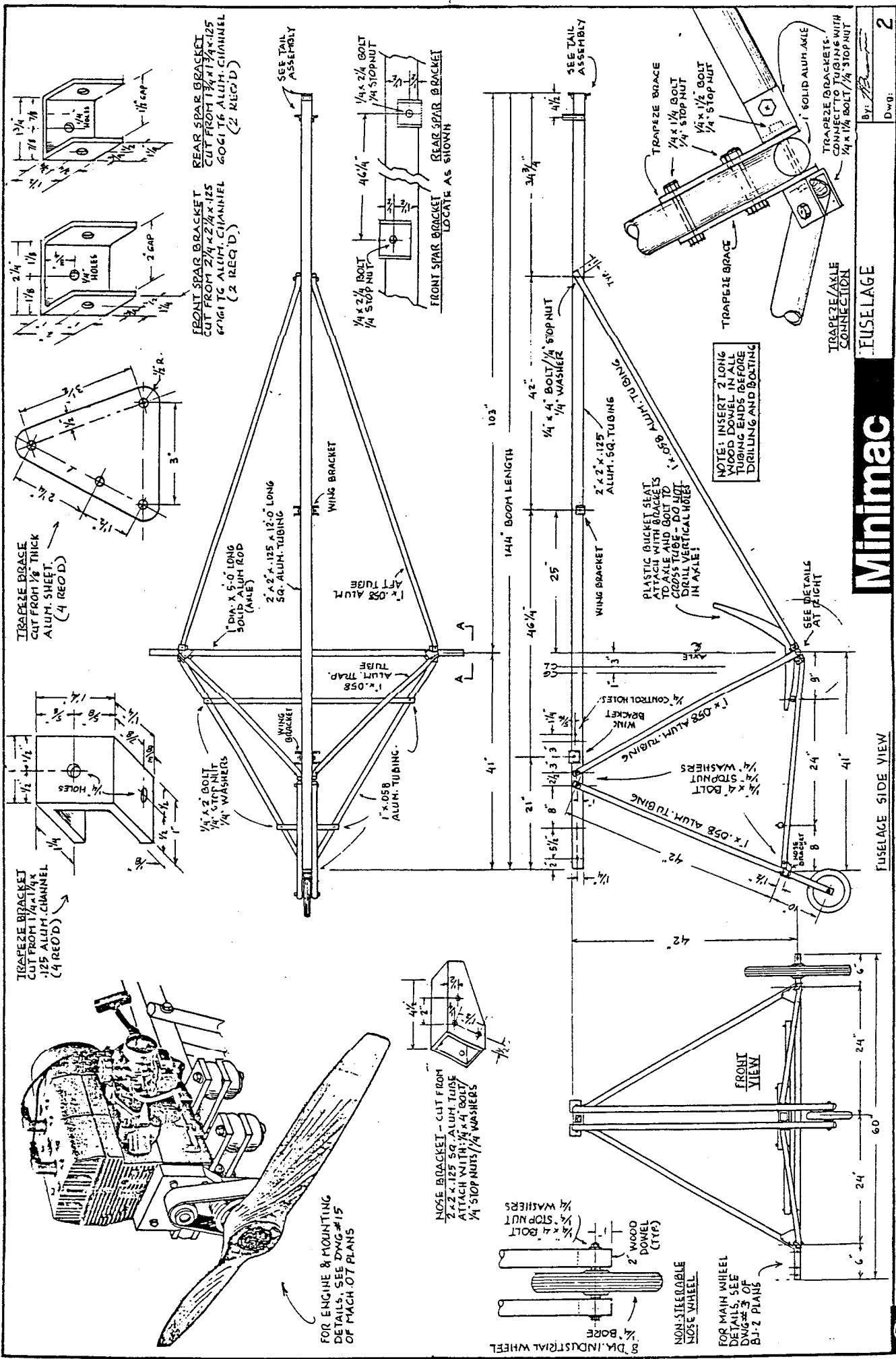
# Windward LANDING GEAR

By: HB  
Dwg: 3

3-VIEW ~ LANDING GEAR



REFERENCE PLANS



## MINIMAC MATERIAL KIT

BOLTS DIA. GRIP	ORDER	QTY.	ROUND ALUM. TUBING QD. WALL LENGTH TYPE	QTY
1/4 x 5/8	AN4-10	6	3/8 x .058 x 12"	6061-T6
1/4 x 1/8	AN4-14	9	1/2 x .058 x 12 FT.	"
1/4 x 1/4	AN4-15	45	5/8 x .058 x 12 FT.	"
1/4 x 1/2	AN4-17	3	3/4 x .058 x 12 FT.	"
1/4 x 3/8	AN4-20	2	7/8 x .058 x 12 FT.	"
1/4 x 1/8	AN4-21	5	1 x .058 x 12 FT.	"
1/4 x 2	AN4-22	2	1/8 x .058 x 4 FT.	"
1/4 x 2 1/2	AN4-23	7	1 1/8 x .058 x 12 FT.	"
1/4 x 2 1/2	AN4-24	12	1/2 x .058 x 12 FT.	2 PCS.
1/4 x 2 1/2	AN4-25	12	1/2 x .058 x 12 FT.	1 PC.
1/4 x 2 1/2	AN4-27	3	1/8 x .058 x 12 FT.	1 PC.
1/4 x 3/8	AN4-34	4	2 x .058 x 12 FT.	2 PCS.
1/4 x 4	AN4-43	10		
	AN4-73	2	SQUARE ALUM. TUBING TYPE 4 x 4 WALL LENGTH	
3/16 x 1/4	AN4-3	5	1 x 1 x 125 x 8 FT. 6061-T6	1 PC.
3/16 x 3/8	AN4-6	12	2 x 2 x 125 x 12 FT. 6061-T6	1 PC.
3/16 x 5/8	AN4-10	12	ALUMINUM ANGLES	
3/16 x 3/4	AN4-11	3	1 x 1 x 125 x 2 FT.	1 PC.
3/16 x 7/8	AN4-12	2	2 x 2 x 250 x 2 FT.	1 PC.
3/8 x 1/2	AN4-14	6	1" DIA SOLID ALUM. ROD	5 FT. LONG
7/16 UNC 1/8 LONG	AN4-17	6	ALUM. SHEET / BAR	
			12" x 5 FT. x .063 THICK	1 PC.
EYEBOLTS			12" x 2 FT. x .090 THICK	1 PC.
EYES DIA. 3/4 I.D.			2" x 4 FT. x .078 THICK	1 PC.
3/16 x 1/4 x 1 1/8	AN4-3-14	20	1/2 x 4 FT. x .025	1 PC.
3/16 x 3/8	AN4-3-21	8	4/30 STEEL	1 PC.
	AN4-2-10	9		
STOPHUTS			CABLE PULLEY MS 20219-4	2
I.D.	AN365-624	6	3/32 DIA. X 7-1/16 CONTROL CABLE	35 FT.
3/8	AN365-428	200	20" INDUSTRIAL WHEELS	2
3/16	AN365-1032	90	1/2" x 2" x 18" NEOPRENE	1 PC.
WASHERS			PLASTIC BUCKET SEAT	
I.D.	AN970-6	16	METAL TO METAL SEAT BELTS	1
3/8	AN960-446	200	5 GAL. GAS TANK	1 GAL.
1/4	AN960-10	100	STITS POLYTAK	2 GAL.
3/16			STITS POLYONE	
1" ID. INDUSTRIAL WASHER		6	1.8 oz DACRON C4 WIDE	28 YARDS
SCOTTER PINS			CUYUNA 430 R ENGINE COMPLETE	
DIA. LENGTH			2:1 REDUCTION DRIVE / GOLTS	
1/16 x 1/4	AN110-357	8	5.2" dia x 27" pitch propeller with	
CABLE SHACKLE - AN 15-21		12	11/16" bolts	
CABLE PRESS SLEEVE - AN 10-4		12		
NICOPRESS SLEEVE - AN 10-4		16		
1/8" STEEL POPRIVETS		500		

SEE PG. 1 OF "HOW TO BUILD  
ULTRALIGHTS FOR LIST OF  
MATERIAL SUPPLIERS

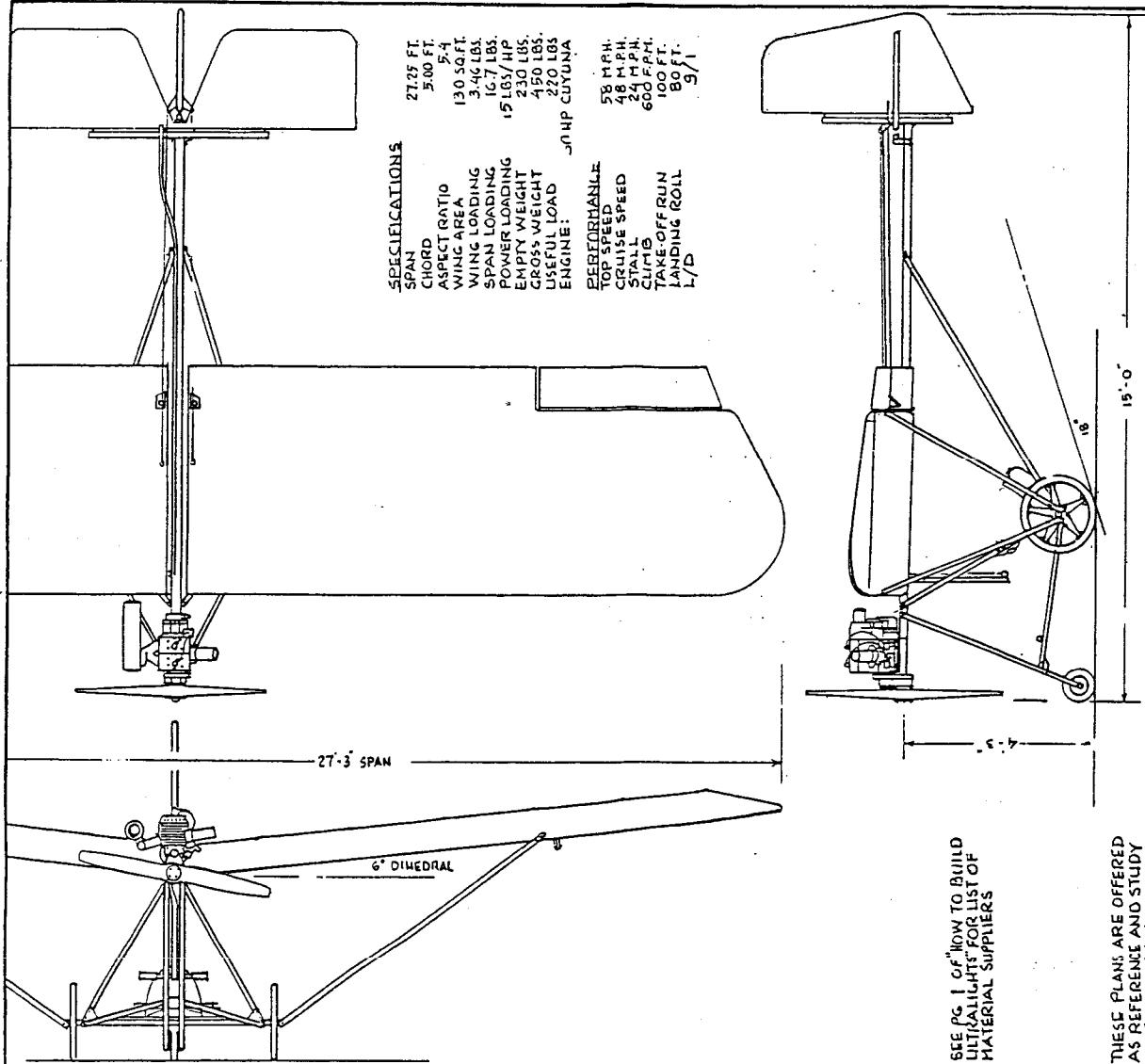
THESE PLANS ARE OFFERED  
AS REFERENCE AND STUDY  
MATERIAL ONLY

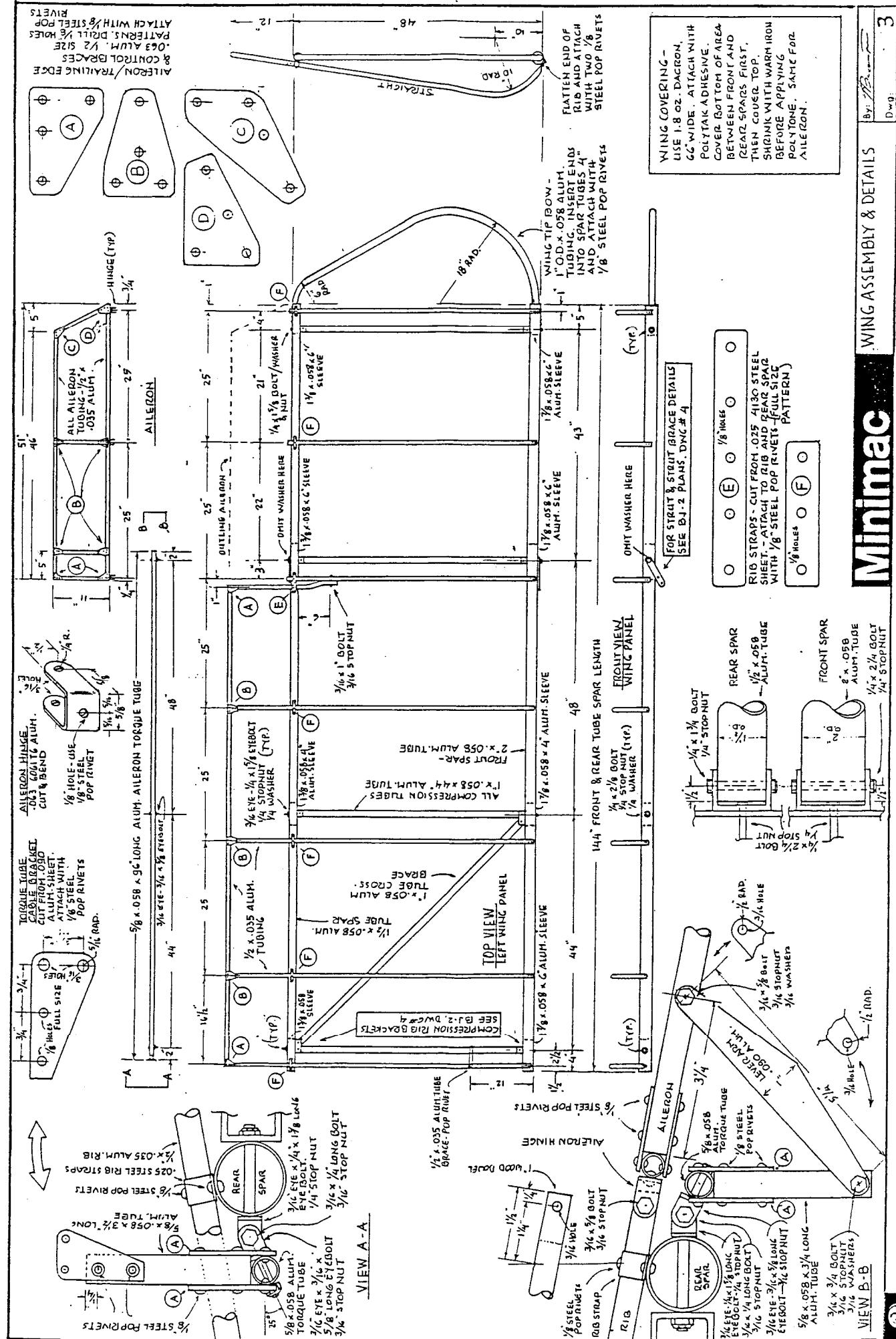
## MINIMAC

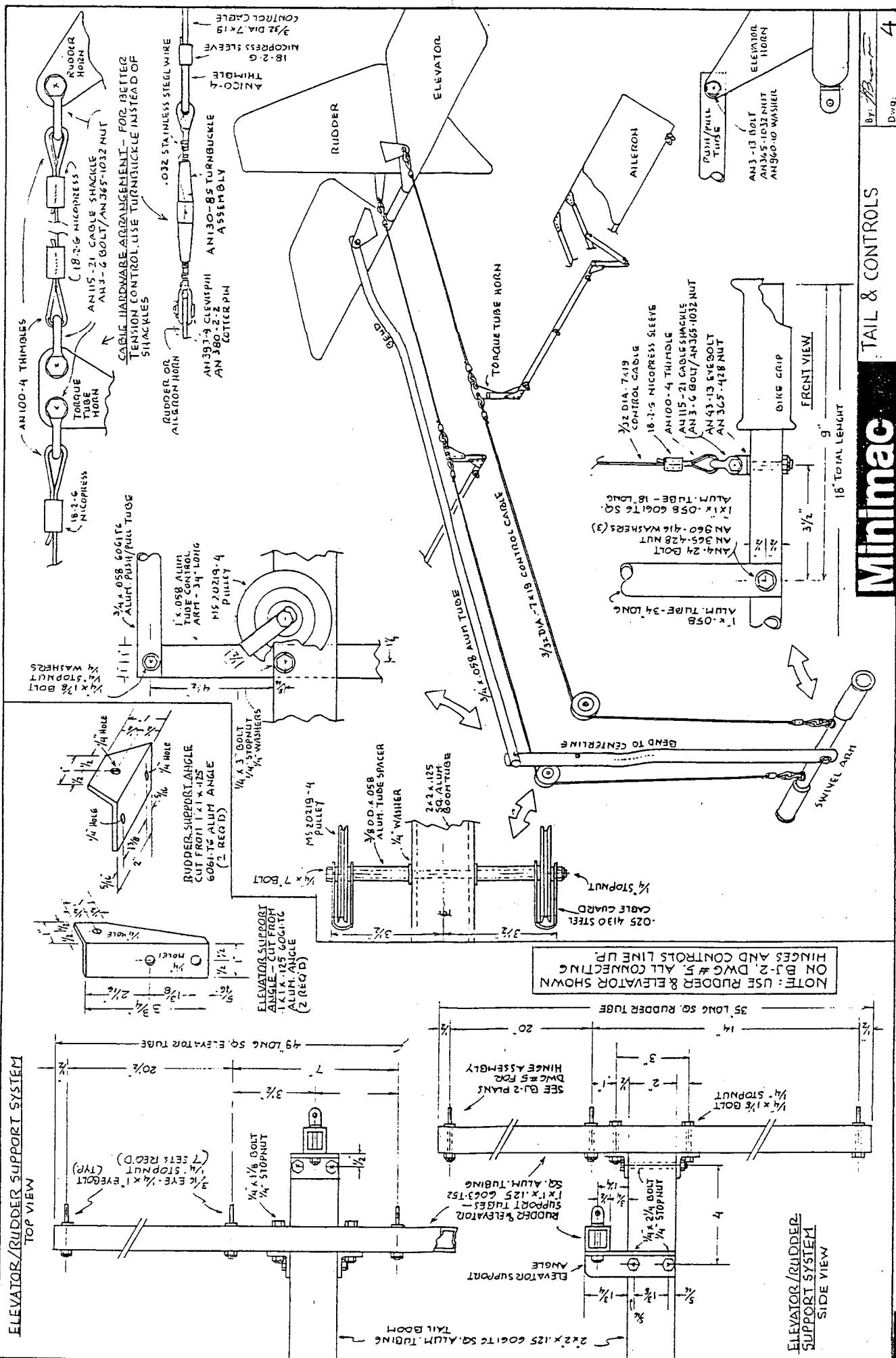
4

3-VIEW  
BILL OF MATERIALS

By: *[Signature]*  
Dwg. 1







# REFERENCE PLANS

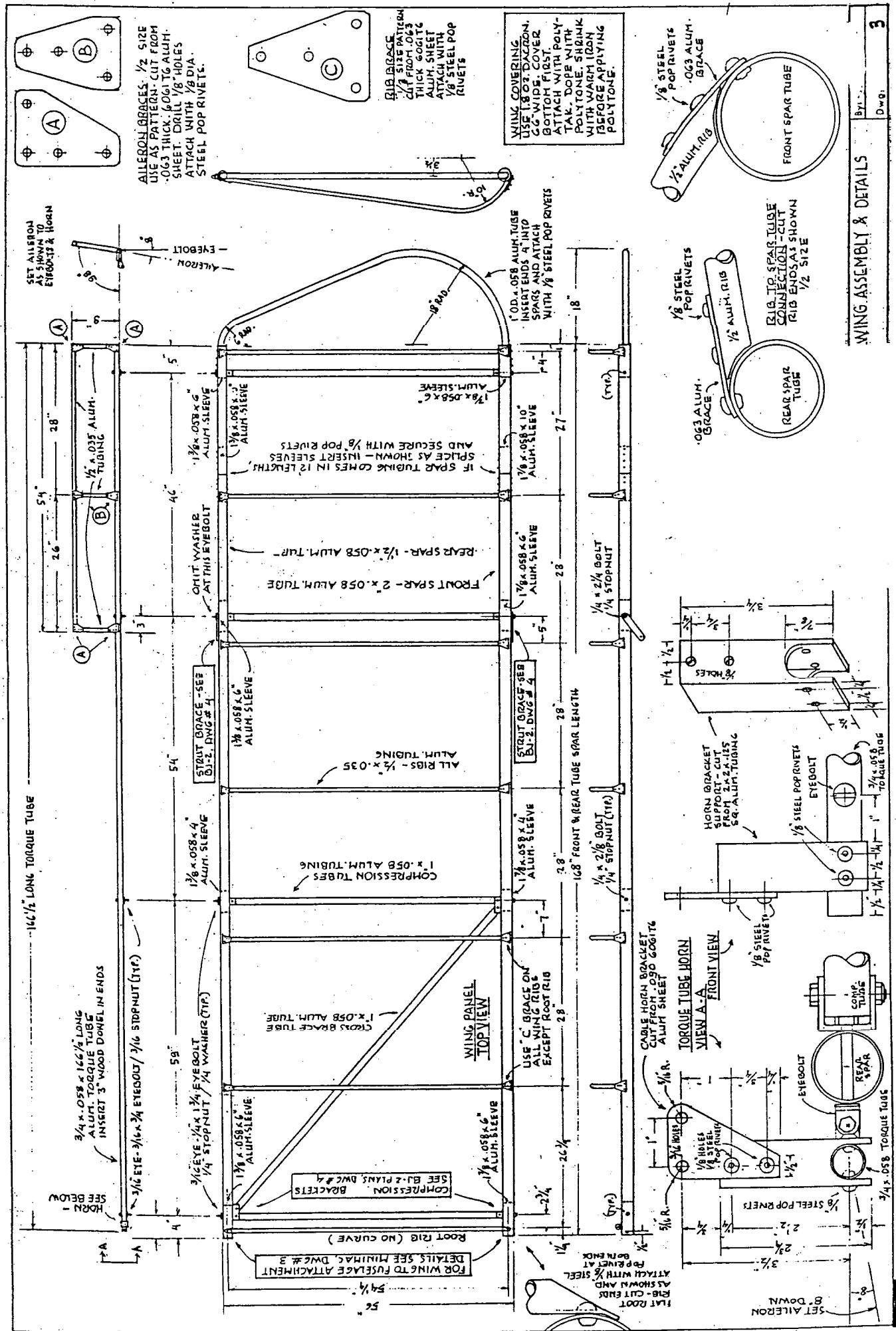
## HARDNOSE MATERIAL KIT

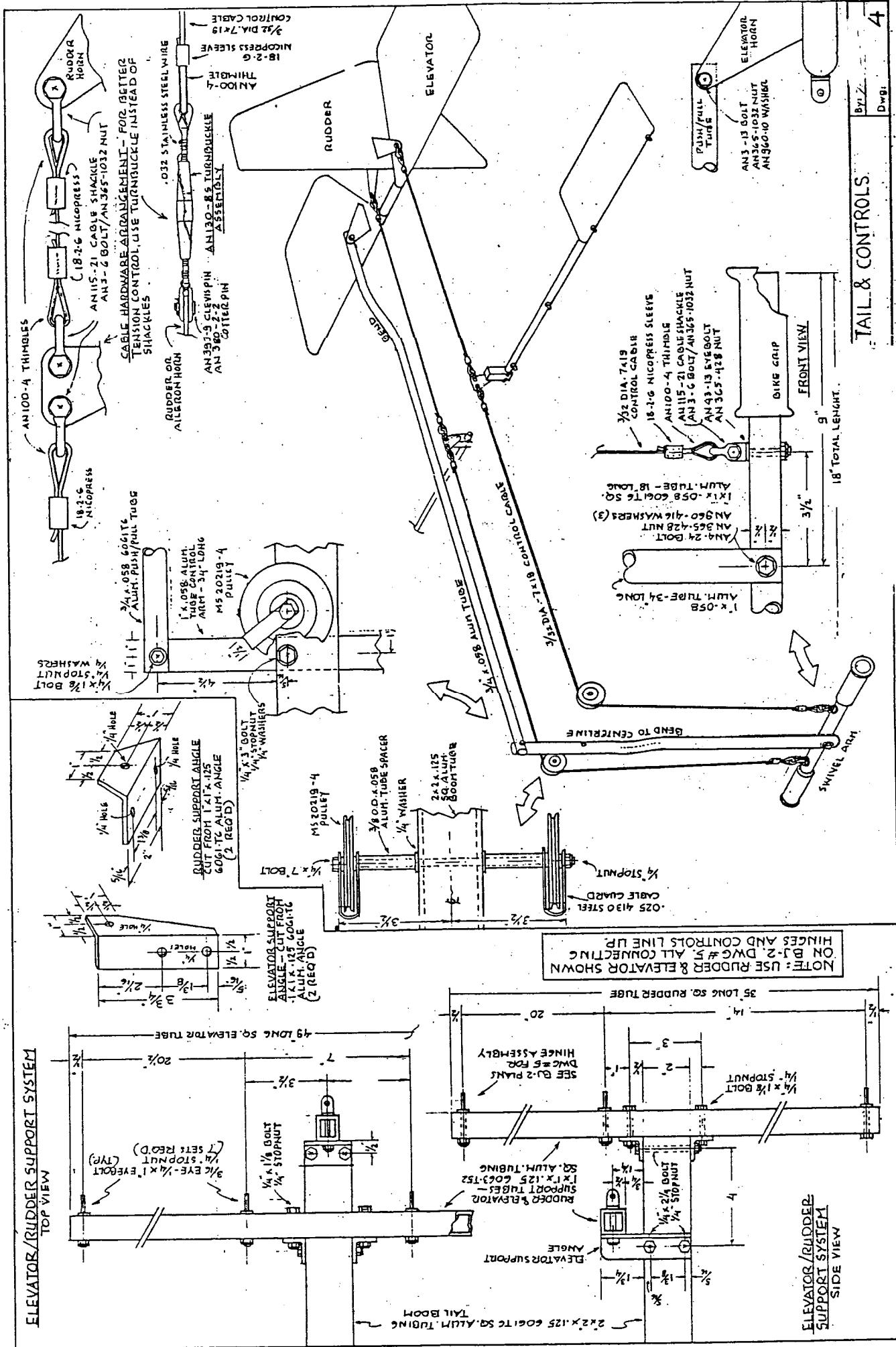
BOLTS DIA. x GRIP.	ORDER	QUANTITY	ROUND ALUMINUM TUBING O.D. x WALL x L	Type	Quantity
5/8 AN6-10		8	3/8 x .058 x 12"	6061T6	1 PC
1 1/8 AN6-14		8	1/2 x .058 x 12 ft	"	9 PCS
1 1/4 AN6-15		4	3/4 x .058 x 12 ft	"	4 PCS
1 1/2 AN6-17		4	7/8 x .058 x 12 ft	"	4 PCS
1 1/4 AN6-21		4	1 x .058 x 12 ft	"	4 PCS
1 1/2 AN6-22		3	1 1/8 x .058 x 4 ft	"	3 PCS
1 1/8 AN6-23		12	1 1/8 x .058 x 12 ft	"	12 PCS
1 1/8 AN6-24		12	1 1/8 x .058 x 12 ft	"	12 PCS
1 1/8 AN6-25		12	1 1/8 x .058 x 12 ft	"	12 PCS
1 1/8 AN6-27		18	1 1/8 x .058 x 12 ft	"	18 PCS
1 1/8 AN6-21		4	2 x .058 x 12 ft	"	3 PCS
1 1/8 AN6-24		4	SQUARE ALUMINUM TUBING O.D. x WALL x L	Type	Quantity
1 1/8 AN6-27		6	1 x .125 x 8 ft	6061T6	1 PC
AN-73		3	1 x .125 x 12 ft	"	1 PC
AN-73		2	2 x .125 x 12 ft	"	1 PC
AN-73		2	2 x .125 x 16 ft	"	1 PC
AN-73		10	W x H x Wall x L	Type	Quantity
1 1/8 UMC 1 1/8 Long		6	ALUMINUM ANGLES		
3/8 x 1 1/2 AN6-14		6	1 x 1 x .125 x 2 ft	6061T6	1 PC
		2	2 x 2 1/2 x .250 x 6 ft	"	1 PC
STEBOLTS 2 1/2 x Dia. x Grip	ORDER	QUANTITY	1 1/2 Dia. solid alum.	Rod 6061T6- 5 ft.	
3/16 x 1/4 AN6-14	AN6-14	20	ALUMINUM SHEET/Bar		
3/16 x 1/4 AN6-21	AN6-21	12	1 ft.x 5 ft.x .050	6061T6	
3/16 x 3/16x3/4 AN6-21	AN6-21	12	1 ft.x 2 ft.x .050	"	
3/16 x 3/16x3/4 AN6-21	AN6-21	12	6" x 1 ft.x .250	"	
		2"	x 4 ft. x 3/8 "	"	
STOPPERS	ORDER	QUANTITY	1/2" x .025 x 4 ft.	4130 steel strip	
1 1/2 AN365-1032	AN365-1032	10	CABLE PULLEY MS20219-4	2 Req'd	
1 1/2 AN365-428	AN365-428	200	3/2 Dia.-719 CNTL CABLE- 35 ft.		
1 1/2 AN365-624	AN365-624	10	20" Nylon Bag	2 Req'd.	
1" I.D. Industrial Washers	ORDER	QUANTITY	10" Industrial Wheels.....	2 Req'd.	
1/4 AN960-10	AN960-10	20	Stits Polytak (Adhesive).....1 Gal.		
1/4 AN960-16	AN960-16	200	Stits Polyton (dope).....1 Gal.		
1/4 AN970-6	AN970-6	8	1.8 oz Lacron, 64 wide.....30 Yards		
COTTER PIN	ORDER	QUANTITY	Plastic Bucket Seats		
1/8 x 1 1/2 AN380-357		8	5 Gal. to Metal Seat Belts		
CABLE SHAKLE AN115-21		12	5 Gal. plastic gas tank		
NICOPREST SLEEVES 18-24		12	52" Dia. x 27" Pitch Prop with Hub		
1/8" STEEL POP RIVETS		560	and collets.		

SEE PAGE 1 OF "HOW TO  
BUILD ULTRAFLIGHTS" FOR  
LIST OF MATERIALS SUPPLIERS

THESE PLANS ARE OFFERED  
AS REFERENCE AND STUDY  
MATERIAL ONLY







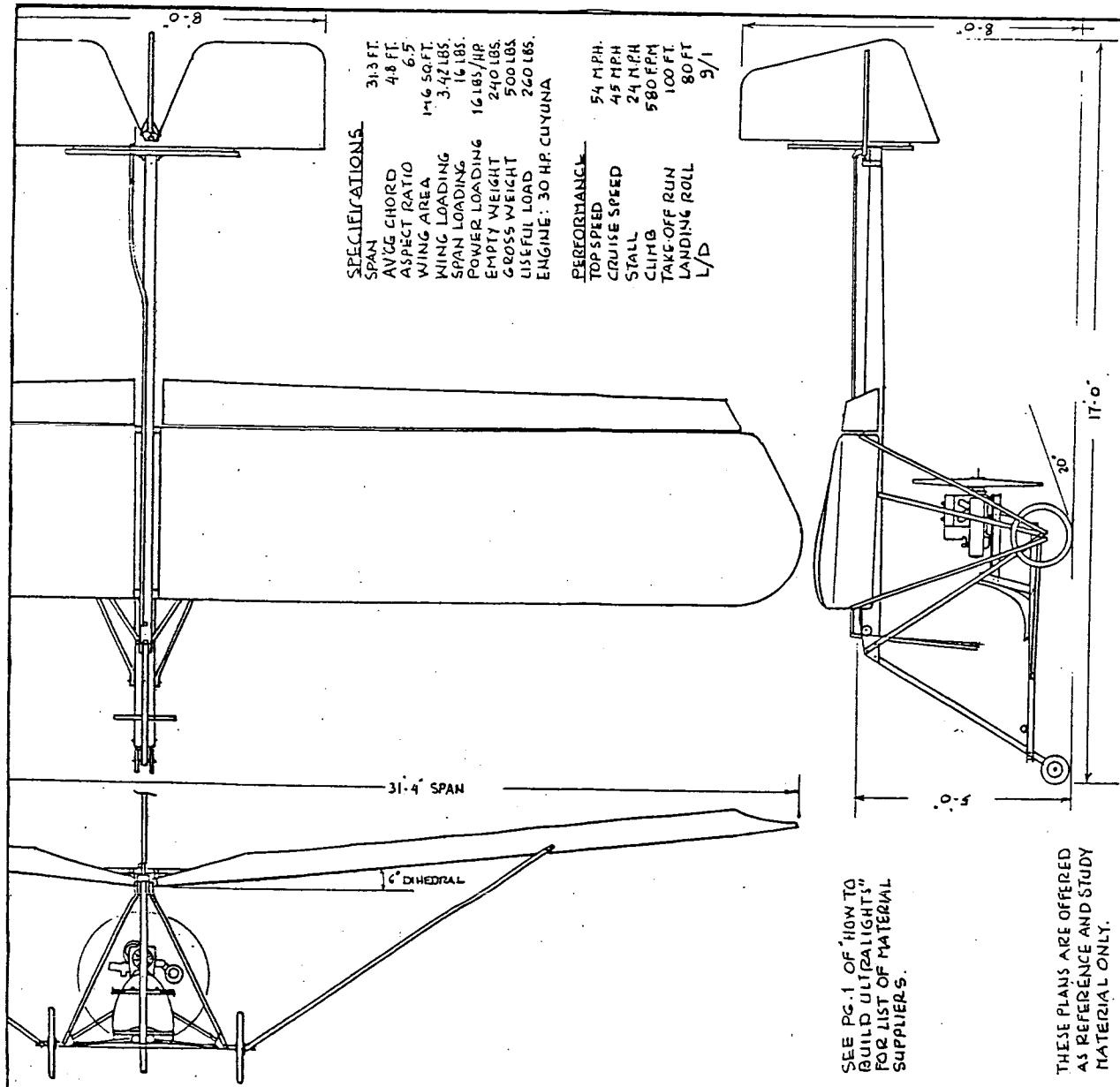
# REFERENCE PLANS

## BJ-2 MATERIAL KIT

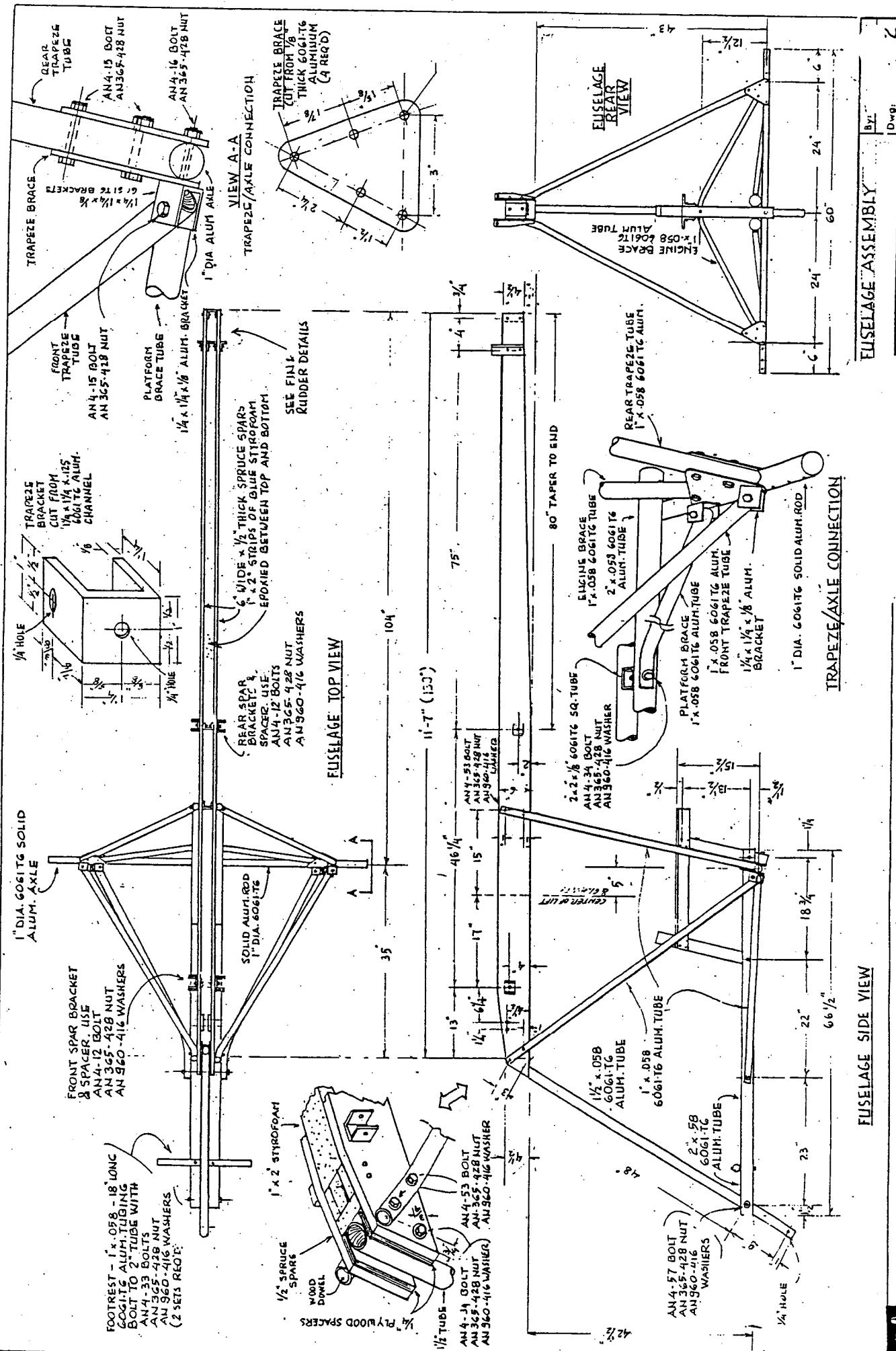
	QUANTITY	ROUND ALUM TURNING COGLITE	QUANTITY
BOLTS			
AN3-4	12	3/8 X .058 X 1 FT.	1 PC.
AN3-5	12	1/2 X .035 X 12 FT.	0 PCS.
AN3-6	12	3/4 X .058 X 12 FT.	1 PC.
AN3-13	2	7/8 X .058 X 12 FT.	1 PC.
AN3-22	2	1 X .058 X 12 FT.	18 PCS.
AN4-10	8	1/8 X .028 X 4 FT.	1 PC.
AN4-12	10	1 3/8 X .028 X 12 FT.	1 PC.
AN4-14	18	1/2 X .058 X 12 FT.	3 PCS.
AN4-15	10	1/8 X .058 X 12 FT.	1 PC.
AN4-16	4	2 X .058 X 12 FT.	4 PCS.
AN4-17	12	2 X 2 X .125 X 6 FT.	6 PCS.
AN4-21	8	1 X 1 X .125 X 8 FT.	1 PC.
AN4-24	2	1 X 1 X .125 X 8 FT.	1 PC.
AN4-25	16	2 X 2 X .125 X 6 FT.	1 PC.
AN4-27	12	2 X 2 X .125 X 6 FT.	1 PC.
AN4-33	8	1 X 1 X .125 X 12 FT.	1 PC.
AN4-34	10	SQUARE ALUM TURNING COGLITE	1 PC.
AN4-35	3	1 X 1 X .078 X 6 FT.	1 PC.
AN4-37	2	1 X 1 X .125 X 8 FT.	1 PC.
AN4-53	6	2 X 2 1/2 X .250 X 5 FT.	1 PC.
AN4-57	2	ALUM CHANNELS COGLITE	1 PC.
AN4-63	3	1 1/4 X 1 1/4 X 125 X 2 FT.	1 PC.
AN4-73	2	1 3/4 X 1 3/4 X 125 X 1 FT.	1 PC.
ANG-21	6	2 1/4 X 2 1/4 X 125 X 1 FT.	1 PC.
7/16 UNC 1/2 LONG	4	1" DIA. ROUND ALUM BAR COGLITE 45 FT. 1 PC.	1 PC.
EYE BOLTS			
AN43-13	22	1 FT. X 5 FT. X .063 COGLITE	1 PC.
AN43-21	12	1 FT. X .050 COGLITE	1 PC.
STOP NUTS			
AN365-1032	50	2" X 4 FT. X .250 202473	1 PC.
AN365-428	180	1/2" X 1 FT. X .025 4130 STEEL STAIR	1 PC.
WASHERS			
AN360-10	50	CABLE PULLY M1520219-4	2' 40 FT
AN360-416	200	3/32 DIA. 7X19 CONTROL CABLE	
1" D. AXLE WASHER	20	1/2" X 6" X 10 FT. SPAN.	2 PCS
COLTIER PINS	6	BLUE STYROFOAM 1" X 24" X 48"	1 PC.
AN380-357	8	20" NYLON MAG WHEELS	2
CABLE SHACKLE			
AN115-2J	10	1/2" X 2" X 18" NEOPRENE (FOR SHOCKS)	1 PC.
CABLE THIMBLE			
AN100-4	10	PLASTIC BUCKET SEAT	1 PC.
NUCORESS SLEEVES		METAL TO METAL SEAT BELTS	1 SET.
18-2-G	16	5 GAL. PLASTIC GAS JUG	1 PC.
POP RIVETS		SAFE T-POXY (TO ATTACH FOAM)	1/2 QT.
1/8" STEEL	500	STITS POLYTAK	1 GAL.
		STITS POLYTON	2 GAL.
		1.8 OZ DACRON .64" WIDE	30 YARDS

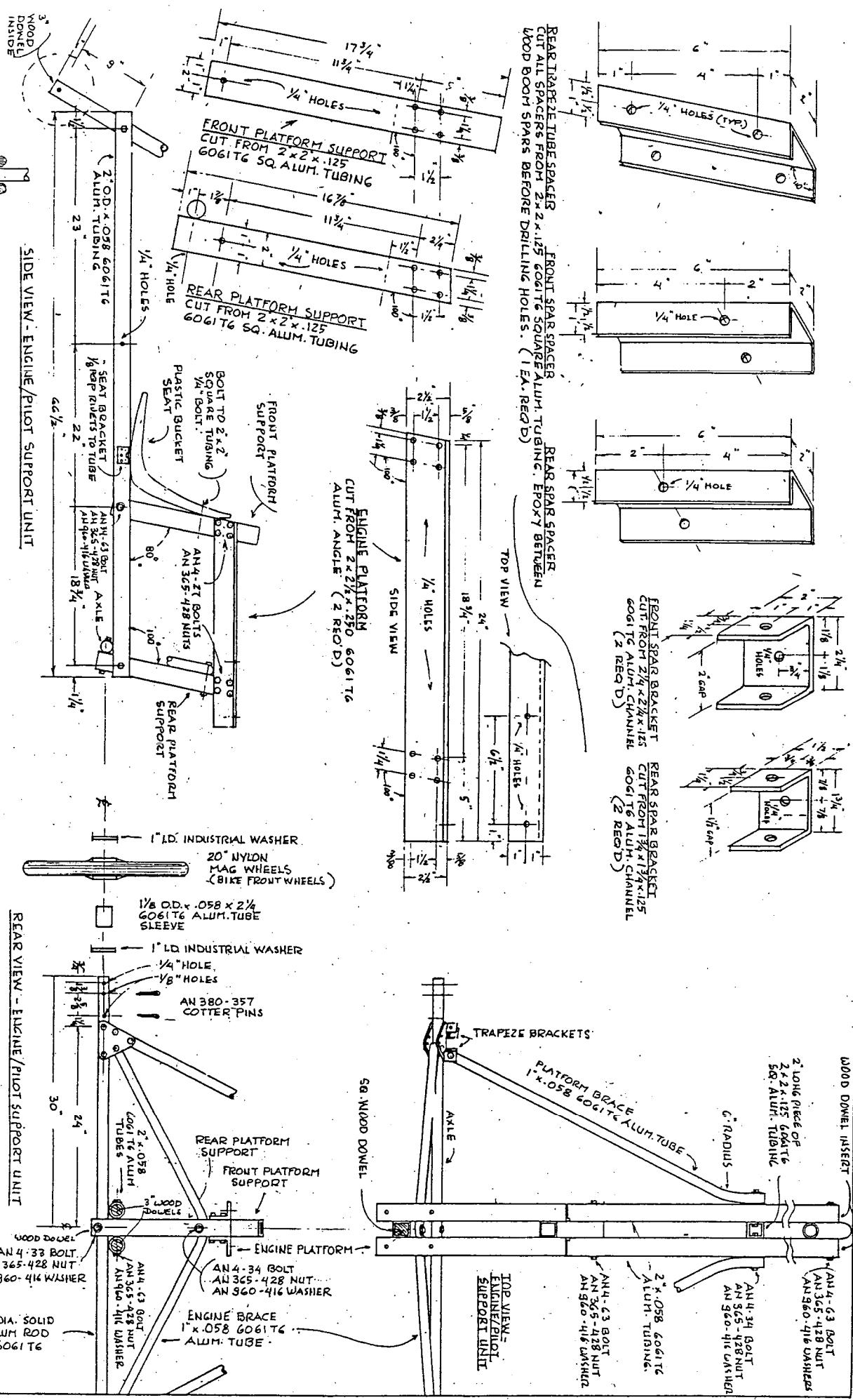
SEE PG. 1 OF "HOW TO  
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3-VIEW  
BILL OF MATERIALS



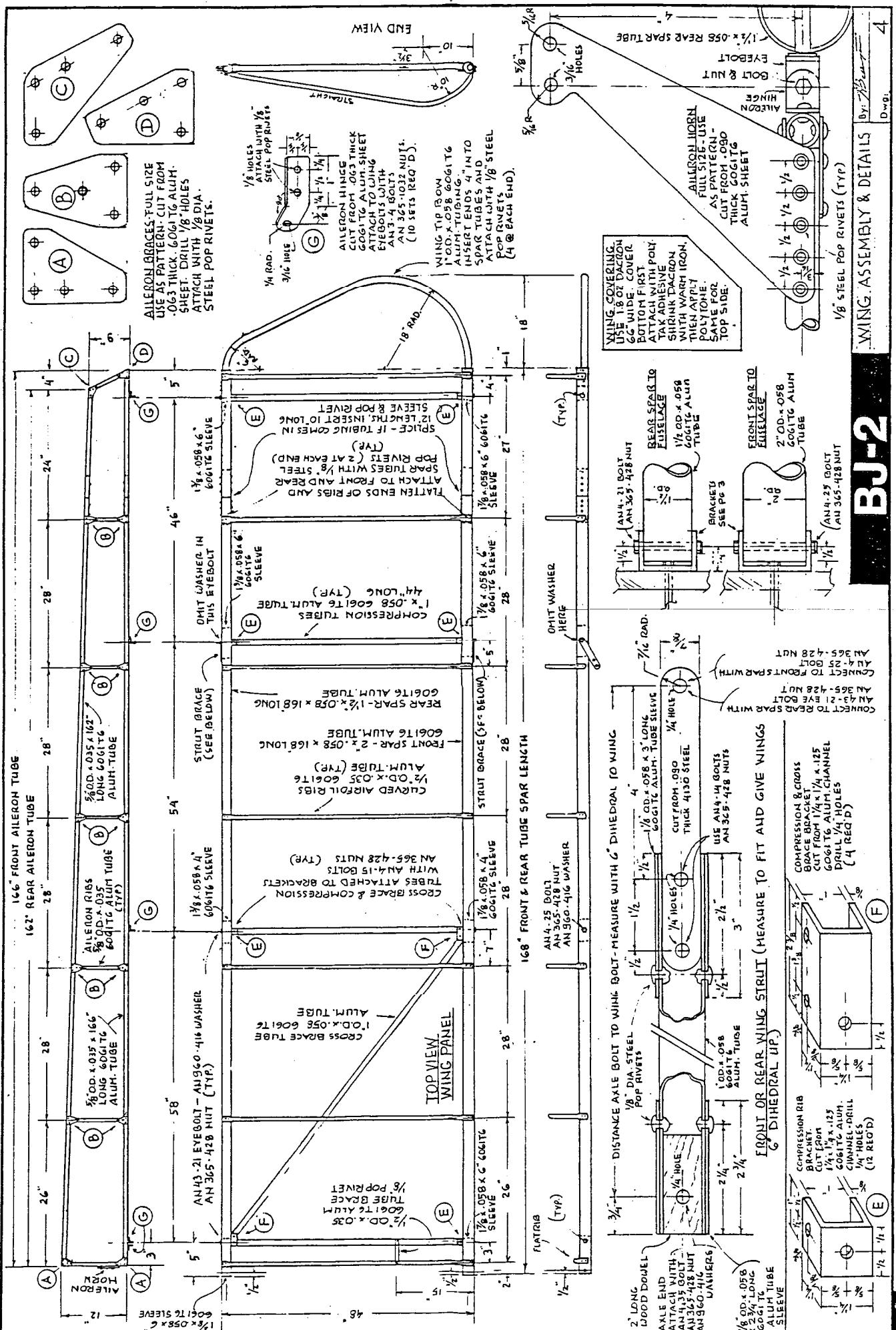


NON-STEERABLE FRONT WHEELS.  
AVAILABLE FROM HARDWARE STORE  
USE BOLT SIZE TO FIT

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七

#### "FUSELAGE" DETAILS

Dwight  
3



23

## ELEVATOR/RUDDER SUPPORT SYSTEM

RUDDER/ELEVATOR BOOM SPACERS  
CUT FROM 2 x 2 x 125 C.G.C.T.  
SQUARE ALUM. TUBE  
(2 RECD)

Technical drawing of an elevator support angle. The drawing shows a rectangular profile with various dimensions labeled: height 3 1/2", width 2 1/2", thickness 1/2", and a cutout section. Material specifications include "16ga. 1/2" thick plate" and "CUT OUT FROM X-125 6016 ALM-A1E 2 RECD".

49 ELEVATOR SA TUBE

24%

20%

3½"

7 SETS BEGD)

(ALL HINGE SETS SAME)

AN-365-103 NUT

AN-3-5 BOLT

HINGE WUT:

AN-265-426 NUT

AN-13 EYEBOLT

ANCHOR WUT

1

SYSTEM - SIDEWALL

RUDDER-SIDE VIEW

**Rudder/Elevator Blaces:** Cut from 6063 T6 ALUM. 1/8 IN. THICK. USE 1/8 IN. STEEL POP RIVETS. 1/2 SIZE (2 RECD) 1/8 HOLES (4P).

**ELEVATOR HORN:** 1/2 SIZE (2 RECD) 1/8 HOLES (4P). INSERT 7/16 X .058 X 6 LONG ALUM. SLEEVE.

**Rudder Horns:** 1/2 SIZE CUT FROM 6063 T6 ALUM. SHEET. USE 1/8 IN. STEEL POP RIVETS. 1/2 SIZE (2 RECD) 1/8 HOLES (4P).

**Splice - Insert 7/16 x .058 x 4 long ALUM. tube and SECURE WITH 1/8 IN. STEEL POP RIVETS. USE 1/8 x .058 GОСГТС ALUM. 1033 throughout.**

This technical drawing illustrates the Hinge Assembly. At the bottom, a large rectangular base plate is shown with a central vertical hinge mechanism. The hinge is labeled "HINGE ASSEMBLY". Above the hinge, a cylindrical component is labeled "RADIOS ON ELEVATOR TUBE". To the left of the hinge, two nuts are labeled: "AN3-5 BOLT" and "AN3-5-103 NUT". A tube assembly is labeled "1A1-125 SO. TUBE". On the right side, a dimension of "19/16" is indicated. The top portion of the drawing shows a cross-section of the hinge mechanism. It features a central vertical post with a horizontal slot. A curved bracket labeled "ELEVATOR HORN" is attached to the side of the post. The bracket has a thickness of "1/2" and a height of "5". A "BEND 90" is shown at the top of the post. The drawing also includes a "BEND 25" angle and several hole sizes: "1/8 HOLES", "1/4", "1/2", and "1 1/4". A note on the right side reads: "CUT FROM ONE THICK GOGGLE PLATE, 1 1/2 IN. SQUARE, AND GLUE IT ON". The top right corner contains the text: "DRILLING HOLES IN BENT ENDS AND DATA ATTACH WITH STEEL POPPERS".

B-2

FINAL ASSEMBLY & DETAILS By B. Burt Date 5

