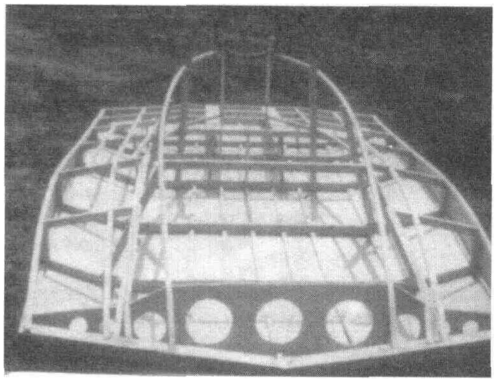
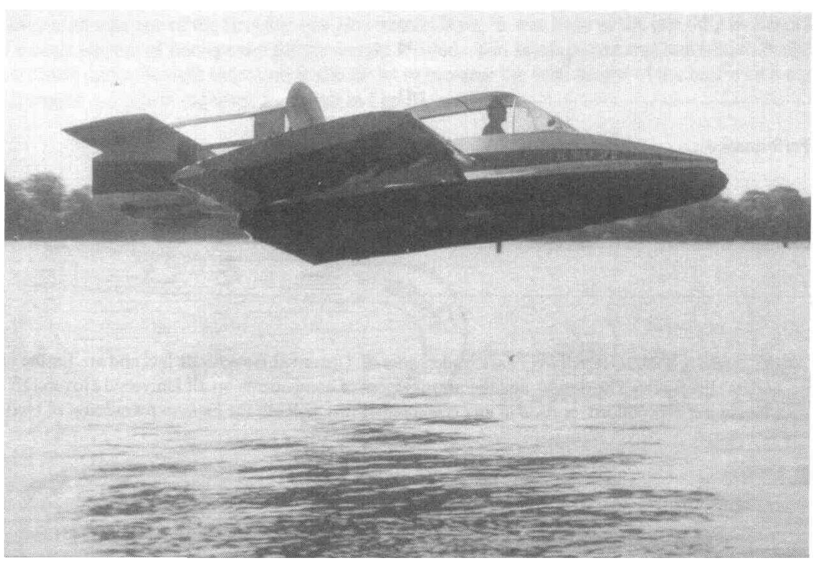
universal hovercraft

HOVERCRAFT CONSTRUCTION



AND
OPERATION



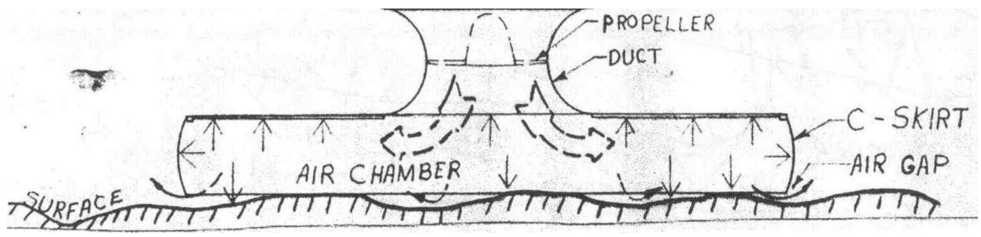
CONTENTS

PRINCIPLES OF OPERATION

LIFT SYSTEMS

A Hovercraft or an air cushion vehicle is a vehicle that travels over any surface on a cushion of air which is trapped in a chamber under the vehicle. This chamber is supplied with air under pressure from a propeller type fan or a centrifugal fan. The vehicle bottom and the surface over which the vehicle is traveling respectively form the top and bottom of the chamber. The flexible skirt forms the sides of the chamber. The simplest skirt is the "C" skirt or the straight skirt shown in Fig. I.

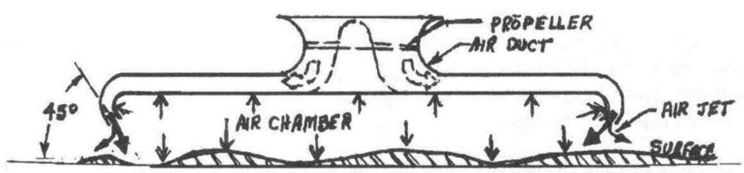
FIGURE I



A vehicle using a "C" skirt must have a round or nearly round platform shape in order for the skirt to inflate and contain the air properly. This skirt should have a maximum height of about 10-15% the diameter of the vehicle. Any greater height will result in less stability, hi other words, the vehicle will be harder to balance with a higher skirt. There must be a sufficient volume of air supplied to the chamber so the air escaping from gaps between the skirt and the surface is replaced. It is easy to see why operating over a smooth surface required less air supply than operating over a rough surface. Operating over grass, especially tall grass, requires much more air than over concrete or ice.

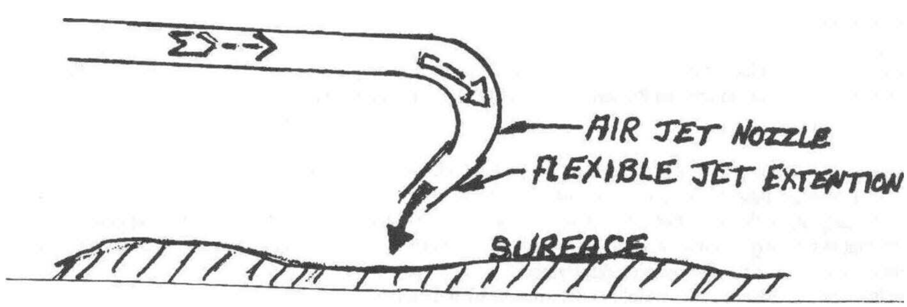
Figure II shows the peripheral jet type Hovercraft, which traps air by means of a curtain or skirt formed by a jet or stream of fast moving air. This jet of air is aimed down and inward at a 45 degree angle for best efficiency and highest lift.

FIGURE II



The peripheral jet hover craft was one of the first full size Hovercrafts built. It was built in the late 50's in Great Britain. This type of Hovercraft required a large amount of horsepower for the weight it lifted. Too much power was required to maintain the air jet. This type of craft was later fitted with a flexible extension to the air jet to increase the total height of the hull with a corresponding decrease in the air jet height and power required, as shown in Fig. III.

FIGURE III



More experimenting with flexible skirts showed that using a bag skirt could increase the lifting efficiency and stability of the craft. (Fig. IV.) The vehicle could be built to almost any platform shape and it is simpler to build because air does not have to be supplied to a jet system all the way around the perimeter of the vehicle. The air could be ducted directly into the bag and the chamber. The pressure in the bag could be equal to or greater than the pressure in the chamber. The greater the bag pressure, the harder the ride over rough surfaces.

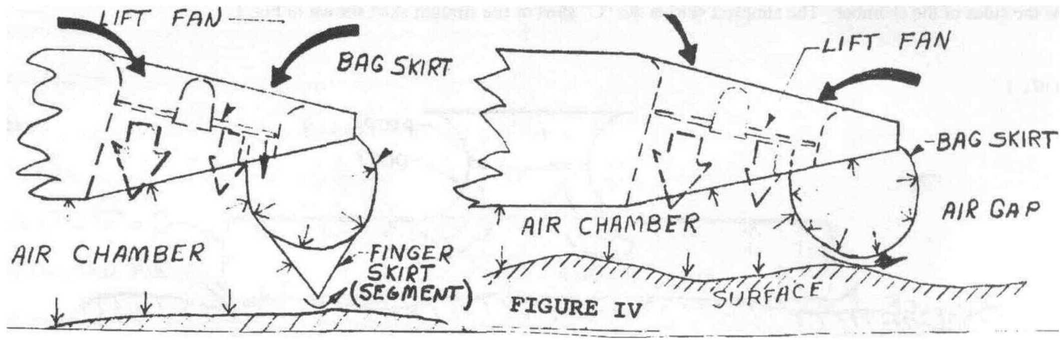


FIGURE IV

Bag skirts generally give the best stability and the roughest ride. To get a smoother ride, Finger skirts may be added to (Fig. IV) the bag skirt or they may be used separately, with a decrease in the operating height of the hull. Finger skirts are difficult to build due to the large number of separate fingers that must be attached. The overall result of flexible skirts is to give greater operating height with less power required for lift. Greater Operating height is desirable for passing over obstacles without damaging the hull of the vehicle.

With flexible skirts the power required for lift varies from 20 to over 200 Ibs. per horsepower and depends on many factors. In general a vehicle that has about 100 to 150 Ibs. weight for every horsepower of lift, will operate well provided an efficient lift fan and duct are used. A sample problem of lift power required follows.

An eight foot diameter 100 Ib. Hovercraft is to have a hover gap of 1/2 inch and lift a 150 Ib. person. Calculate the power required.

Perimeter = Diameter x = 25. 12 Feet (Ft)

Area from which air will escape is the (Perimeter) x (Hover Air Gap)

(25. 12 Ft) x (1/2") x 1Ft - 1.047 sq. Ft.
12"

Now for a small Hovercraft we can assume the air is escaping from the air gap at about 60 Ft. per second. (This velocity depends on the pressure of the air in the chamber.)

Therefore: (60 Ft./Sec) x (1.047 sq. Ft) = 62.8 cu. Ft/Sec, is the total volume flow of air required.

The total weight of the vehicle must lift is 100 plus 150=250 Ibs.

The area on which the air is lifting is:

(Radius) squared X 3. 14 = 4 X 4 X 3 . 14 = 50sq. Ft.

The pressure required is equal to the weight divided by area:

250Lbs. = 5 Lbs. /Ft
50 Ft.

The total energy required is the pressure x volume flow

5 Lbs/sq. Ft. x 62. 8 Ft. /Sec. = 314 Ft. Lbs. /Sec

One horsepower is 550 Ft. Lbs/Sec. but since a good propeller and duct is only about 70% efficient, each horsepower will provide only 550 x 7 = 385 Ft. Lbs./Sec. energy to the air. Therefore the power required is 314 Ft. Lbs /Sec. = .815 HP
385 Ft. Lbs. /Sec. /HP

In general a hover gap of about one inch is desirable. This would take about 2 x .815 = 1.63 HP

In actual practice you would find that you may need about 3 HP to get a one inch gap. The problem is that as the air must move twice as fast through the duct, the efficiency drops drastically. A larger duct would improve efficiency, but may cause other problems such as needing a fan that is too large for the lift engine or result in very high fan tip speeds which increase noise and blade erosion. A good lift system must then be a compromise of many factors.

The limiting payload or gross weight is determined by the ability of the craft to exceed planing speed on slightly rough water (6 inch waves) into a mild head wind at the specific weight or payload. Payload should not be limited by the lift system. A good lift system should lift 1 1/2-2 times max payload.

Maximum obstacle clearance is about the height the craft will raise off the ground when the lift engine is running at full power Experimenters wishing to increase this height should be cautious because increased height makes the craft less stable and more likely to plow in especially at high speeds

PROPELLER & FAN SAFETY

A 26 inch diameter lift fan turning at 3000 RPM has a blade tip speed of 232 M P H For this reason it should be guarded by covering the duct with 1/2 inch grid screen wire The wire should be attached well enough to support a person who may fall against it The plain of rotation of the propeller should also be shielded with 3/8 inch of wood or fiberglass or 1/16 inch of aluminum or 1/32 inch steel sheet The shield may be formed around the air duct and should extend about 3 inches below and above the plane of rotation It should provide complete protection to the passenger compartment of the craft in event the fan fails or hits a loose part The lift fan, mount, and engine should always be checked before operating Check for fatigue cracks and loose fasteners on the entire lift system All spectators should be kept at least 25 Ft away while the vehicle is operating While operating a propeller or fan, no one should stand or remain in the plane of rotation The operator should be aware that if any components fall into the propeller, they could be ejected at high speed in the plane of rotation

PROPULSION SYSTEMS

With its lift systems operating, a Hovercraft can slide over a level surface almost free from friction drag But, it must have some means for getting its motion started If the Lift System provides enough air to give a good air gap, tilting in the direction you wish to travel may propel the Hovercraft This tilting causes most of the air to escape in the opposite direction of the crafts travel, resulting in a small thrust This thrust is usually to small for travel over anything but a perfectly level surface

Maintaining travel in the desired direction is also difficult With a little practice, directional control can be had by tilting enough to cause the skirt to drag on the surface, causing the vehicle to turn in the direction of the dragging skirt This should be tried on a day with very little wind

Another method of propelling a craft with just a lift system is by bleeding off some of the lift air and aiming it in the opposite direction of the desired direction of travel By putting a rudder in this stream of air, the craft can be steered But the lift system must be capable of supplying enough air for both requirements Both of these propulsion systems are inadequate on windy days, or for operating at anything but slow speeds on water

A Hovercraft operating over a solid surface will continue to accelerate until the thrust is balanced by air drag There are two types of air drag to consider in Hovercraft operation The first is form drag caused by a greater air pressure at the front of the vehicle than at the rear when the vehicle is traveling forward A more streamlined shape will decrease this type of drag
The second type of air drag is momentum drag of the lift air when this air is brought to rest under the vehicle The amount of drag depends on the volume of flow of air per second and the speed of the craft (See Sample Propulsion Problem)

In addition to air drag, a Hovercraft operating over water, will experience three other types of drag The first, which is present all the time in varying degrees is wave drag Since the lift chamber contains air under pressure, this air depresses the water surface under the craft For every 5 Ibs per Sq Ft pressure, the water surface is depressed about one inch As the craft starts traveling forward this depression moves with the craft and also causes a wave to form in front of the craft This wave keeps getting bigger until the craft reaches planning speed At this speed the craft is moving faster than the wave it is making and it passes over the wave At this speed the wave drag is at maximum As speed increases beyond planning speed the wave drag decreases but is still present Above planning speed the air in the chamber is still pressing against the surface of the water, but the craft is moving fast enough so the air doesn't have a long enough time to depress the surface of the water very far As speed increases wave drag decreases As a result, wave drag calculations are usually made to determine if the craft has enough thrust to exceed the planing speed We can see that the Hovercraft planes similar to a boat

The second type of drag over water is friction drag This drag is caused by the skirt occasionally contacting the water surface, due to an out of balance condition, insufficient lift, or waves on the surface of the water

The third type of drag is wave impact drag, which is caused by the skirt plowing into the waves in rough water As you can see there are many types of drag the Hovercraft must overcome This is why a propulsion system is used In order to get a good performance, the propulsion system should have more power than the lift system A good propeller should produce 4-6 Ibs thrust per horsepower, whereas a centrifugal fan will produce only 2-4 Ibs thrust per horsepower The term horsepower means the horsepower available at the R P M the engine is to be run at An engine that has 10 H P at 7000 R P M may only have 5 H P at 4000 R P M

Sample Problem Determine the maximum speed of a 12' long 6' wide, 3' high Hovercraft over land Weight is 700 Ibs loaded and the craft uses 100 cubic feet per second air for lift The propulsion engine develops 20 H P with its propeller

Since the craft is operating over land there are two types of drag to consider The first is form drag We must estimate the form drag coefficient (CD) A perfectly streamlined shape has a CD approaching zero and a flat shape has a CD of about 1 0 The average Hovercraft will have a CD of about 0 5 The form drag is the frontal area x CD x Dynamic air pressure (PD), where PD = (V/29) where V is velocity in feet per second (FPS)

So form drag (DF), is DF = 6' x 3' x 5 x (V/29)

Momentum drag (DM) = Mass flow X Velocity (V)
DM= 00238 X 100 X V

Calculating for Several Values of V at 29 FPS, Form Drag = 9 Ibs ——————at 29 FPS DM= 6 9
58 FPS, Form Drag = 36 Ibs ——————at 58 FPS DM= 13 8
87 FPS, Form Drag = 81 Ibs ——————at 87 FPS DM= 20 7

The thrust available at zero speed (static thrust) is about 5 Ibs per horsepower or about 20 x 5 = 100 Ibs thrust But thrust decreases as speed increases

Thrust at speed (T) = Static Thrust x(l-V/340)

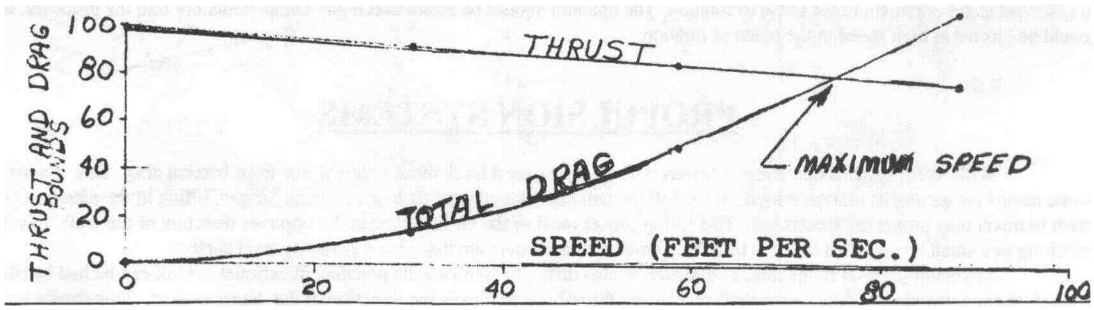
Where V is Speed in Feet per Sec.

So the thrusts at our selected speeds are:

V = 29 FPS	T = 91.51bs.
V = 58 FPS	T = 83.0 Ibs.
V = 87 FPS	T = 74.5 Ibs.

Now we must make a plot of thrust and drag versus speed. Add both drags (Form drag + Momentum drag) and plot the point at the corresponding speeds.

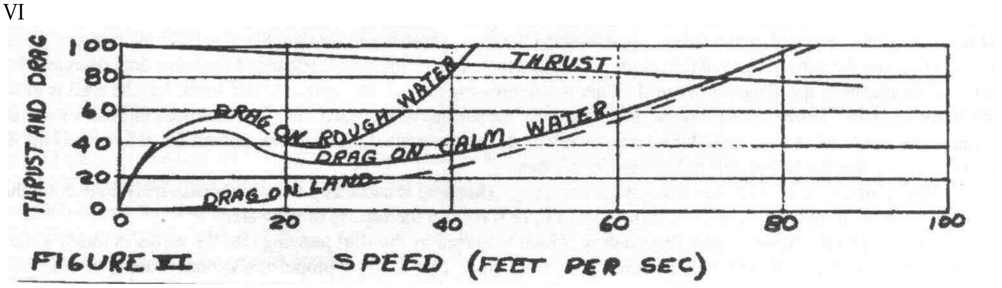
FIGURE V



The plot in Fig. V shows that the maximum speed on land is about 75 Ft./Sec. or about 51 MPH. If you are going against a 10 MPH wind your actual ground speed will be 41 MPH. If you go with the wind your maximum speed will be about 61 MPH. The maximum speed is obtained where the thrust is equal to the drag from Fig. v.

Over smooth water with a properly trimmed vehicle the maximum speed would be almost the same as over land. There may be a few MPH difference due to the small amount of wave drag or occasional touching the surface of the water. Over rough water the vehicle would slow down considerably due to impact drag and friction drag. At low speed, the drag in water is much higher than on land or ice. A typical drag versus speed chart is shown for the same Hovercraft as the sample problem, only this time the vehicle is over water. (Fig. VI)

FIGURE VI



FUEL CONSUMPTION AND POWER

The four cycle engine is generally quieter and more economical than the two cycle engine, but it is also heavier and more expensive to purchase. A four cycle engine burns about one-half pound of fuel per hour for every horsepower being developed by the engine. The two cycle bums almost twice that amount or about one pound of fuel per horsepower per hour. At low r.p.m. two cycle engines may become even less efficient; but some of the new liquid cooled two cycle engines are more efficient quieter, and more reliable than the air cooled. This is because liquid cooling is more uniform and permits closer tolerance of all moving parts. Various types of reed valves and rotary valves on the new two cycle engines provide more power and efficient operation, but most two cycle engines must drive a propeller through a reduction drive so the engine can run in the range of 5,500 to 8,000 r.p.m.'s at full power while the propeller may turn 2,000 to 3,500 r.p.m.'s (for 48 to 60 inch diameter propellers) to reduce propeller noise and blade

SAMPLE PROBLEM

A Hovercraft develops 32 horsepower from its four cycle engines to maintain 40 mph speed. Fuel burned = 32 horsepower x 1/2 Ib. /horsepower hr. = 16 Ibs/hr. Since there are about 6 Ibs. of gasoline per gallon, you will burn 16 Ibs. /hr. /6 Ibs. /gal. = 2. 7

gals./hr Your mileage is 40 miles per hour/2.7 gals, per hr. = 15 miles per gallon. A 6.75 gallon tank is good for 6.75 gals./2.7 gals/hr. = 25 hours. Your range at 40 m p.h. is 40 mi./hr. x 2 5 hrs. = 100 miles.

For best economy the Hovercraft should be loaded slightly tail heavy. When thrust is applied the craft will trim more nose down. Move fuel or passengers to trim for best speed. Do not depend on your mileage figures because they will change with the weather conditions and with water surface conditions.

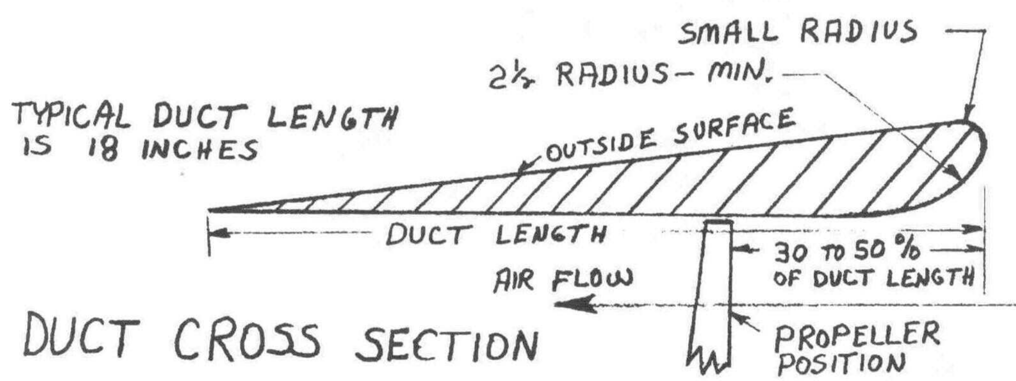
PROPELLERS

Choosing the correct propeller for a Hovercraft is so important that a wrong choice can result in very poor performance. To get best performance from a given engine the propeller must let the engine turn up high enough to develop good horsepower, but not so high that it will exceed the maximum engine r.p.m. when the craft is at full speed. Note that the maximum propeller r.p.m. at full throttle will increase as craft speed increases, usually about 100 r.p.m.'s increase per 20 m.p.h. speed increase or 5 r.p.m.'s per mile per hour.

Choosing the correct propeller diameter is just as important as the correct engine r.p.m. to develop best thrust, from a given engine. A large propeller will always develop more thrust than a smaller diameter propeller. See the chart on propeller thrust near the end of this book. For example, a 2 foot diameter propeller will develop about 45 pounds of thrust at 10 horsepower while a 4 foot diameter propeller will develop about 75 pounds of thrust. The number of blades or the width of the blades makes little or no difference in thrust for practical purposes. What all this is telling you is to use the largest 2 blade propeller you possibly can to get best performance; but very large propellers need large and heavy guards and mounts and very high reduction drive ratios for proper engine r.p.m. Larger propellers also cause more nose down pitching on a Hovercraft, so there must be a compromise on propeller size Forty-eight or fifty-four diameters are the most practical sizes for small crafts driven by two cycle engines on reduction ratios of between 2 and 3. Seventy-two to ninety-six inch diameter propellers are best on larger crafts using auto engines, again using reduction drive ratios between 2 and 3. On the mower type engines a belt drive system is usually not worth the extra effort and weight because propellers can be made to match the engine speed close enough. The only reason you might consider a reduction drive on these engines is to turn a larger high pitch propeller at a very low r.p.m. to reduce noise. Propellers with more than 2 blades are very helpful in reducing blade tip speed, noise, and blade erosion; but these multi-blade propellers are heavy and take longer to spin up to speed, and spin down again resulting in poor throttle response. For these reasons we prefer a high pitch, wide blade, 2 blade propeller for best performance. The Wide blade and high pitch both serve to slow the propeller for lower noise. The wide blade is also very rugged where dirt, sand, stones, and an occasional bolt may go through the propeller.

DUCTED PROPELLERS

Everything said about propellers holds true for ducted propellers, that is, larger diameters give more thrust and less noise on a given engine. You may put a duct around your 2 blade propeller and if done correctly you can expect 10 to 15% more thrust without changing drive ratio or anything else; but the duct must be done correctly, that is, in shape, surface smoothness, and propeller tip clearance. The propeller should pass no more than 1/4 inch from the duct wall all the way around, less would be even better. The duct wall should look flat and smooth inside and out, but especially inside. The cross sectional shape of the duct is very important; it should have at least two and a half inlet lip radius and relatively sharp trailing edge. A typical cross section is shown below. Notice that it looks like an upside down airplane wing.



If the duct is not made correct or the tip clearance is not correct you may actually loose thrust instead of gaining. If you don't feel you can work carefully enough to complete the duct correctly, then don't even start on one, you would be better off to just make a guard around the propeller. A good duct should take 10 to 40 hours to make and install. With such close tip clearances the duct must be mounted very rigid to the craft. It is usually necessary to mount the duct in several places by use of fins, that is, stream lined, airfoil shaped fins. Two of these fins should be attached to the rear thrust shaft bearing mount. This does transfer some vibration into the craft from the engine mount, but it is the only way to keep the propeller centered in the duct. See duct construction and photos elsewhere in this book.

A multi-blade fan, 3 or more blades, can also be used in a duct to reduce tip speed, erosion, and noise; but the multi-blade fans are usually heavier, more complex, and have a much longer response time to throttle changes. Multi-wing plastic fans are available in sizes up to 48 inches in diameter, but are usually difficult to find. When small diameters are necessary the multi-wings are a good choice. We find that in the 48 to 54 inch diameter sizes a 2 blade duct propeller gives about the same thrust as a 4 blade ducted fan.

Duct lengths of 12 to 24 inches will provide best performance for the weight and also serves as a guard for the propeller tip. We use an 18 inch length with the propeller running 1 to 2 inches in front of the center of the duct, but not in the inlet lip radius.

UH-15P with thrust duct

WOOD & RIB STRINGER CONSTRUCTION METHODS

Study the complete plan carefully before starting work A large flat surface, such as a cement garage floor will be needed on which to construct the ribs and to assemble the frame. If such a surface is not available, the ribs may be constructed on a 4' x 8' piece of 3/4" plywood or particle board. The frame may be assembled on a jig made from two pieces of 2 x 6 wood standing upright and leveled. Open the blueprint of the full size ribs and lay it out on a level surface. Remove all wrinkles and cover it with a thin piece of vinyl plastic. Obtain the wood shown on the rib detail drawings. Lay this wood over the full size rib outlines and cut to size for each rib. Do one rib at a time. Make the splice cuts and glue the rib while it is lying on the full size drawing. Use 3/4" wire nails or staples to hold the joints while the glue is drying. Keep the ribs on a flat surface until the glue is dry. When all the ribs are made gluing a piece of 1/8" plywood over each joint should strengthen the joints. This is then the overlap splice joint shown on the wood joining page of this book. Plan ahead and don't put nails or staples where you will have to cut through or pull them when cutting notches

Cut notches in each rib as shown on the detailed rib drawings. Check each notch with a piece of stringer to insure proper fit. A metal template is helpful in drawing these notches on the ribs. Cut the stringers from any standard size 3/4" thick piece of wood. Stringers should be about 6-12 inches longer than the craft to allow for bending. Stringers should also be free from knots which would reduce strength. Some very small knots will effect strength only slightly and should be positioned close to a rib during assembly.

Additional vertical braces (3/4 x 3/4, 3/8 x 1 1/2 or 3/4 x 1 1/2 wood) should be used on ribs where you will be climbing in and out of the craft and standing to start the engines.

The frame is now ready to be assembled. Help will probably be needed on this job. First, mark the position where each rib is to be set on the level surface, or on your jig, or on the stringers. Starting from the rear, stand each rib up and support it by nailing it to the jig, or by supporting with paint cans, boxes etc., or by partially nailing a stringer in place. Check to see if all ribs are standing straight and in the proper position. Glue and nail the four corner stringers. The front rib, which is higher than the rest, should be installed by setting it up on blocks to the height shown on the drawing. Use weights and large rubber bands (cut from auto inner tubes) to hold the ribs and stringers in place while nailing. Install the remaining stringers in the same way. You may have to put one on the top and one on the bottom at the same time to prevent bending of the craft. Where stringers are difficult to bend, cut the stringer one or more times lengthwise in the area of the bend. Put glue in the cuts and make the bend. When the glue dries the stringer will have its original strength.

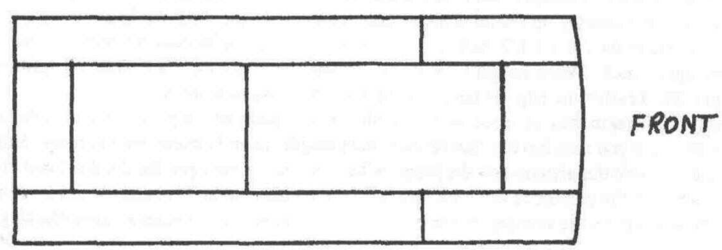
By installing nut plates in the wood for mounting lift and thrust systems and gear boxes, bearing, etc., you simplify your work in that you won't have to get into tight places after skinning the hull to install nuts. Note, that most rubber mounts have short threaded sections; so you may have to set the nut plate about 1/4 inch into the wood in this case.

Before covering the ribs and the stringers, sand smooth so there are no high or low spots (so that contact area between skin and ribs or stringers is a maximum.)

All stringers should be glued and nailed to the ribs except under the passenger compartment where glue and long screws should be used. Long screws should be used on all wood where engine mount frames are to be attached.

COVERING WITH PLYWOOD

The plywood covering or skin is where the craft gets all of its strength in bending and twisting. Start by covering the two sided first. Be sure the craft is on a level and flat surface because the skin will lock the ribs in place to prevent any further bending, although the craft will still twist, This is why it is necessary to level each of the ribs. The craft gets all of its strength from its skin so be sure to do a good job when gluing the skin. The craft is designed to be covered with standard 4' x 8' sheets of plywood and leaves a minimum of waste material. Always run the plywood grain lengthwise in the craft for best strength. Turn the craft upside down and skin the bottom. Check all ribs with a level before skinning. The plywood cross joints should be made at a rib when possible and should be staggered so they are at different longitudinal locations (different ribs) so there are no weak areas. Plywood not joined at ribs should be joined with 1/8 plywood inside and a piece of fiberglass tape outside. Two inch wide tape works best. Fiberglass tape is the term used for a narrow strip of fiberglass cloth. Resin must be used with this fiberglass tape.



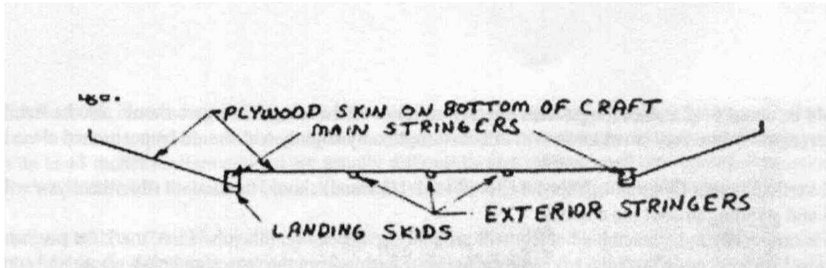
TYPICAL BOTTOM SKINNING PATTERN

The best nails to use for skinning are the 3/4 to 1 inch brass boat nails with ring shanks, but galvanized #3 nails also work well. There are also some short 3/4 to 1 inch aluminum nails which are good for skinning. Easiest to use is a pneumatic stapler with 3/4 inch long x 1/4 inch wide galvanized staples. Most small electric staple guns do not shoot a 3/4 inch long staple or the staples are wide and thin and will show through the paint on the surface.

Space the nails 3 to 4 inches on all ribs and 6 to 8 inches on all stringers. If gaps still exist between the skin and the ribs or stringers, use more nails to close these gaps. Use extra glue when skinning the bottom to be sure it is water tight. Always apply glue to both surfaces (skin and ribs and stringers).

Nail or screw tack strips, landing skids and exterior stringers to each rib. Then use nails through the skin from inside the craft into the exterior strips.

Good landing skids properly placed will prevent skirt and hull damage.



A method of attaching stringers on the bottom is shown above This external attachment provides better protection for the skin, stronger ribs, and easier cleaning and drainage for the interior floor

Landing skids should be positioned in the best place to provide protection for the skirt and the hull

Now turn the craft right side up and seal all seams from the inside by brushing polyester resin or epoxy resin into cracks and seams Paint the interior bottom to protect against rot Most later model crafts have a drainage system designed into the hull On older models a notch about 3/4 x 3/4 inch should be cut in each rib along the main stringer on each side of the floor Include a drain plug on each side of the craft and an inspection door to remove and replace this dram plug Keep the drainage area clear of dirt, sand, leaves, and grass

Before skinning the top of the craft install whatever positive flotation is desired This flotation should be widely separated to provide stability Consider in its placement the location of heavy engines, passengers, etc The best method is to tie milk jugs to the sides inside the craft before skinning the top Smaller crafts will need about sixty one gallon jugs The 16-18 foot crafts will need 125 to 150 jugs You may also pout urethane foam on plastic milk jugs which are laid against the sides inside the hull Do not pour foam or glue foam to the floor or anywhere water might settle Even if the foam doesn't absorb water, moisture will get between the foam and wood and will rot the wood

This is a good time to install any interior cable rollers or electric wiring and also any t-nuts or drain holes and dram plugs If you must drill holes in ribs for cables or wiring drill small holes only at the center of the rib or slightly above center for pieces under the deck and slightly below center for pieces on floor One-half inch diameter should be the maximum hole size Any larger holes should have a vertical support piece (if wood 3/8 x 1 1/2) directly over the area where the hole is to be drilled to attach the top and bottom part of the rib

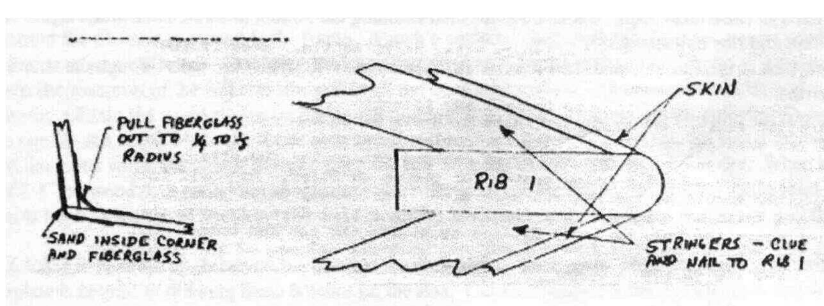
The top of the hull may be skinned now Skin the whole top except the opening for the passenger compartment Then locate the position of the lift duct center relative to a rib and cut the opening for the lift duct On some crafts it may be necessary to cut through a rib to cut out the duct hole in the top and bottom skin The duct itself will provide the strength lost by cutting the rib Run the plywood gram lengthwise on the craft for best strength and for bending in the area of the cockpit All bends can be made without wetting the plywood The area behind the cockpit will be most difficult to bend in most crafts Start bending a little at a time to give the wood grains a chance to ad|ust to their new position Once the wood bends far enough mark it so you are left with 2 or 3 inches of overlap on the piece coming up the other side Use extra glue in the joint Hold a piece 1 x 2 wood under the joint and above the joint and drill holes for 1/4 x 2 1/2 bolts and washers If using staples only the bottom piece of 1 x 2 is needed Use extra staples, at least 4 per square inch When the glue hardens completely, remove the 1 x 2 wood by splitting and prying off Grind off wood that will not pry off Feather the edge of the plywood and fiberglass over the joint

Other joints in the skin may be made strong by bluing on a piece of 1/8 plywood across the inside of the joint, about 2 inches wide Under the deck you may have to use several short lengths to go between the stringers Hold a block of 2 x 4 wood across the joint to nail or staple the plywood on the joint When the glue is hard pry the 2 x 4 off and clip the excess length of nails or staples Then fiberglass over the outside of the joint and feather the edges of the fiberglass to achieve the desired appearance Where the horizontal deck plywood joins the vertical plywood on some crafts join these pieces by fiberglassing inside and outside with 2 inch wide fiberglass strip

On the outside the fiberglass can be made to form a smooth radius of 1/4 to 1/2 inch for better appearance as shown below Heavy fiberglass cloth will not bend around sharp corners Use lighter glass cloth or increase the corner radius More than one coat of resin may be needed to fill pin holes in the glass cloth

Paint all exterior wood surfaces with at least two coats of good enamel, poly-urethane, or epoxy paint Extend the life of the hull by keeping it covered when not in use and avoid walking on the hull surface Put non skid tape directly over the ribs on the deck near the cockpit for stepping in and out

On crafts with a horizontal rib 1 the stringers and skin may be joined as shown below



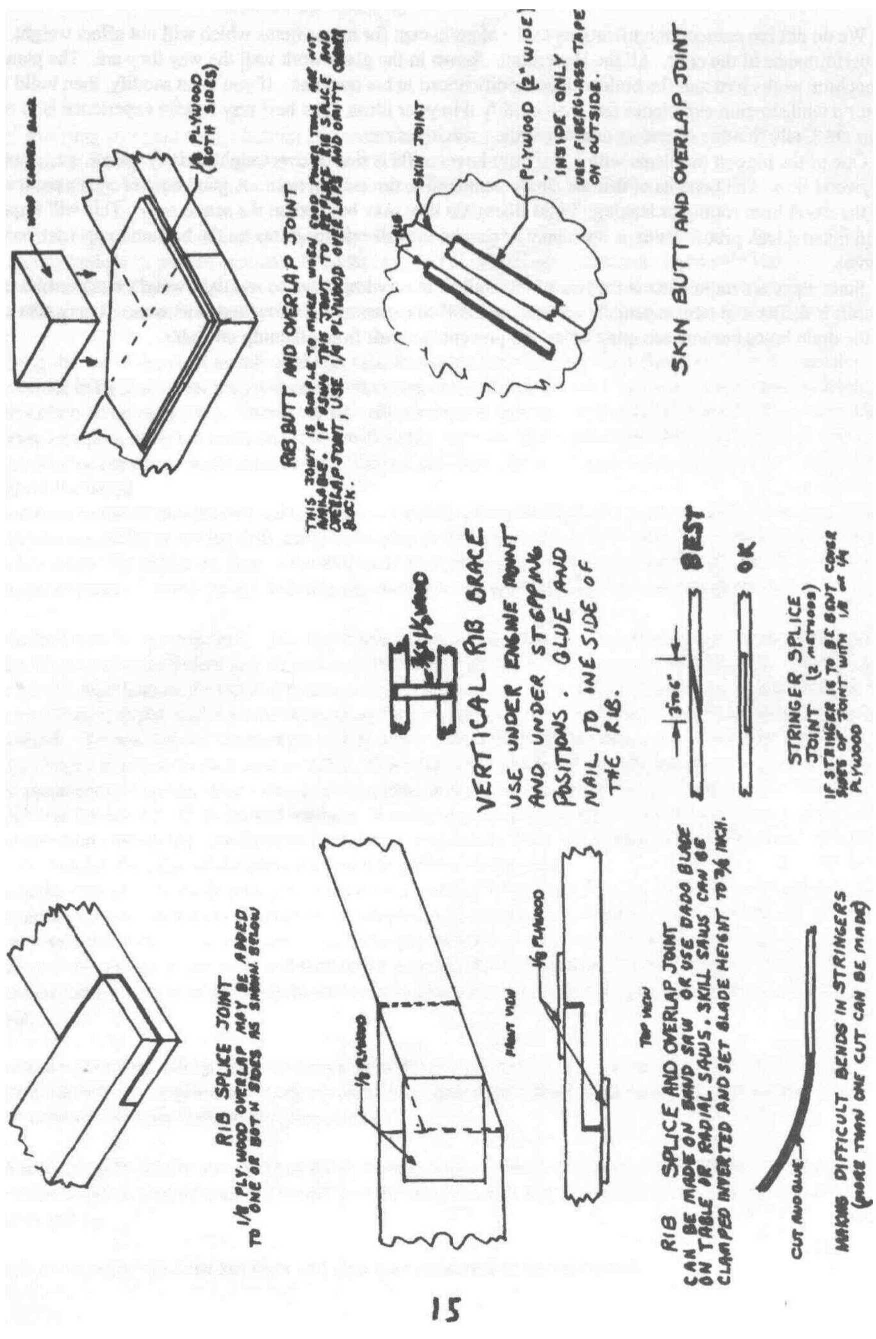
MODIFICATIONS

We do not recommend modifications to the plans except for minor items which will not affect weight, balance, simplicity, safety and performance of the craft. All the Hovercrafts shown in the plans work well the way they are. The plans show the way we think the machine works best and the builder does modifications at his own risk If you must modify, then build it first as shown. Operate it for a while to gain experience and then modify it to your ideas. The best way to gain experience is to come to a Rally and operate your craft, talk to other operators and watch their machines run.

One of the biggest problems with home built hovercrafts is that of overweight. Many people are tempted to fiberglass over the plywood skin. The benefits of this are small compared to the extra weight. A good coat of epoxy paint will be more helpful in keeping the wood from rotting or leaking. Light fiberglass tape may be used on the seams only. This will improve strength across the joint and make it leak proof. Paint or resin may be poured into all interior joints on the bottom to prevent water from collecting in the small areas.

Since there are more parts at the rear of the craft, it is very important to use light weight components in construction. A tail heavy craft is difficult to steer especially on land, and will cause excessive spray and skirt wear. It may also cause the skirt to deform so the drain holes become scooping holes and prevent the craft from planning on water.

Wood Joining Techniques



Foam Hull Construction

Foam and plywood hovercraft have many advantages over rib and stringer hulls. They float forever no matter how badly damaged the bottom is. Bilge pumps and drain plugs are not needed. The craft can be parked on rocks without concern of puncturing the bottom. A foam hull is simpler to build because you don't have to build ribs and stringers It is also easier to keep clean of grass leaves, dirt and sand.

Purchase your foam and 1/8-inch plywood skin first. The plywood should be exterior or marine grade. If true 1/8-inch plywood is not available try for 3, 4 mm or 5/32". Use extruded Styrofoam only. This foam is available from most lumberyards in 4' X 8' X 2 inch thick sheets. Some foam factories will have 3 inch available. Foam should have a density of 1.8 - 2.2 Ib. Per cu foot density. Another foam that works well is 2 Ib Per cu foot urethane This foam is not affected by gasoline or polyester resin. Some builder have used white bead foam in 1 -2 Ib density, but this foam is weak, cracks easily and absorbs water. Choose foam with a flat surface and smooth edges to make gluing and laminating easier Lay up the pieces so the butt joints do not occur in the same place on different layers on the length and width. Use a flat piece of wood with course sandpaper glued to it (about 18-24 inches long) to ensure a flat surface for gluing. Use only epoxy glue on Styrofoam. Fit pieces to make the hull about an inch larger than shown on the plans.

Vacuum Bagging

Vacuum bagging can be used in various parts of hovercraft construction. The following text will refer to Styrofoam hull construction. The two most common types of vacuum bagging are surface and enclosed bags. Both vacuum bagging techniques are easy and effective. The surface is any flat level surface including a large table or a concrete floor. It is important to note that the hull will resemble the surface it was vacuumed to. The bagging process will begin when the Styrofoam pieces that make the hull are ready to be glued together. It is recommended to have 2 workers, one to mix the epoxy and the other to spread the epoxy onto the Styrofoam surfaces. The work area should be 60-85 degrees F, until the epoxy is cured.

Materials Needed:

2-4 blankets (large enough to cover the craft 2 times)
2 pc. 4 - 8 mm plastic (larger than the hull on all sides)
1 or 2 pc. 4 - 8 mm plastic (2-4 feet longer and 2-3 feet wider than the hull)
20' - 1 1/4" - 2" vacuum hose or plastic pipe (drill 1/4" holes into the tube every 4"-6")
1 vacuum pump or shop vac
1 - 2 rolls of duct tape (to tape the plastic to the flat surface)
Paint roller
2 pc. 3 - 4 1/2" roller covers
Long screws or nails (to prevent the Styrofoam from moving)
Optional: bathroom scale

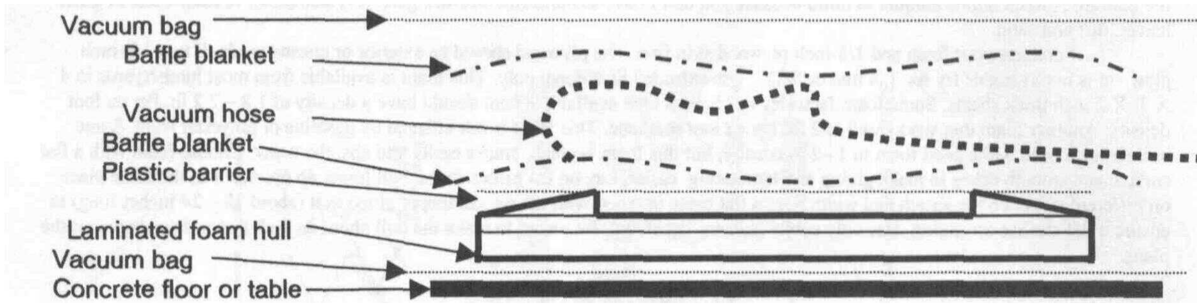
Start by laying down the plastic over the area that the hull will be vacuum bagged to. Lay the Styrofoam on top of the plastic. Mix epoxy completely for 2 - 3 minutes, and spread onto both Styrofoam surfaces that are being joined. Spread the epoxy on with a paint roller like a thick coat of paint. Recoat if the epoxy soaks into the Styrofoam. Use long screws or nails to hold the Styrofoam in place while the epoxy cures. Next, lay the 2nd piece of plastic over the hull. Lay down blankets to cover the entire hull. Next, lay the vacuum hose onto the hull as in the drawing below. Cover all of the exposed hose with another blanket. If the optional scale will be used, put the scale close to the center of the hull. The scale should read between 50 -150 pounds when the vacuum is turned on. This setup should put about 1Ib./sq. in. or 144 Ibs./sq. foot on the hull. The larger piece of plastic can now be placed over the hull. Tape the plastic down around the perimeter, 6" away from the hull. This will leave slack in the plastic until the vacuum is turned on. Attach the vacuum to the hose with adapters or duct tape. Turn the vacuum on. Within 30 seconds, the plastic should be pressed firmly up against the hull. Check for leaks in the vacuum bag and seal with tape. Pull on the plastic in a few different areas. It should be difficult to pull. If it isn't, there are leaks in the bag. The leaks need to be found and taped. The vacuum should have some air moving over the motor. It may be necessary to position a fan next to the motor on the vacuum to cool the motor. Watch the setup for at least 1 hour before leaving. The vacuum should run for 4 — 12 hours until the epoxy in the cup is cured.

The enclosed vacuum bag is the same except that there is no level surface to vacuum to, so the bag goes around the entire hull. The plastic can either be one large piece folded in half, or 2 pieces. The bag on the top and bottom are taped together at the seams. The first piece of plastic is the larger one. Next, lay down the small piece of plastic, then the hull. After the hull is glued, lay another small piece of plastic over it. Put on the blanket, then the hose and then another blanket. Finally, cover the hull with the other large piece of plastic or fold the larger piece over the hull. Tape the seams and turn the vacuum on and check for leaks.

Carefully remove the vacuum bag and save it for the next job. Mark a center line on the top of the hull and measure left & right of the line to get the correct hull side shape at several positions as shown on the plans (for pointed craft). Bend or hold curved a long thin piece of wood or metal intersecting previously marked points. This piece of wood will give the finished shape of the craft. Mark and cut this curve carefully with a hotwire or saw. Be sure the cut is 90 degrees or perpendicular to the hull's top surface. A gravity hot wire may be used for this cut (place a weight on the end of a wire). Sand the edges so the skirt attach strips will fit with no gaps between the foam and wood. Glue the outer skirt attach strips to the foam hull. Hold in place with 4 1/2" screws until the glue is dry.

Now shape the hull top by removing foam at the topsides to form a smooth curved surface for bonding the 1/8" plywood to the top foam and to the top of the skirt attach strips. Fiberglass from the top plywood, around the attach strip onto the bottom. Use the vacuum bag to attach plywood onto the deck.

Using the vacuum bag again, glue the bottom foam and plywood which supports the landing skids and the inside skirt attach strips on to the hull. Use 4 *1/2"* screws to hold the foam from moving while the vacuum bag is put in place. The inside skirt attach strips are glued and stapled to the 1/8" plywood after the vacuum bag is removed. The aft skirt attach strip is glued into a slot cut in the foam hull.



Vacuum bag diagram

General Construction Tips

All joints and seams must be fiberglassed with 2 layers of 6oz fiberglass cloth. Wood strips are glued to the plywood deck to attach the cockpit, seats and belt guards. Thrust engine mounts are glued to the top of the plywood skin with bolts running through to the bottom.

Lift system mounts are made from 1" X 4" or 1" X 6" wood foamed and fiberglassed into the hull. The lift duct is a cylinder made from 1/8-inch plywood with a foam and fiberglass inlet lip. The topside should be paint with a light color to prevent heat build up from the sun. This is especially important with the top of the thrust duct and trim wing. All exposed foam should be painted with latex paint or epoxy glue to prevent moisture from absorbing into the foam.

LIFT DUCT

Locate the lift duct center position on the top deck and on the floor. Cut bottom hole about 3/4 inch diameter larger than the lift fan and the top about 3 to 3 1/2 inch diameter larger than the fan. Note that you may have to cut through a rib on some crafts. It is very important that the fan tip clearance is no more than 1/4 inch all the way around, so work carefully.

We prefer making out ducts by pouring a ring of foam 1 1/2 to 3 inch thick using styrofoam and tape as an outer form and 1/8 plywood duct wall as the inner form. Two wood disks 1/2 inch larger than the diameter of the lift fan are used to hold the duct wall round until the foam is poured. The 1/8 plywood duct wall is nailed to the disks with 3/4x17 nails. When the foam is hard these disks are kicked out and nails are pulled or ground off. Install any wood needed for m mounting gear boxes, etc., before pouring the foam. This mounting wood may also be glued and fiberglass to the duct wall after foaming.

The foam will bond itself to any wood it touches. The foam used is a 2-Ib. per cubic foot density rigid urethane in a two part liquid mix. Pour about 1 cup at a time so you can check your form for leaks and learn to handle the foam. After the foam expands out the top, a smooth inlet lip radius of about 1 1/2 to 3 inches may easily be cut and sanded. Two or more layers of fiberglass should be used in this area over the inlet lip to provide strength.

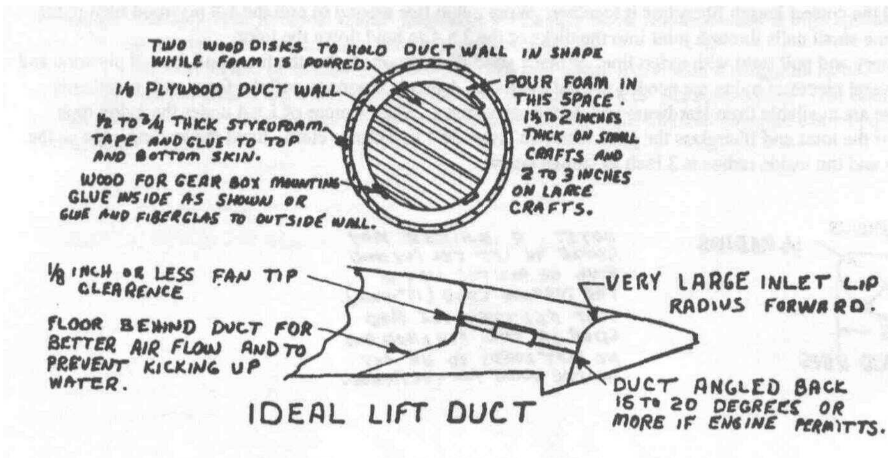
Feather the fiberglass into the deck and the duct. Fill any pits with wood filler and use another layer of light fiberglass to hold the filler in place. This inlet lip radius is important in achieving good lift performance especially at high speeds. But most important is the fan tip clearance with the duct wall. Any place this clearance is more than 1/8 inch should be built up with wood or fiberglass or both until there is no more than 1/8 inch clearance or less if possible. Note that the wood fans will not be destroyed from hitting the duct wall. We don't recommend the fan should always hit the duct wall because it would soon wear through. But some occasional hitting on rough water is okay. Closer tip clearances may require stiffer rubber mounts or more rubber mounts. But if rubber mounts are too stiff then too much vibration and noise is transferred into the hull and to the passengers.

This type lift duct is usually good enough to stop most nuts and bolts which fall into and are hit by the fan from entering the passenger area. But an item as large as a muffler falling into the fan may cause destruction of the fan and duct so as to let pieces of the fan enter the cock pit at high speed. Adequate protection can be had by adding a piece of 1/8 plywood extending about 6 inches above and 6 inches below the plane of rotation of the fan and about halfway around the duct. This piece may be glued fiberglass or tied in place. Protection can also be had by a 1/16 thick piece of aluminum.

Glue a piece of 1/8 plywood by about 4" wide in the plane of rotation of the fan to fill in excessive tip clearance. This process will reduce fan noise and vibration and provide greater safety from objects coming through the duct wall and into the cockpit.

A second method for making the duct is to just fiberglass the 1/8 plywood duct wall in place both inside and outside on the bottom. Then glue foam about 2 inches thick all around the top of the duct to make the inlet lip radius. Sand and fiberglass as before and add the protective piece. Some additional fiberglass on the duct wall (on the inside and outside) may help reduce noise in the passenger area.

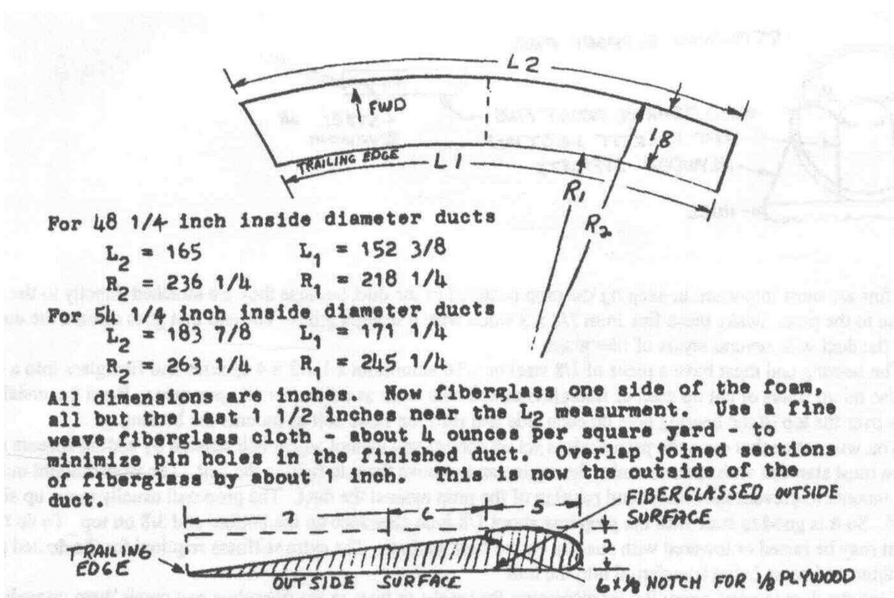
There are many methods for making lift ducts. But we find these two to be best and easiest and the 1/8 plywood wall withstands occasional fan hitting better than foam and fiberglass. The lift duct may be set in place with a backward facing angle if desired so the duct will more easily recover the incoming flow advantages at high speeds. But the angle should be limited to about 20 degrees when using a 4 cycle lift engine because of lubrication problems or fuel problems in the carburetor at greater angles. The aerodynamic advantages to tilting the duct are very small at speeds under 60 mph. But there is another advantage for the tilted duct. It is less likely to kick water up the duct during slowing or plowing in or low speed floating mode maneuvers, especially if the lift engine is still idling. The most important aspect of preventing water kick up in the duct is to angle the floor up just behind the aft duct wall as shown below.



THRUST DUCT (OPTIONAL)

A thrust duct will provide about 15% more thrust if done correct. But sloppy work could result in a loss on thrust over the open prop. If you don't have enough time (10-40 hours) to do the job right don't start on a duct for thrust.

The duct is made from styrofoam, 1/8 plywood, and fiberglass. Use 2 inch thick styrofoam, and epoxy for all gluing. A 4 foot by 8 foot sheet should make a 48 or 54 inch diameter duct. Cut the foam to the radius shown below. Two pieces will be joined to give correct length.



All dimensions are inches. Now fiberglass one side of the foam, all but the last 1 1/2 inches near the L2 measurement. Use a fine weave fiberglass cloth - about 4 ounces per square yard - to minimize pin holes in the finished duct. Overlap joined sections of fiberglass by about 1 inch. This is now the outside of the duct.

Cut the foam as shown above from the trailing edge to a line 4 inches behind the leading edge. The full length of the foam. Sand or file this surface flat and smooth Notice that the foam can be bent as much as desired without breaking if the foam part is on the inside of the bend and the fiberglass is to the outside.

Now set the foam aside and cut a 13 inch wide piece of 1/8 plywood about 6 inches longer than L1. Two pieces of wood need to be joined by fiberglassing with 6oz cloth X 2 inches wide on both sides. After the glue hardens, wrap this plywood around 2 plywood disks 1/4 inch in diameter larger than the prop or fan. The 2 plywood disks can be made from 1/2 inch cheap plywood and held apart about 3 1/2 inches by nailing small pieces of 2 x 4 wood between the 2 disks in about 6 places. Cut the 2 x 4 pieces about

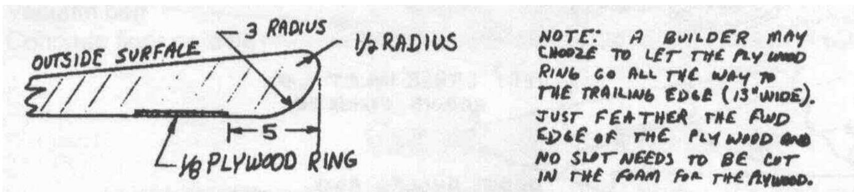
L

4 to 6 inches long and be sure cuts are 90 degrees (square) to edge. These 2 x 4 pieces are used to line up the 2 disks with each other by nailing the 2 x 4 right on the edge of the disks.

To make removal of the disks easier wrap a piece of 1/16 nylon string around each disk before wrapping the 1/8 plywood. You may need to tap the string to the disks with masking tape. The disks won't be removed until the duct is completely installed with all fins and braces on the craft. But these strings will make removal easy by pulling the strings before removal of the disks.

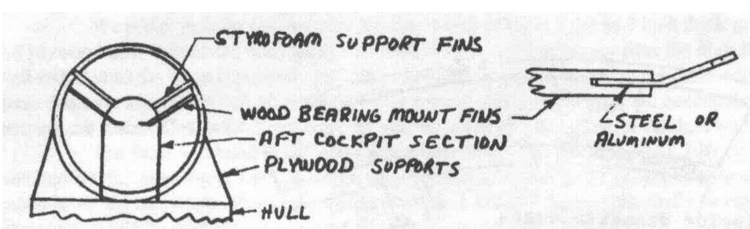
Cut the 1/8 plywood the correct length fiberglass it together. Wrap nylon line around to pull the 1/8 plywood tight to the disks. You may need to use some small nails through joint into the disks or the 2 x 4 to hold down the joint.

Cut and fit as necessary and pull tight with nylon line. When a good fit is obtained glue the foam and the 1/8 plywood and wrap the foam a final time. Several pieces of nylon are needed to hold the joint. A handy device to pull the foam ends together is ratcheting strap tie down. These are available from Hardware and Automotive stores. Slide a piece of 1 x 4 under the nylon rope about 3 inches from each side of the joint and fiberglass the joint with two layers of 4 to 6 ounce cloth. Sand the leading edge so the outside radius is about 1/2 inch and the inside radius is 3 inch as shown below.



Use small pieces about 10x10 of fiberglass to do the leading edge. Be sure the glass goes over the 3/4 inch of exposed 1/8 plywood, but not on the disk itself. Sand and fill in any low places so the duct is smooth.

Install the duct on the craft with the worst looking side down toward the deck of the craft. Cut off a flat area of the duct with a hand saw of about SO square inches (about 7 x 7 inches) for gluing to the deck. Sand away any paint from this area. Position, align and square the duct with the craft so thrust line is parallel with the bottom of the craft. Glue with "Great Stuff' urethane foam in a can and sand smooth, then fiberglass this surface and the duct to the deck with 2 or more layers of 6 oz fiberglass to be sure moisture does not enter and rot the deck under the duct. Fiberglass 2 fins made from 1/8 or 5/32 x 10 x 20 plywood to the duct and edge of the craft. Use 2 or 3 additional fins from the back of the cockpit to the duct. Make these fins about 3/4 to 1 inch thick and an airfoil shape like on the rudders. Fin width should be about 3 to 6 inches.



The 2 wood fins are most important in keeping the prop centered in the duct because they are attached directly to the aft bearing which is close to the prop. Make these fins from 3/8 x 3 wood with a straight grain. The end that goes against the duct is just fiberglass to the duct with several layers of fiberglass.

The bearing end must have a piece of 1/8 steel or 3/16 aluminum x 1 1/2x4 epoxies and fiberglass into a slot in the end of the wood. Use micro fibers or cut up ends of fiberglass mixed with resin as a filler for all open areas. Bend the metal and drill a 3/8 hole so it fits over the top of the bearing hole on each side and uses the same bolt as mounts the bearing.

You will notice that once the prop shaft is set up correct you cannot adjust belt tension by adding spacers under the bearing. You must start out with spacers under the engine and remove them to tighten the belt. The whole mount must be rather stiff in its rubber mounts to prevent movement and rubbing of the prop against the duct. The prop will usually move up slightly as more thrust is used. So it is good to start with the prop low about 1/8 inch clearance on the bottom end 3/8 on top. To do this the whole engine mount may be raised or lowered with spacers on the deck mounts. The extra stiffness required for the ducted prop will result in more vibration and noise being transferred into the hull.

Keep the duct in good condition by inspecting for breaks or tears in the fiberglass and repair them immediately before moisture can get in the foam and increase the weight. Also be sure there are no pin holes in the fiberglass where moisture can get in. Once moisture gets in the foam duct or rudders or trim elevator it cannot be removed. It is a good idea to keep the craft inside or covered when not in use. Any dark paint on the duct or trim elevator can cause the foam to melt from the heat of the sun.

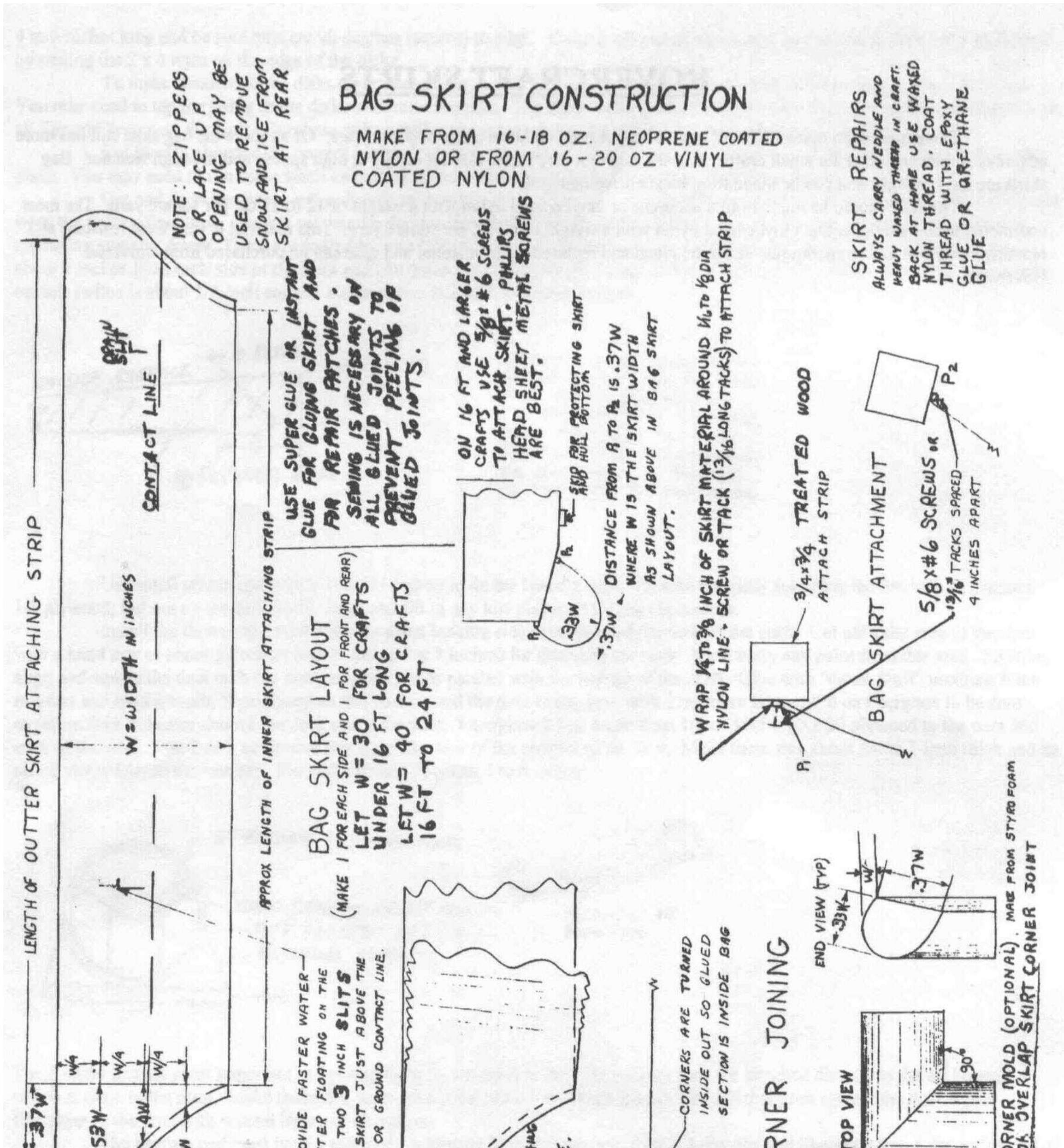
The rudders may be attached to the duct by fiberglassing a piece of 1/2 x 1 1/2 wood to the outside of the duct on top and bottom. For the outside rudders or trim wing you may need to carve a support from a larger piece of wood to get all the angles correct. Sand the edges of the wood to a large radius so the fiberglass will follow the surface. Use 2 layers of fiberglass cloth. Inspect all attachments on the duct regularly and repair any defects.

On some crafts the use of a duct may require more rudder area for good steering especially at low speeds and in windy weather. The builder should consider larger rudders or more rudders.

HOVERCRAFT SKIRTS

There have been many different types of skirts used on hovercrafts over the years Of all these the bag skirt still has more advantages than any other for small crafts Bag skirts give a very stable ride especially at high speeds and in rough weather Bag skirts are easy to make and can be made from inexpensive material

The skirt should be made from a neoprene or vinyl coated nylon with a weight of 12 to 21 oz per square yard The most commonly used material is the Vinyl coated nylon with a weight of 18 oz per square yard This material is very wear resistant and remains flexible at low temperatures It can be glued and repaired Skirt material and glue can be purchased from Universal Hovercraft



Most skirts for small crafts are made from 30 inch wide material. So try to find material 60 inches wide and cut it in half. Draw out the S shape corners found in the full size rib outline of most plans or as shown on bag skirt construction page of this book, on the skirt material so as to use minimum material.

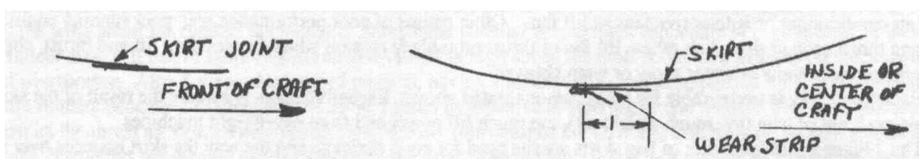
The W on the skirt construction page is width in inches, for most small crafts W = 30..53 w = 15.9,.37w = 9.9..4w = 12,. 16w = 48 w/4 = 7.5.

Measure all inner and outer skirt attach strips on the craft and cut the skirt material 1 inch longer on each piece to allow material for gluing and sewing. Check the material to see if one side has more coating than the other and put that side to the outside. The best glue for skirt work is HH-66 Vinyl glue or instant glue. Contact cement (except latex types) works fair if you follow label instructions. Other types of glues including urethane bond and epoxy work fair but require overnight clamping. On all skirt joints the gluing and sewing work together to give a strong joint. Gluing alone may not be good enough.

Glue about 1 inch of material at each corner joint so glued sections will be inside as shown on the comer jointing in the bag skirt construction page Run 2 or 3 rows of heavy nylon stitching over the glued joint A more wear resistant joint can be had by making a corner mold and overlapping one inch of material and bonding with vinyl glue Glue just 3 or 4 inches at a time Mark the material so you know how much you are overlapping You will have to force the material into position and you may get some wrinkles But avoid wrinkles near the surface contact line Use 2 rows of heavy nylon stitching on each corner Be sure all overlaps will face the rear of the craft when the skirt is installed This is important You may use a combination of both methods, using the turned in material at the beginning and end of the S, and the overlap at the center by the contact area We run the overlap 12 to 18 inches and do not use a corner mold for this job because there is very little curvature in this area Make a complete corner from paper for practice and to insure proper fit before cutting the expensive skirt material

All thread should be coated with a light coat of urethane glue on the inside and outside to prevent wearing and unraveling Note that urethane glue expands when drying and if it is too thick it will peel off Other glues can also be used for coating but urethane is best It can be found at many hardware and department stores If excess wear is found at some area of the skirt, urethane glue can be spread over that area

For extended operation over concrete, asphalt, gravel or ice a wear strip should be stitched to the bottom of the skirt at the contact line The contact line is 1 inch in (toward craft center) from the center of the skirt material (16 inches from outside on 30 in wide skirt material and 21 on 40 inch wide skirts) Make the wear strip from a 1 1/2 inch strip with a narrow strip of glue down the center to hold while stitching Run one row of heavy nylon stitching down the center of the 1 1/2 inch strip



Then fold the outside flap toward the center of the craft and stitch it down as shown above so this flap is about 1/4 inch shorter than the lower piece Again coat all thread with a thin coat of urethane glue

We have tried many methods of skirt joining and repair including the use of pop rivets and grommets but the stitching and coating method has proved best Tears can be repaired by hand sewing the tear with nylon or waxed nylon thread and then coating with glue It is a good idea to carry a needle and thread in the craft to repair the skirt When you get home let the skirt dry out and coat the thread with glue

Installing the Skirt

Place the craft on a low bench and screw the 4 corners inside and outside first Then adjust the skirt to the best position for least wrinkling and even hanging all around By adjusting the skirt you are trying to get the contact line to be all in the same height plane What happens to the rest of the skirt is not important Just the contact line is important in achieving good performance Use a 1/2 x #6 round phillips head sheet metal screws so there will be a screw every 4-6 inches Run the lift engine to see if any further adjustments are necessary while the craft is on the bench

It is best to check skirt adjustment with the craft Hovering on a hard level surface such as a cement floor Put extra weight on the front of the craft to trim and level the craft when on cushion Inspect for wrinkles and high or low areas, especially at the corners Adjust by taking in or letting out material at the skirt attach strip or by moving the tack line either way In extreme cases you may have to redo a corner to take up more material But the extra 5 to 15 mph in speed is worth the effort

The aft part of the skirt is likely to get most wear and tear Extra care should be taken when attaching the skirt especially across the aft inside attach strip The skirt attach should be checked after high speed operation on rough water Rough water imposes high pulling forces on the skirt and on attach strips Loose attach strips or screws can cause very large tears in the skirt by failing at high speed and permitting the skirt to scoop water Properly placed skirt attache strips, good driving techniques and a properly balanced craft will prevent a lot of skirt repair

The best way to attach a skirt correctly the first time is to mark perpendicular chalk lines on the skirt every three feet on each side Then mark the corresponding lines on the hull perpendicular to the outer skirt attach strip, or tangent line at that point, marking the outer and inner skirt attach strip Attach the inside skirt at these points and adjust the excess material evenly between these points It is easiest to do this with the bottom of the craft up before building the top structure

The skirt should be checked and repaired if necessary before each outing One loose screw can cause others to come loose until the skirt no longer functions properly A small tear can quickly get large enough to impair performance if it is not repaired

When a Hovercraft is shut off on the water the bag skirt will slowly fill with water, because the skirt tends to sink in the water It would be very helpful if the skirt did float on water or if there was a good way to attach some flotation to the skirt Most methods we have tried seem to be more trouble than they are worth A good skirt drainage system is necessary to drain the skirt after the craft has been shut down on the water

Two large slits 3 to 4 inches long starting just behind and above the contact line in the aft skirt should dram any skirt in 15 to 30 seconds with the lift system running at low power and the thrust system at 1/4 to 1/3 power On single engine crafts use just enough power for a stable hover Use of more power causes excessive spray and propeller blade erosion as well as more noise and possible belt slippage Note that slipping belts will wear aluminum sheaves very rapidly

Most of the snow drawn into the skirt system will be removed if a 3 to 4 in. section of the comer is left open just above the ground contact point. Choose the rear corner closet to the lift fan and in the direction of rotation of the fan as it passes over the skirt air duct.

If the front skirt tucks back easily when the craft is at cruise speed check for loss of skirt air at the tack strips. Sometimes you may have to use fiberglass to seal and help hold these tack strips to the hull. Check for holes or tears in the skirt. The skirt air feed opening should be about 3 to 4 inches depending on craft size, at the widest point to insure enough air is fed to the skirt. This skirt air feed duct should extend up close to the lift fan to keep the skirt at a higher pressure than the air cushion chamber. Fan tip clearances should be as small as possible, especially over the skin air duct. The lift fan should be placed as high as possible in the duct to prevent water damage during a plow in condition, but at least I in. below the bottom of the lift air duct inlet lip radius. By putting the fan further down in the duct it would be out of reach of your fingers, but it should be guarded with wire cloth. A handle should be put on the front of the craft so no one is tempted to move a craft by putting a hand part way down in the lift duct.

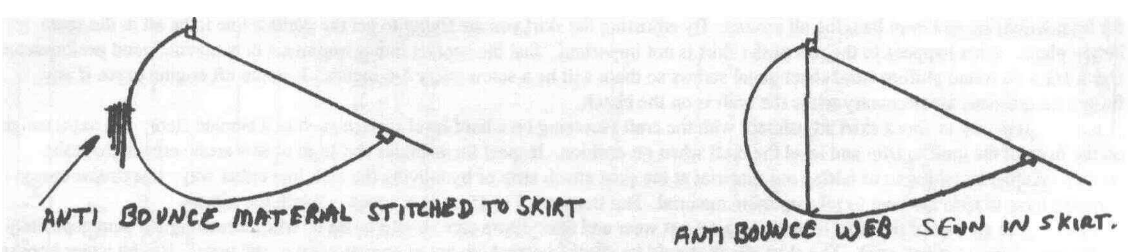
Hovercrafts with lift fans at the back are generally more difficult to get over planing speed and to run at high speeds because the skirt does not recover from tucking back as quickly as it would with a front mounted lift fan. If the craft won't plane out at full power ease off the power to let the skirt recover from the bow wave (About 1 to 2 seconds) and then quickly apply full power again. Planing is more difficult in shallow water (6 to 30 inches), and easiest in very shallow water up to 6 inches. To make planing easier reduce lift power so the craft is just barely on cushion. This will let the bow wave pass under the skirt easier by having the skirt softer. If a craft won't plane as it should, first check the skirt and the tack strips for damage or looseness. Check for water in the skirt or in the hull. Check for tears or drain holes that may be scooping water. A small flap over the drain hold may help prevent scooping. Check the height adjustment of the skirt. If some parts are too low this may cause excessive drag. The craft may be out of balance (Driver and Passengers may have to shift their weight). The wrong lift fan will also prevent planing. Do not use a two bladed propeller or air conditioning or automotive fans as lift fans. Other causes of poor performance are; poor running engines, wrong engines, wrong thrust prop or drive belt ratios, lift fan or thrust prop blade erosion which causes poor lift and thrust, slipping belts due to improper tension, snow or water spray or warn sheaves.

Excessive spray is undesirable for many reasons stated above. Excessive spray is usually the result of the skirt being out of adjustment, craft out of trim (too much weight aft), too much lift power and from overweight machines.

The 2 biggest disadvantages of bag skirts are the need for good drainage and the way the skirt bounces over smooth surfaces. To help the drainage problem be sure there are no openings which can scoop water especially near the back of the skirt. Be sure the skirt is firmly attached to the tack strips with no openings for water to enter. Be sure the skirt drain holes are large enough and high enough to drain the skirt when it is full of water. When a skirt is full of water it deforms as thrust is applied so with a lot of thrust drain holes might become scooping holes instead. If you intend to use your craft for fishing or leave it parked on water for long periods of time you may consider a very large drain slit with a nylon lace so it can be loosened just before starting engines and then pulled tight once the water is drained. Make the lacing line long enough to reach the operators seat.

The skirt bounce problem is most severe on ice or smooth pavement so most builders who operate very little on these surfaces need not be concerned about bounce. But reduced lift power means more skirt wear on ice and smooth surfaces, and more likely to plow at higher speeds on smooth water.

There are many methods to control skirt bounce. One is to add weight - preferably weight that floats on water to a line 1/2 way up from the contact line to the top outside of the skirt. We prefer using 4 layers of skirt material 5, 4, 3, and 2 inches wide sewn to the skirt as shown below. Floatation is achieved by trapped air. This method also helps control spray.



Another method is the use of an anti bounce web which is sewed to the bottom of the skirt and tacked to the tack strip. This web should have many holes to permit water and air flow. The web is usually difficult to adjust and to keep sewn to the skirt. Method 1 & 2 are done all the way around the whole skirt. Another method of controlling bounce is by use of heavier skirt material. But this will cause more drag on rough water and on land. This is why we prefer the first method and then only if necessary.

Skirt Repair

Most damage to skirts occurs in the rear panel. Most of the damage could be avoided by trimming the craft correctly, driving carefully, avoiding snags and sharp objects and avoid sliding backwards when departing from a parked position on a hill. Don't let the skirt slide under the skids when landing or departing.

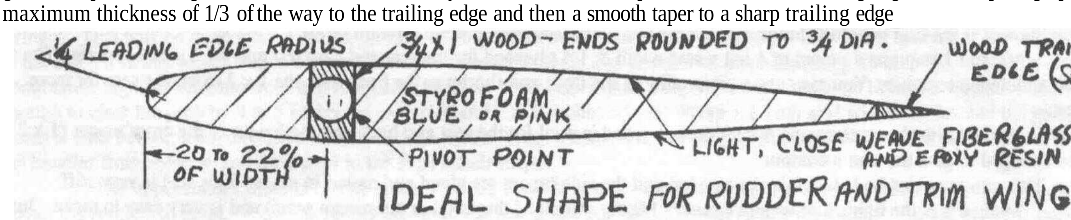
The vinyl coated nylon glues better than other skirt materials and if done correctly the corners can be glued without sewing Patches can also be glued without sewing Tears can be repaired with inside outside patches or by whip stitching the tear with I 8 inch stitch spacing For increased wear resistance, coat the exposed thread with vinyl or urethane glue The inside outside patch is done by putting the patch on the inside in the forward direction and on the outside in the aft direction

PUFF PORTS

What about the use of puff ports to aid in directional control' Puff ports are controllable openings which release cushion air in the desired direction to aid in controlling a craft at low speeds We find they are generally unnecessary for recreational crafts The push force provided by puff ports is too small to be useful on hills or in strong winds and generally makes driving more difficult and adds to the complexity of the craft The same is true for ground contact or retractable water rudder systems We find that it is best to have a good multiple rudder steering system that turns through large angles We are not condemning these other systems They just need much more development work before they become practical if they ever do

RUDDERS & TRIM WING

The purpose of the rudders is for steering the Hovercraft and for maintaining directional stability, that is to keep the craft pointing into the wind when the rudders are straight Directional stability is important especially at high speeds If there is insufficient rudder area or if one or more rudders should fall off at high speed the craft could turn sideways or backwards with a possibility of overturning Also during a high speed plow-in, having a lot of rudder area is important for safety Most hovercrafts have 2 or more rudders because 2 rudders may be up to 3 times as effective in steering as one rudder The ideal amount of rudders is enough to turn all the thrust air flow Three rudders will usually turn most of the flow and also provide enough directional stability for high speeds 5 Rudders are usually needed to turn all the flow The rudders should turn at least 60 degrees in each direction for good low speed steering All rudders should have a symmetrical airfoil shape That is a small leading edge radius tapering up to a maximum thickness of 1/3 of the way to the trailing edge and then a smooth taper to a sharp trailing edge



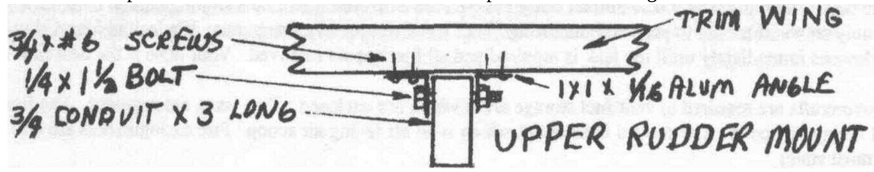
The pivot point on the rudder and trim wing should be 20 to 22% the width as shown above If the pivot is further forward the rudder will be difficult to turn especially to large angles If the pivot point is further aft the rudders will be difficult to hold straight especially at high speeds and possibly dangerous at high speeds But they will easily turn to large angles
The rudders and trim wing are made by cutting wood the same width as the thickness as the foam Most crafts use one inch thick rudders and trim wing Larger crafts may use I 1/2 inch thick foam Round the last 3 inches of wood on each end to fit 3/4 conduit Glue the foam to the wood on a flat surface Use a sureform file to file the foam to shape on one side only Sand and fiberglass with a fine weave fiberglass cloth (2 to 4 oz/yd) and epoxy resin Polyester resin will dissolve the styrofoam The weave is important in preventing pin holes which let moisture in and increase weight especially on the trim wing Paint will not fill these holes (Optional) - Install the wood trailing edge piece as shown above File and sand the other side Fiberglass and sand smooth all surfaces Apply another coat of epoxy The finished rudder should weight 1/1/2 Ibs Some builders make rudders from 012 or 016 aluminum which is slightly heavier than foam and fiberglass Do not use 1/8 plywood due to the extra weight

The purpose of the trim wing is to make minor adjustments in the nose up or nose down trim (pitching trim) at high speeds The trim wing is not effective or even noticeable below 40mph speed It will not correct a tail heavy or nose heavy craft The craft should be properly balanced first and then the trim wing used to adjust for changing wind conditions or changes in thrust

More thrust will cause a nose down pitch because the thrust line is above the center of gravity and the center of drag For this reason the trim wing should be in the thrust air flow from the propeller as much as possible This may mean reducing the height of the rudders to lower the trim wing

The trim wing can be mounted to the guard by welding a short piece of 3/4 inch conduit to the guard at the proper height on each side The conduit on one side can be made removable by welding a tab on it and bolting it to the guard This way the rudders and trim wing can be quickly removed for a long tailoring trip

The top of the rudders are mounted to the wood spar in the trim wing as shown below

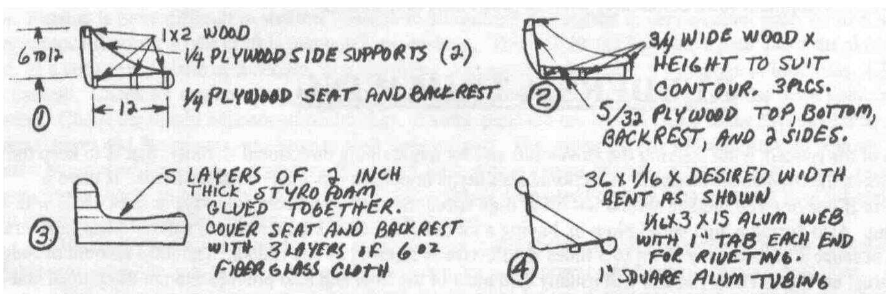


The rudder top slides into the 3/4 conduit This permits the rudder and trim wing tree movement The conduit serves as a bushing tor the wood rudder pivot Grease the wood inside the conduit about once a year and it will last the life of the craft

To mount a trim wing to a thrust duct start with a 1 1/2 x 1 1/2 x 26 piece of wood for each side Drill a 13/16 hole about an inch from one end for holding the trim wing end Cut and fit the wood to the outside of the duct so it extends the full length of the duct Radius all comers so fiberglass can be used to hold it to the duct Round out the front so it looks good and can be used to support one of the duct tins on each side Again grease the inside of the hold for long life The trim wing can be removed by cutting out a piece of wood behind the hold Then screw or bolt it in for reassembly It is a good idea to safety wire the trim wing in place to avoid failure and breakage of rudders

SEATS

A good bench seat can be made from one of the methods shown below.



Moving the seat is the best way to trim the craft so the seat should be easy to slide forward or aft

Method 1 requires 4 pieces of 1 x 2 x seat width & 1/4 plywood for the seat and backrest and the 2 side supports The seat is glued and nailed together You may use a piece taller at the front and shorter at the back than the 1 x 2 to tilt the seat for more comfort

Method 2 is almost the same except thinner wood is used for the seat and back and the height of the cross pieces (1x2) may be changed to give the seat a contour

This contour must be held while the seat top and the side braces are glued and nailed in place This seat is very stiff

Method 3 is the lightest in weight (usually 1/2 the weight of the wood or aluminum seats) and is very easy to make Just cut and glue the 2 inch thick styrofoam Sand it to contour and fiberglass all but the sides, back and bottom You may want to glue on a piece of wood if this seat is to slide on a narrow board But if it is to slide on the floor leave the foam as is

Method 4 is aluminum, which will come out nearly the same weight as wood The aluminum can be bent by clamping it in a vice between 2 steel bars or between two 2 x 4's and bend by hand A small sheet metal bender would make this job much easier The two aluminum webs that support the backrest are riveted so they are directly under the seat and behind the backrest

On all the methods, except on the styrofoam, foam rubber and a vinyl cover may be tacked or riveted over the seat and backrest for more comfort and reduced vibration

FUEL SYSTEMS

The best fuel tank for a Hovercraft is the 6 3/4 gallon plastic outboard tank These tanks are compact and light in weight and have a fuel gauge in the cap They may be removed from the vehicle for filling to avoid dangerous fumes and spillage of fuel The tank also can be moved around to shift the center of gravity of the craft Any number of tanks can be used to get the desired fuel quantity and range Note that plastic tanks may be illegal in some stages Check your local boating laws

Fuel tanks can be made from fuel cans Be sure to make and use the vent Fuel tanks of any size and shape can be made from fiberglass and epoxy resin First make the fuel tank to the desired shape from styrofoam Radius all corners to at least a 1/2 inch radius Lay up 4 or 5 layers of 4 to 6 ounces per square yard fiberglass cloth with a close weave (to avoid pin holes) Large tanks over 10 gallons may need more fiberglass or thin wood strips fiberglassed in the sides and bottom of the tank until you lay a thin piece of plastic over it Remove the styrofoam by breaking it up and sanding the inside of the tank Coat the inside of the tank with epoxy resin to be sure it is leak proof Test for leaks by filling with water Then dry completely and glue the top on with resin and micro fibers Fiberglass in the fuel pickup line, vent, and a filler neck and cap from an old automobile tank Use resin and micro fibers to fill and smooth the tank Paint the tank red Paint all but a 1 inch wide strip which will be a slight gauge to determine fuel level Mount the tank securely on a soft mount to prevent puncturing Fuel leaks can be very dangerous If a leak is found shut down the engine and all electric devices immediately until the leak is repaired and all fuel vapors removed Your nose is the best fuel vapor detector

All boats and hovercrafts are required to vent fuel storage areas which are enclosed Two vents are required The first is an inlet which is a forward facing air scoop The second is an outlet which is an aft facing air scoop Fire extinguishers are also required on hovercrafts in most states

The fuel system and the electric system should be separated as much as possible The operator should be able to shut off the fuel supply to any engine from his seat in the vehicle It should also be possible for the operator to switch off the ignition to any engine Builders should get a copy of CG-466 and Ml6752 2, free from your nearest Coast Guard office to comply with rules and safety standards for boats

WINDSHIELDS

There are many ways to make a windshield and canopy We find the easiest is to bend 1/2 inch conduit to the desired height and shape and screw it to each side of the cockpit Three-fourth by three-fourth wood is mounted to the deck in a smooth curve to mount the windshield down to the deck It may have to be cut from a larger piece of 1 by 6 or 1 by 8 because bending may be too difficult Do not use plywood because the screws from the windshield will not hold well in plywood Sand the wood to the correct angle to match the windshield and glue, and nail it down to the deck Use 1/6 thick clear polycarbonate for the windshield This material can be wrapped around any curve or shape without pre-bending Fasten to the conduit and wood with 1/2 by #6 sheet metal screws Use a 1/2 by 1/16 strip of aluminum between the screws and windshield A complete cockpit enclosure can be made by bending and welding 1/2 conduit to shape and covering with polycarbonate or by stretching and tapping 10 mil clear plastic to the conduit You may use 1/8 plywood or vinyl coated nylon on top for protection from the suns heat Hinges may be installed to open the canopy as all one piece or in 2 or more pieces If a canopy is used the windshield should be equipped with a hand operated or electric wiper The use of a wiper will require tempered safety glass (automotive type) under the wiper polycarbonate or other plastics will usually scratch from use of a wiper When cleaning any windshield do not wipe off dirt dry Use soap and water to avoid scratching A good idea on plastic windshields is to use a peek hole, about one inch high by 8 inches wide at eye level

GUARDS

The propeller guard is the most important safety item on the craft and also serves to mount the upper part of the rudders and trim wing if desired The best way to make a guard is to bend and weld 1/2 inch electrical conduit It will take a little practice to weld the thin metal with an electric arc welder On 36 inch diameter and larger you will have to butt weld two ten foot pieces together then bend and cut off to size Make two of these and mount one to the back of the last rib with two u-bolts on each side The front bar should go through the deck and mount to a piece of angle iron which is attached to the bottom of the craft on the main stringer This may be done after skinning through an inspection door in each side Drill a 1/4 hole in the bottom of the conduit and in the angle iron and attach with a 1/4 by 1/1/2 bolt Screw the angle iron down with three-fourth by #8 screws Weld in a cross bar about chest high between the front and rear bars Front and rear bars should be spaced a minimum of 18 inches and should be long enough to clear the prop by 4 to 5 inches on each side and 2 to 3 inches on top Wrap 1/2 inch grid wire cloth around the guard and fasten it with bailing wire, electric wire ties, or 1/16 nylon string Fasten it about every 3 inches On foam and plywood crafts, make the handles from nylon straps and screw to the skirt attach strips

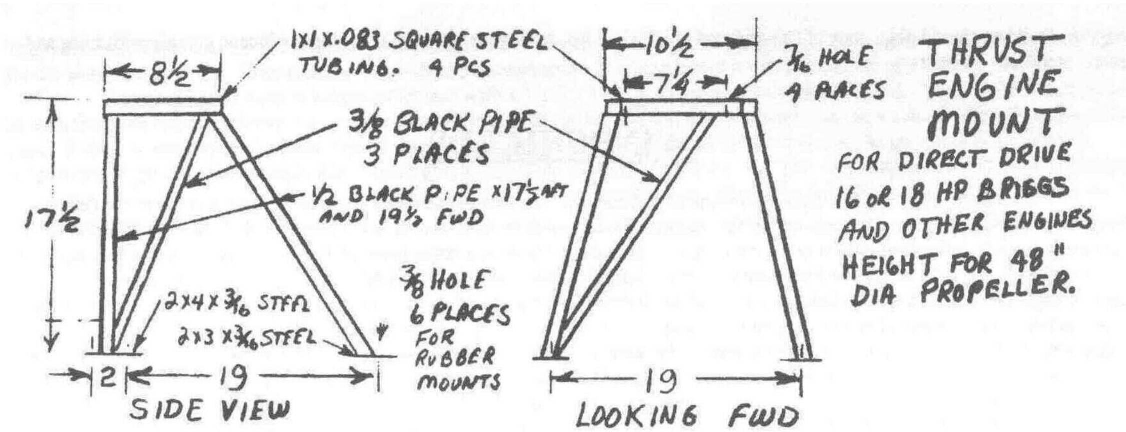
The upper rudder mounts can be made from 1/2 conduit with a short piece of three-fourth conduit welded to the end to permit the rudders to pivot Weld the rudder mount to the rear guard bar before installing the wire cloth The lift guard is made by bending 1/2 conduit to about the diameter of the lift duct and welding the ends together fasten 1/2 inch grid wire cloth as above and cut out to fit over the lift engine Use 1 or more pieces of 1/8 wire stretched across the guard for additional support of the wire cloth Fasten this guard to the lift engine with wire ties or bailing wire At this time handles should be installed, two at the front and two at the back are the minimum needed to keep hands away from dangerous areas during handling The best handle is the 1 inch wide steel handle with a bolt hold at each end, fasten through the comer stringer and skin with two 1/4 by 1 1/2 bolts on each handle These handles are very important safety items

ENGINE MOUNTS

The engine mounts on a Hovercraft are subjected to millions of vibration cycles in their life time So it is important that mounts are welded together rather than bolting The soft steel-in black iron pipe is ideal for simple electric arc welding Better grades of steel such as chrome molly aircraft tubing could be used dm thinner walls if gas or heli-arc welding is used in fabrication This would save weight but is beyond the capability of most homebuilders

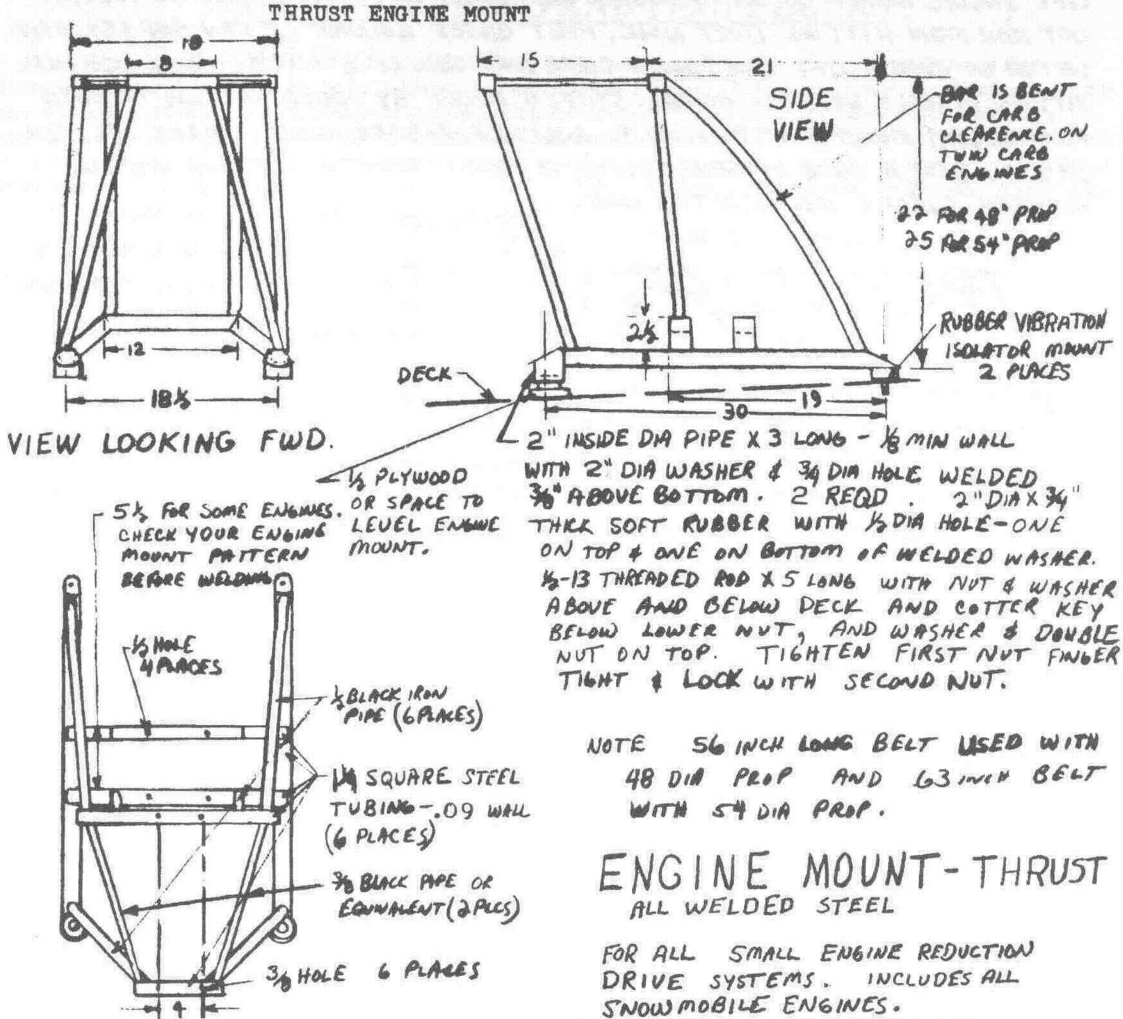
The mount is made with the engine and prop or fan mounted to insure proper fit Tack weld all pieces while the mount is on the craft The welding process will cause some movement of any joints not welded due to expansion from the heat of welding Remove the mount and finish all welds Be sure to chip flux every time you stop welding so you don't weld over flux and leave voids Spray paint the mount to avoid rust

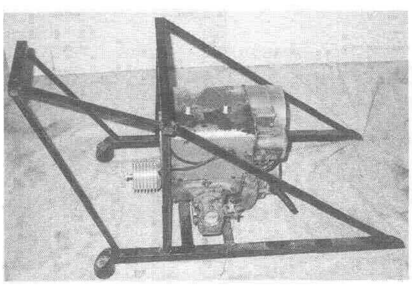
Mounts should be isolated from the craft by soft rubber The softer the rubber mounting the less vibration is transferred into the craft The lift mounting must be firm enough to prevent the fan from hitting the duct wall Usually 5 or 6 of the standard air conditioning mounts are sufficient These mounts are about 2 inches in diameter and three-fourth inch thick rubber with a three-fourth inch thick rubber with a three-eighths threaded rod on each end as shown below on the two front mount positions for the thrust engine mount The 2 rear mounts should be of the fail-safe design to resist thrust and lifting forces The next mount is an engine mount for all small engine reduction drive applications The final mount is a typical lift engine mount

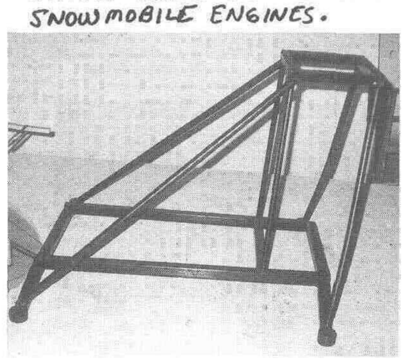


1x1x.083 SQUARE STEEL TUBING. 4 PCS
8½
3/8 BLACK PIPE 3 PLACES
½ BLACK PIPE x17½ AFT AND 19½ FWD
17½
2x4x3/16 STEEL
2x3x3/16 STEEL
3/8 HOLE 6 PLACES FOR RUBBER MOUNTS
2
19
SIDE VIEW
10½
7¼
7/16 HOLE 4 PLACES
19
LOOKING FWD
THRUST ENGINE MOUNT
FOR DIRECT DRIVE 16 OR 18 HP BRIGGS AND OTHER ENGINES
HEIGHT FOR 48" DIA PROPELLER.

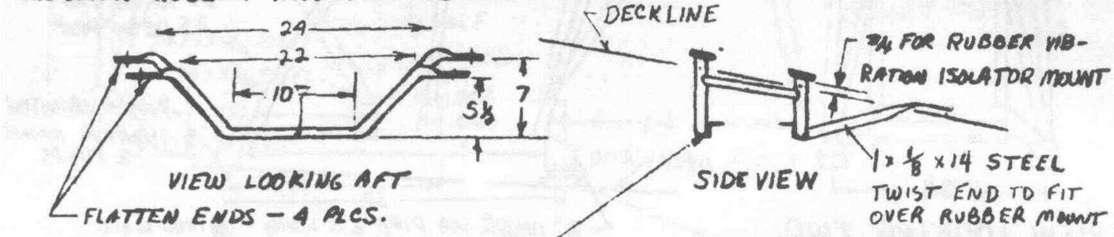
THRUST ENGINE MOUNT



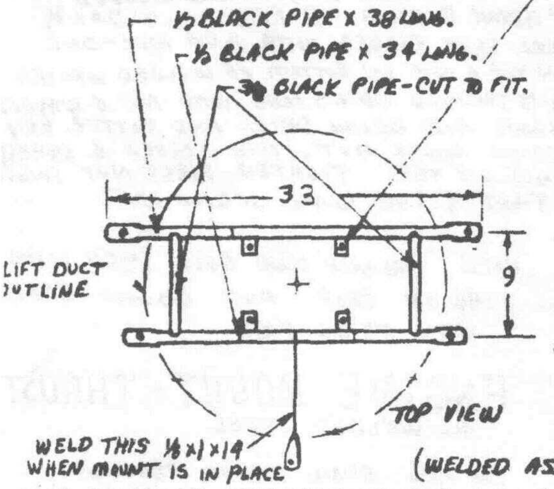




LIFT ENGINE MOUNT NOTE: IF RUBBER MOUNTS ARE NOT STIFF ENOUGH TO PREVENT LIFT FAN FROM HITTING DUCT WALL, FIRST CHECK BALANCE OF FAN AND CENTERING OF FAN ON SHAFT. LIFT FAN SHOULD CLEAR DUCT WALL BY 1/8 INCH. SOME OCCASIONAL HITTING IN ROUGH WATER IS NORMAL. STIFFEN MOUNT BY ADDING ONE LEG FORWARD FROM ENGINE MOUNT BOLT POSITION TO ANOTHER RUBBER MOUNT. MAKE LEG FROM 1/8 x 1 STEEL. GLUE A PIECE OF WOOD, 3 x 6 x 3/4, TO DECK IN FRONT OF DUCT AND INSTALL ANOTHER RUBBER MOUNT IN THIS WOOD.



DIMENSIONS ARE FOR 26 DIA FAN.

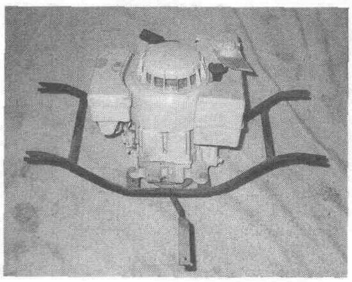


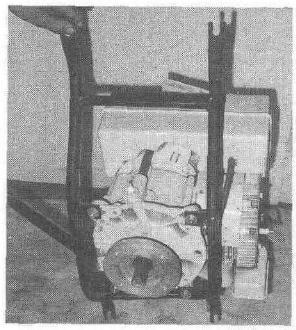
1½ ANGLE IRON x 1 LONG. SOME ENGINES MAY HAVE ONE MOUNT POSITION OFFSET AND MAY NEED A LARGER PIECE OF ANGLE IRON TO FIT.

CONSTRUCTION METHOD: BOLT ANGLE IRON TO ENGINE. INSTALL LIFT FAN AND CENTER IN DUCT. POSITION ½ BLACK PIPE TO GET 9 INCHES OR MORE SPACING OF RUBBER MOUNTS. TACK WELD ANGLE IRON TO PIPE AND ⅜ PIPE AS SHOWN. REMOVE AND FINISH WELDING. NOTE: OVERSIZE HOLES IN PIPE ARE FOR MINOR POSITION ADJUSTMENTS. ALSO USE WASHERS AS SPACERS BETWEEN RUBBER MOUNT AND PIPE TO ADJUST FAN POSITION.

(WELDED ASSEMBLY.) LIFT ENGINE MOUNT

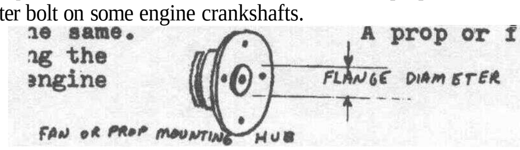
USE A MOWER THROTTLE HANDLE FOR LIFT ENGINE. FOR WINTER OPERATION USE AN UNSHIELDED CABLE OR ROD FOR THROTTLE CONTROL TO BOTH ENGINES TO PREVENT FREEZE UP.



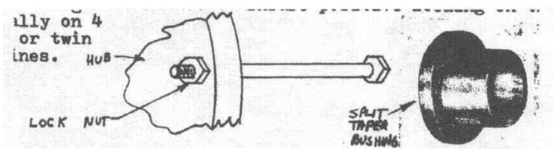


MOUNTING FANS AND PROPELLERS

Some propellers are balanced and centered by the mounting bolt holes. This system can cause problems. If the prop is damaged and repaired it will probably be out of balance and will be difficult to check. If the prop is centered by the center bore, it is easy to balance and will center itself, even if the mounting bolt holes are oversize or not drilled accurately. When mounting a propeller or fan on an engine or shaft be sure some of the shaft goes into the center bore for accurate centering. (The more the better.) If the shaft does not extend into the center bore, a flange should be mad eon the mounting hub to center the prop or fan. This flange diameter should be a standard size equal to or less than 1 1/2 ins. diameter. The prop or fan bore should be the same. A prop or fan may also be centered using the center bolt on some engine crankshafts.



The hub should be threaded for the mounting bolts. Nuts should be used on back of the hub to lock the bolt in place. Hubs for most engines and shafts can be made from roller chain sprockets purchased from power transmission or bearing dealers. Best use a split taper bushing on all hubs to insure positive locking on the shaft especially on 4 cycle single or twin cylinder engines.

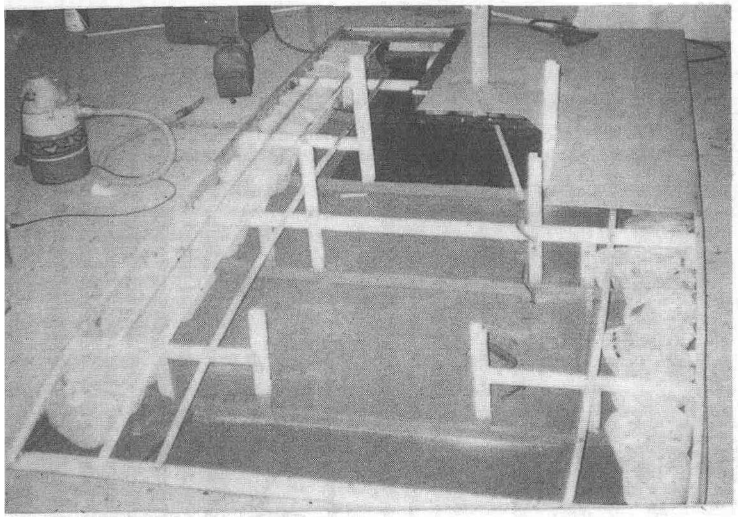


TRAILERS

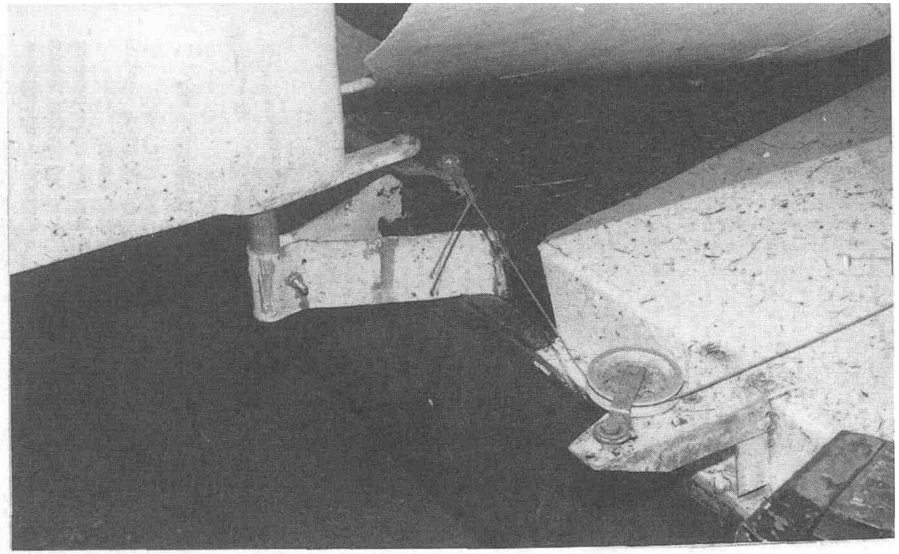
Many small Hovercrafts up to about 500 Ibs. and 6 1/2 ft. wide can be carried on car tops. A good strong set of car top carriers (two sets will be stronger) will work well if you have people available to life the craft. For saltwater operation be sure to wash the craft before putting it on top of the car as the salt will cause rust. A trailer makes loading and unloading much easier. One person can usually do it by himself.

The ideal trailer is a very low flat bed trailer with a plywood deck large enough for the Hovercraft. The craft can be winched on by operating the lift system and tilting the trailer until the aft part is near or touching the ground. To get the craft off the trailer, just tilt the trailer with the craft untied and the lift system operating. The craft will slide about halfway off. Pull the trailer forward while it is still tilted to clear the craft.

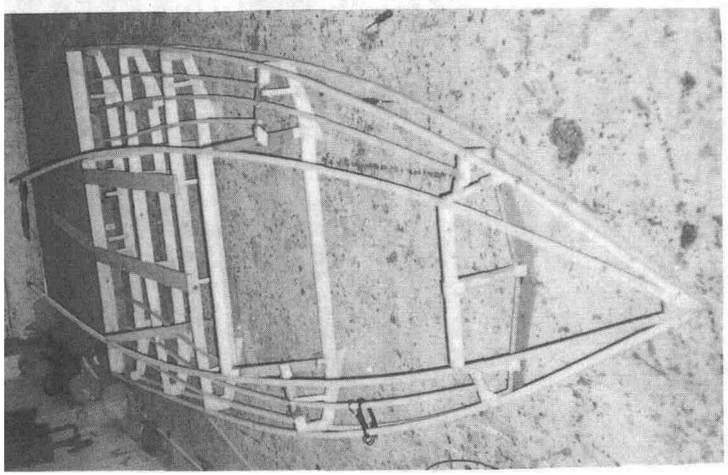
Boat trailers can be modified or a trailer can be built up from parts. The trailer will generally be very light in weight (usually less than 500 Ibs.) as the Hovercraft it will carry will be lighter than an equivalent sized boat.

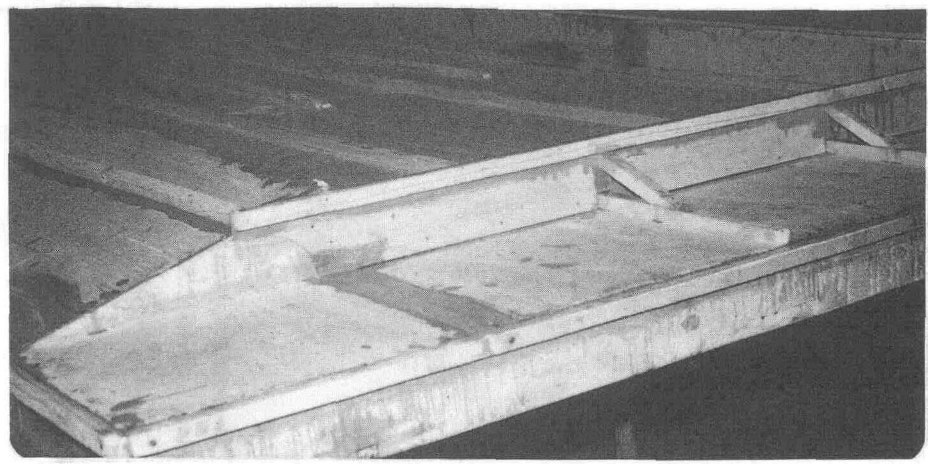


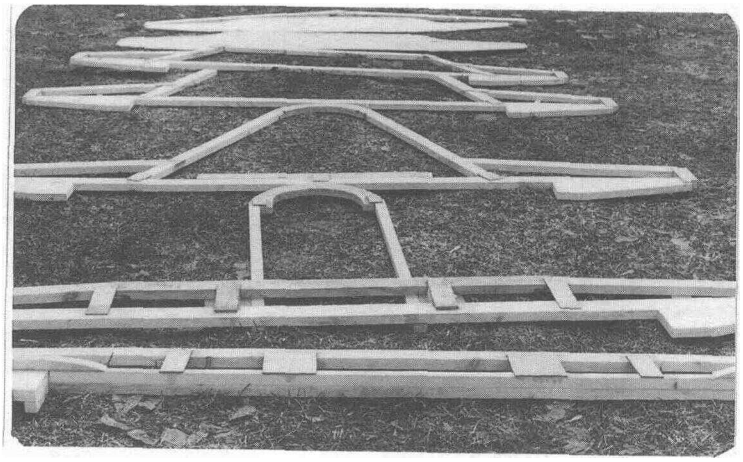
UH-12T3 SHOWING FRAMING, SKIN, AND MILK JUGS FOR POSITIVE FLOTATION.



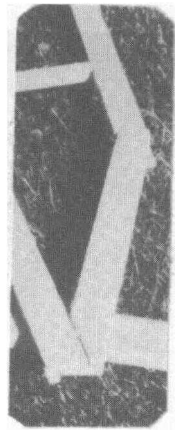
STEERING SYSTEM AND LOWER RUDDER MOUNT



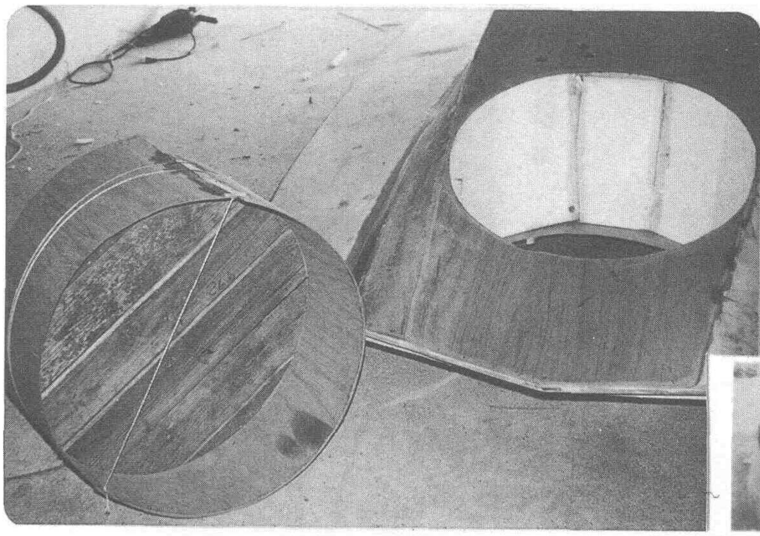


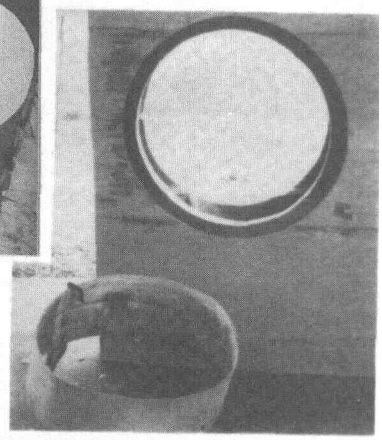


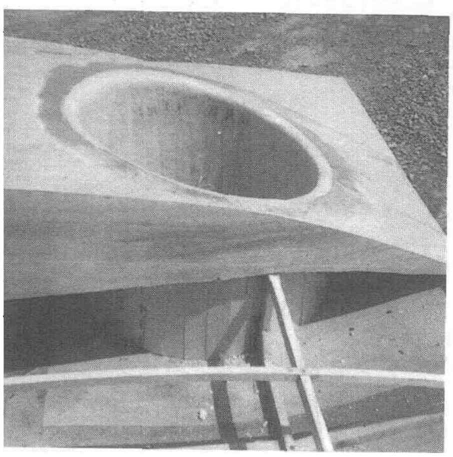
RIB DETAILS UH-13T BEFORE 1981 REVISION



RIB SPLICE JOINTS





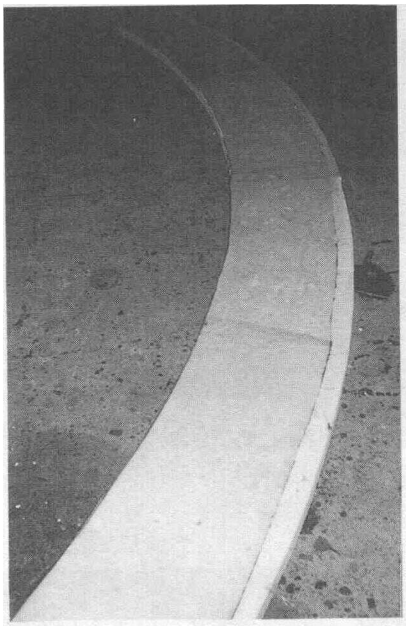


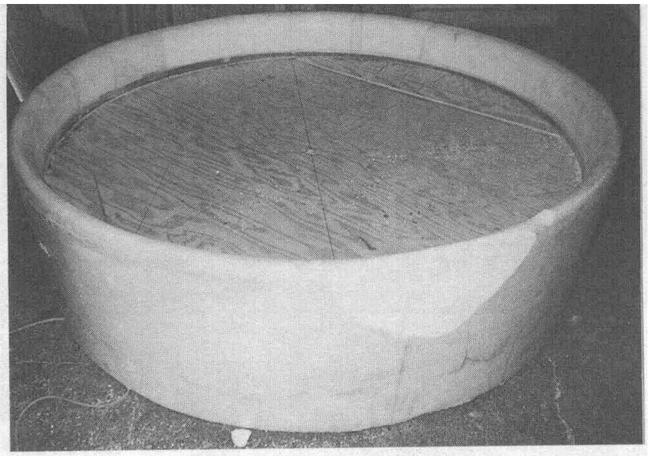
UH-13T LIFT DUCT. PLYWOOD CYLINDER HELD ROUND BY WOOD DISKS. SEE PG.14. STYROFOAM FORM IN CRAFT. TWO PART FOAM POURED BETWEEN PLYWOOD CYLINDER AND STYROFOAM FORM.

UH-12T3 LIFT DUCT: TWO INCH THICK VERTICAL FOAM STRIPS COVERED WITH FIBERGLASS.

UH-11 LIFT DUCT. FOAM INLET RING AND PLYWOOD CYLINDER.

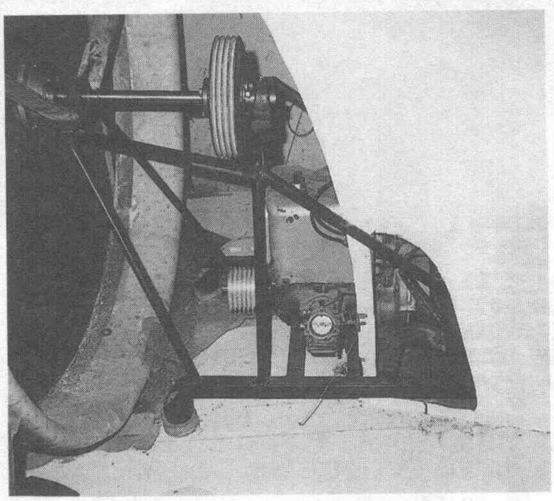
SHOWN ARE 3 DIFFERENT METHODS TO CONSTRUCT A LIFT DUCT. THE BEST AND STRONGEST IS THAT USED ON THE UH-13T, CENTER LEFT PHOTO.

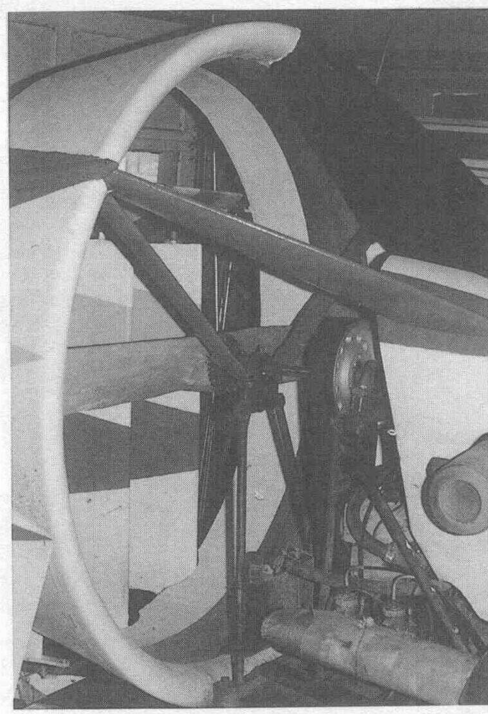




FINISHED DUCT READY FOR MOUNTING
NOTE FLAT AREA FOR MOUNTING TO
DECK.

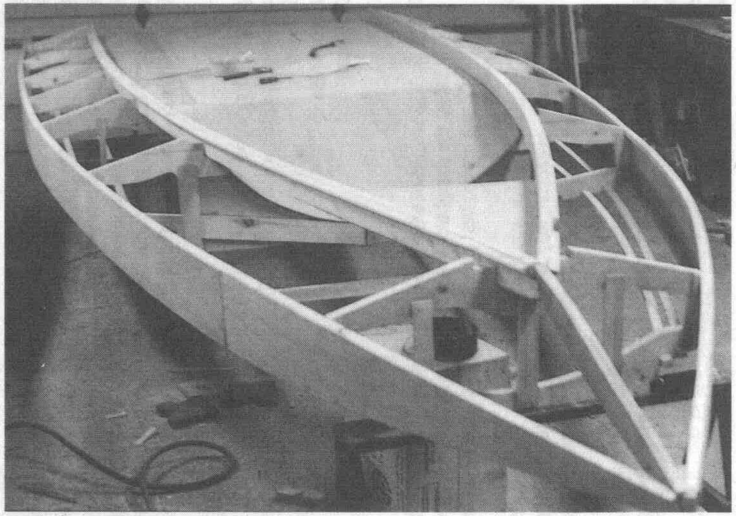
FOAM SEMI CIRCLES
WITH FIBERGLASS



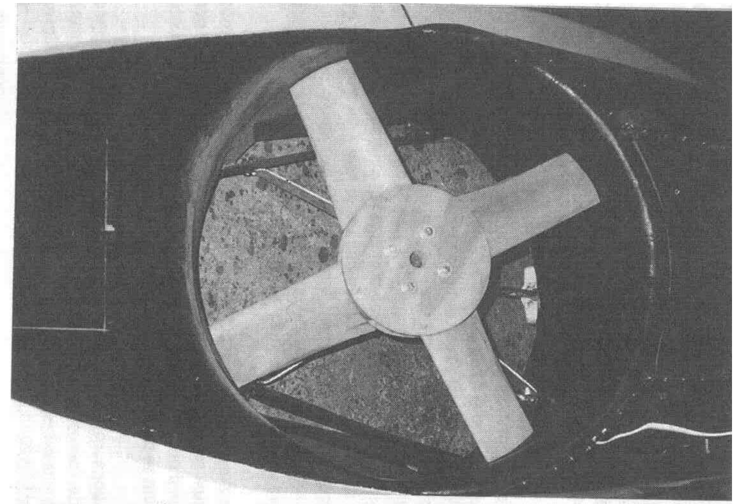


PLYWOOD DISKS LEFT IN PLACE UNTIL DUCT IS COMPLETELY MOUNTED AND ALL FINS ARE IN PLACE. NOTE ONE INCH HOLE IN PLYWOOD DISK FITS PROP SHAFT.

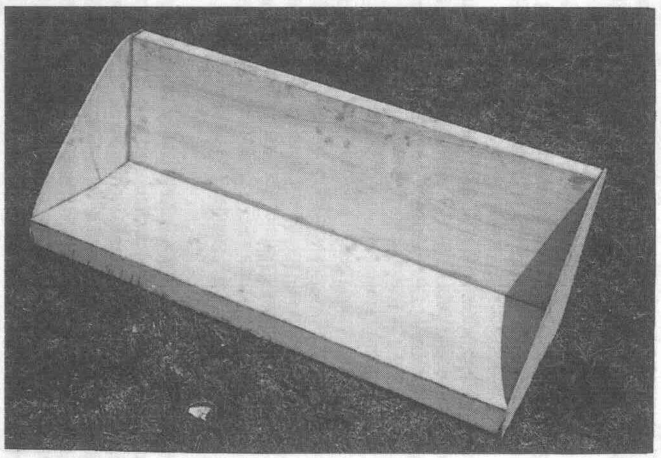
COMPLETE DUCT WITH THREE FINS MOUNTED TO AFT COCKPIT, TWO WOOD FINS TO AFT BEARING, AND THE TWO SIDE FINS TO THE DECK.



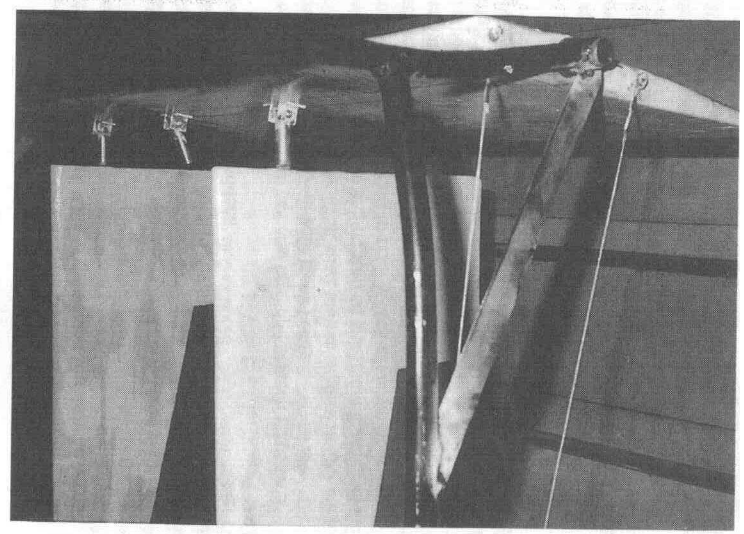
3½ INCH STEP ON MODIFIED UH-19P BOTTOM



NOTE CLOSE TIP CLEARENCES ON THIS LIFT FAN. THIS IS VERY IMPORTANT FOR GOOD PERFORMANCE



TYPICAL SEAT CONSTRUCTION



MATERIAL SUPPLIES AND INFORMATION

A Hovercraft is supported by pressurized air which is trapped between the hull and the surface over which it travels. The air is supplied by a fan or blower and must be continuously forced under the hull due to the small gap between the flexible bag and the surface. Since the weight of the craft is supported by air under pressure it is important that the weight be kept to an absolute minimum to reduce the pressure of the air and therefore, the power required for lift. For over water operation, the weight is even more critical because with a heavier weight and therefore a higher cushion air pressure the thrust required to exceed planning speed or hump speed is much greater. In other words, any decrease in weight results in an overall performance increase. For this reason the Hovercraft is constructed of the lightest materials available. Below is a list of materials and there weight per cubic foot.

Spruce (Sitka) wood	26-28 Ibs.	Tin & Zinc	440 Ibs.
Eastern white pine wood	27-29 Ibs.	Iron & Steel	490 Ibs.
Fir wood	26-34 Ibs.	Fiberglass	120 Ibs.
Styrene foam	1 Ib.	Urethane foam	2-15 Ibs.
Aluminum	170 Ibs.	Water	62.5 Ibs.

NOTE: The weight of wood varies *from* piece. The lightest pieces with the smallest knots and least amount of knots and with the straightest grain should be chosen. Get your wood at the local lumber yard. You can hand pick common pine or fir and cut the best parts for stringers. Left over pieces with more knots will make ribs. Don't use pieces with large knots. This is the least expensive way to build your craft. Remember to choose pieces light in weight with a straight grain. An easier, but more expensive way is to buy clear or select wood which is 2 to 3 times as expensive as common. Wood sizes 1 x 2 through 1 x 6 are 3/4 thick x 1/2 in. less than the width number. Example: 1 x 4 is 3/4 x 3 1/2 inches.

Probably the most difficult item to get for your Hovercraft is the 1/8 plywood for the skin. Many builders have used plywood wall paneling. But this material must be protected with good paint and a good cover to protect it from the weather. The inside must be kept dry when not in use because paneling is an interior grade plywood and it will delaminate when exposed to prolonged moisture. On larger hovercrafts, such as the 18 and 26, 1/4 A-C exterior grade is available everywhere. 1/8 marine plywood is very expensive and can be ordered through some lumber yards. Aircraft grade plywood is also available, but it is even more expensive than marine. In some places you may find 1/8 plywood exterior grade door skins which are suitable for your purpose. 1/8 exterior grade plywood can also be located by mail order. Look in boating, Popular Science and Mechanics or call Universal Hovercraft.

Aluminum and fiberglass skins are not recommended due to expense and difficulty to attach these skins to a rib and stringer frame work. Plywood skinning is very simple and inexpensive by comparison to other methods. We are not saying these other methods are no good or impossible. The machines work well when built to the plans. One of the biggest problems in home build machines is overweight due to too many modification on the plans.

We have used weldwood plastic resin glue in the past for all our wood gluing. It is water resistant and very strong when properly used. Parts must be clamped or nailed with no gaps or spaces. There are some better glues which are completely water proof and fill gaps better, but these are usually two part mixes which are more difficult to work with and are more expensive. We now use epoxy resin for all our wood and fiberglass work including making foam and fiberglass rudders.

Metal for making mounts can be purchased at hardware stores (Black pipe), but can also be found at scrap yards for a lower cost. Pick only pieces that do not have deep rust pits. A good scrap yard can supply all your metal needs.

Small two cycle engines used for lift are becoming more difficult to find. The vertical shaft mower engines from 3 1/2 to 16 HP work very well as lift engines and are available from most mower shops. Choose an engine with an aluminum housing as these are much lighter than the cast iron engines. Two cycle snowmobile engines are more difficult to find. Check at snowmobile shops, all terrain vehicle shops, cart shops, dealers who advertise in magazines related to recreation. You may also find components for the automatic lift systems as well as short shafts, bearings and sprockets at these places.

We do not recommend the use of jet engines or pulse jets on hovercrafts for these reasons.

1.) They are extremely noisy and there is no effective way to muffle them.

2.) Jets have rather low thrust and are very inefficient burning twenty times as much fuel per pound thrust as a gas engine and propeller.

We also do not recommend the use of motorcycle engines except by skilled mechanics because of the difficulty in converting the engine. Some motorcycle engines may be easier to convert than others. Prime factors to be considered are the starting system, proper cooling for the engine, and attachment of propeller hubs or V-Belt pulleys. Fuel flow on motorcycles is by gravity feed which means the tank must be higher than the carburetor. Some engines have oil injection systems which must be hooked up properly. If you must use a motorcycle engine than choose a late model liquid cooled engine. Use an auto heater core for a radiator. All air cooled motor cycle and free air snowmobile engines have fins set up for cross flow which is wrong for a Hovercraft installation.

Most larger towns and cities have bearing dealers or power transmission equipment dealers where they may have in stock the necessary bearings and sprockets. Parts they don't have in stock they can order for you. (Right angle gear boxes and long shafts or special bearings). Look in the yellow pages of the telephone book for these.

Skirt material can be found by looking for canvas shops in the yellow pages of the telephone book. Vinyl coated nylon and neoprene coated nylon are both suitable.

The use of incorrect lift fans and thrust propellers have been responsible for poor performance as well as other problems in many small hovercrafts. Unless you are a good design engineer in the field of aerodynamics, do not substitute fans or propellers from those recommended by the designer. Do not use fans from cars or from air conditioning equipment. Fans and propellers may be purchased through mail order from companies dealing in Hovercraft supplies. See the page "Propellers and Fans" in our catalog. For those who wish to make their own fans and propellers it is recommended you obtain a copy of Simplified Propellers by R. W. Hovey available from book stores or purchase propeller fan templates and plans from Universal hovercraft. See materials and supply sources section in this book.

Here is a list of other Reference Books for the Hovercraft Builder available at any large library:

1.) Light Hovercraft Handbook - The HoverClub of Great Britain
2.) Hovercraft Design and Construction - by G. H. Elsley and A. J. Devereau
3.) Jane's Surface Skimmer Systems (reference book) edited by Roy McLeavy (Contains information on Hovercrafts from all over the world)
4.) Helicopter and Hovercraft Design - by Basil Arkell
5.) The Hovercraft Story - by Gary Hogg 1970
6.) Homebuilt Hovercraft - by G. H. Williams
7.) This Is The Hovercraft - Clover 1972
8.) Hovercraft - Croome 1962
9.) Your Book of Hovercraft - Desoutter 1962
10.) Marine Hovercraft Technology - Trillo 1971
11.) Light Hovercraft Design Handbook - Waters
12.) History of Air Cushion Vehicles - by Leslie Hayward
13.) Light Hovercraft - Design and Construction - by R. Schneider and D. Holditch
14.) HoverClub of America News Letter - Box 908, Foley, AL USA (334)-946-3800, www.hoverclubofamerica.org

BLACK PIPE SIZES

SIZE	1/8	1/4	3/8	1/2	3/4	1
O.D.	.405	.540	.675	.840	1.05	1.315
I.D.	.269	.364	.493	.622	.824	1.049
THICKNESS	.068	.088	.091	.109	.113	.133
WT PER FT.	.25	.42	.57	.85	1.13	1.68

2000 MATERIAL COST APPROXIMATION

4' x 8 ' x 1/4 in. Exterior Plywood $16.00419.00
4' x 8 ' x 1/8 in. Marine Plywood $25.00 - $50.00
4' x 8' x 1/8 in. Exterior Plywood $20.00 - $40.00
4' x 8' x 1/8 in. Interior Paneling Plywood $10.00 - $20.00
1 Board Foot Fir or Pine Wood $. 80 - $ 1. 20
Polyester Resin (Gal.) $19.00 - $30.00
Boat Paint (Gal.) $25.00/$55.00
Lexan(Sq. Ft.) $1.50 -$3.00
Vinyl Coated Nylon (Sq. Yd.) $7.00 - $13.00 Neoprene coated nylon $ 11. 00 - $20. 00 Vinyl Glue $ 12. 00 - 15. 00/ pint
Black Pipe (Ft.) $.40 - $.75 Fiberglass Cloth (Sq. Yd.) $2.50/$5.00
Weldwood Plastic Resin - Glue - (Lb.) $3.50 - $4.50
3 to 5 HP Mower Engines (New) $110.00 - $180.00 8 to 11 HP (New) $355.00 - $500.00
2 Cycle Engines $200. 00 - $2, 000. 00 Auto engines $50.00 - $800.00
Propellers and Fans (See Catalog) $65.00 - $400.00
Steel Plates, Bar & Tubing $. 10 - $.60 Ib.
Ball Bearings $15.00-$45.00 Aluminum Tubing $.90 - 2.80 ft.
Foam $. 18 - $.35 (Board Ft.) Epoxy Resin $45.00 - $70.00 gal.

CHOOSING THE ENGINES

Two cycle engines are generally chosen due to their light weight, low initial cost and simplicity. These engines, usually snowmobile engines, generally burn more fuel than four cycle engines. They are usually more difficult to muffle, but there are no competitive four cycle engines manufactured in the 12 to 130 HP range. When purchasing an engine, the first thing you will notice is the horsepower. You should also see at what RPM the engine develops this power because you may never be able to use all this power simply because your propeller won't turn enough Rpm's. Generally a 3 6 - 42 inch thrust prop or 24 - 26 inch lift fan should turn 2600 to 3400 RPM. When choosing the engine look at the horse powers RPM curve and compare engines at the

RPM you are interested in. Generally the four cycle mower engines will develop their best power in the 2500 to 3600 RPM range and make good lift engines. Another important factor is vibration in these two cycle engines. Generally the more cylinders the engine has the smoother it runs. So if you can get a twin cylinder engine for a few more dollars.

Automobile Engines

Starting with about 1980 models on some cars and later on others, ignition timing and carburetor settings are controlled by a computer. The engine has sensors at various places and if a sensor malfunctions the engine will run very poorly or not at all. Trouble shooting these engines is difficult for the home mechanic. A builder may use a later model engine and an earlier model carburetor and distributor to avoid working with the computerized systems.

Purchasing a whole car is usually the best way to get an engine. Many small cars with unibody construction (no frame) will rust out and loose structural strength long before the engine wears out. These cars can be had for junk yard prices or even for free. You can test run the engine while it is in the car This way you get a complete engine with starter, charging system, bell housing (to mount starter if necessary) and radiator. You may even get a usable battery. The heater is easy to hook up on the Hovercraft if desired. The front or rear windshield may be usable along with the windshield wiper system. You may even find use for the wheels and axles when making a trailer.

Below is a list of information on some auto engines. Power shown is estimated at the fly wheel. Weight includes a 7-10 Ibs. fly wheel (heavier fly wheels should be turned down in a lathe and balanced). Weight also includes the starter, alternator, air cleaner intake and exhaust manifolds and carburetor. Not included in weight is mufflers, radiators, oil, dirt on engine and pollution devices. All engines shown below are in line 4 cylinder unless noted.

ENGINE TYPE	SIZE CC.	ESTIMATED POWER/RPM	WEIG1ST LBS.	REMARKS
77-80 OMNI	1588	80/5200	272	
DODGE COLT	1410	75/5200	225	
DODGE	1598	85/5200	225	
TOYOTA 2TC	1588	88/5500	275	VERY SMOOTH
TOYOTA 3TC	1770	80/4600	280	
DATSUN 1600	1592	80/5200	275	
DATSUN 2000	1952	95/5200	285	GOOD POWER &
			LIGHT	
RENAULT R-16	1647		220	
HONDA CIVIC	1180	55/5000	240	(SOME ROTATE
HONDA CIVIC	1237	60/5000	240	REVERSE)
HONDA CIVIC	1488	70/5000	240	
FORD PINTO 1600	1599			VIBRATION
PINTO 2000	1999	85/5000	300	VIBRATION & HEAVY
PINTO 2300	2294	100/5000	340	HEAVY
CHEVY VEGA	2290	85/4400	295	75 UP STEEL CYL.
CHEVY II & NOVA	2510		295	LARGE & LIGHT
PONT. CITATION	2474			
BUICK V6 78 PICKUP	3786	115/4000	420	HEAVY
FORD V6 72-79	2792		375	SMOOTH & HEAVY
CITATION V6	2837	120/4800	325	COMPUTER 81 UP
BUICK V8 61-63	3251	200	320	ALUM V8
CORVAIR 145 H-6	2377	80/4400	275	REVERSE ROTATION
CORVAIR 165 H-6	2688	110/4400	275	REVERSE ROTATION
TOYOTA 20R	2189	100/4800	340	HEAVY
SUBARU	1800	80/4800	210	Very Light, good power
DODGE 2.2		107/5600	82	NO COMPUTER
FORD V6 82 UP	3800	130	320	
CHEVY 3.8 V6	3800	120/4600	427	
FORD ESCORT 83	1600	90/5200		GOOD BALANCE
MAZDA ROTARY	1146	100/6500	SOME HEAVY	
MAZDA ROTARY	1308	120/6500		
VW 1500 BUG H-4	1500	53/4400	240	AIR COOLED
VW 1600 BUG H-4	1600	60/4400	240	AIR COOLED
FORD V8 302	4950	150/4200	485	

MINIMUM POWER REQUIRED

THE MINIMUM POWER REQUIRED ON A HOVERCRAFT DEPENDS ON MANY FACTORS IN THE DESIGN, BUT GENERALLY IS AS FOLLOWS:
LIFT -1 HP per 150 Ibs. Gross Weight
THRUST -1 HP per 75 Ibs. Gross Weight

An average weight water skier can be pulled with a 50 hp Hovercraft but for fast easy starts and for starting on 1 ski a thrust engine of about 100 hp is needed. Most important for water-skiing is a light weight properly trimmed craft with good skirt drainage and an experienced operator.

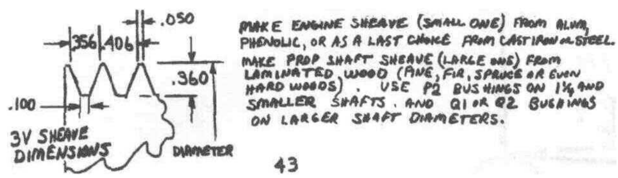
V-Belt Drive System

A belt drive system permits use of large slow turning props which develop more thrust per horsepower and run much quieter. More power may be taken from an engine because it does not need to be limited to prop speed. These advantages far exceed the losses in belts and bearings and the extra weight carried on all except small four cycle mower engines.

Wood Sheaves

We have many thousands of operating hours using wood sheaves on the prop shaft on crafts ranging from single seat racer to a 10 seat 21 ft. craft. We have never worn out or had any other problems with a wood sheave. The prop shaft sheaves usually has 2 to 3 times as much belt in contact with it as does the engine sheave. So a loose belt will never slip on the large sheave; any slippage and wear will always occur on the small sheave.

Make the sheave by laminating 1 x 4 or 1 x 6 wood so alternating layers have grain direction 90 degrees to layer below and above. Bond with epoxy. Nail and clamp until epoxy sets. Saw to round shape leaving an extra 1/4 inch on the desired diameter. Turn a slot about 1 inch wide and 1/2 inch deep in one side. Clamp in lathe in this slot and do all machining and coating before removing from the lathe. Coat all surfaces with 3 coats of epoxy. Machine the epoxy smooth without removing too much. Seethe 3V sheave dimensions below.



V-Belt Drive Systems have been around since 1920. But only recently have they become light and compact, efficient, and inexpensive. The introduction of the 3V, 5V, and 8V belts in 1959 and the recent introduction of the Poly V and multiple belts in a single unit construction has given belt drive systems advantages above all other forms of power transmission in many applications, including use of hovercrafts.

ADVANTAGES OF V-BELT DRIVE

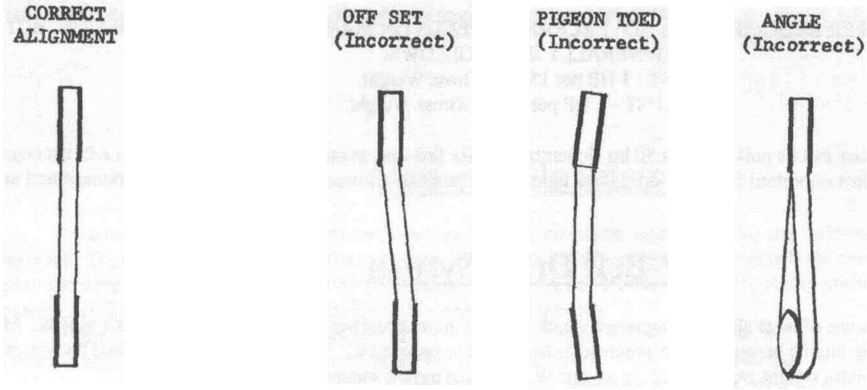
1. Wide horsepower range - From 1/6 HP to over 2000 HP
2. Quiet operation - Long service life
3. Large speed ratios possible.
4. Provide high shock absorption (built-in safety valve)
5. Can be used as an effective means of clutching
6. Capable of transmitting power around corners or out of plane drives
7. V-belt will operate in practically all conditions
8. Belting is usually easily installed or removed
9. Require little maintenance
10. Low initial and replacement c o s t ,
11. High Efficiency (About 95%)

INSTALLATION

Move the sheaves together to allow belt installation. Never pry or roll belts on the sheaves as this may cause serious damage to the belts. Work the belts around the sheaves by hand.

SHEAVE ALIGNMENT

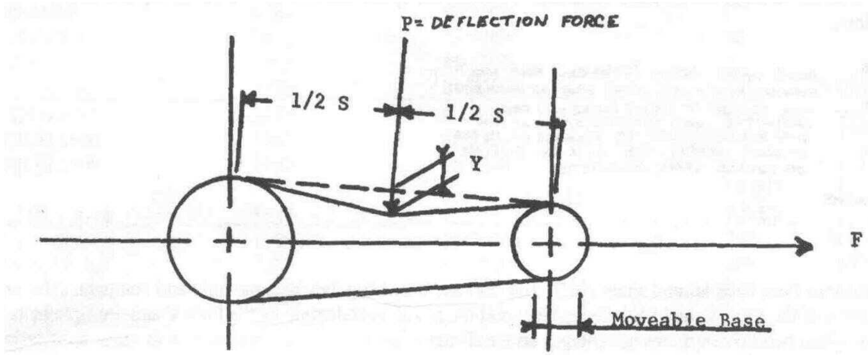
The sheaves must be aligned as close as possible. Check all of the items shown below. These items can usually be checked with a steel tape, a straight-edge, or carpenters level or a plumb.



BELT LENGTH FORMULA

$$L = \frac{D1 \times 3.14}{2} + \frac{D2 \times 3.14}{2} + 2C$$

Where L is belt length, Dl is diameter of small sheave
D2 is diameter of large sheave, and C is center distance between the two sheaves,
This formula can be used to determine belt length, sheave sizes, or center distances.



To tension a drive by this method, a force (F) must be applied to the moveable unit so that a specific force (P), will deflect the belts at midspan 1/64" for each inch of span (S). Tensioning cards giving the force (P) for the different cross-sections of each type of belt are available on request. A typical tension tag is shown below. The tools needed are: equipment to apply force (F), a scale to apply and measure force (P), a tape to measure span (S), and a ruler to measure deflection (Y).

RECOMMENDED DEFLECTION FORCES (Ib.) P

BELT	NORMAL	MAXIMUM	NEW BELTS
A	2	3	4
B	4	6	8
3V	4	7	9
5V	9	12	15
8V	20	30	40
Poly-VJ	3/4	7/8	7/8
Poly-VL	21/4	3	3
Poly-VM	7	83/16	83/16

SIMPLE TENSION METHOD
Tighten belt just tight enough
so it does not slip under full power

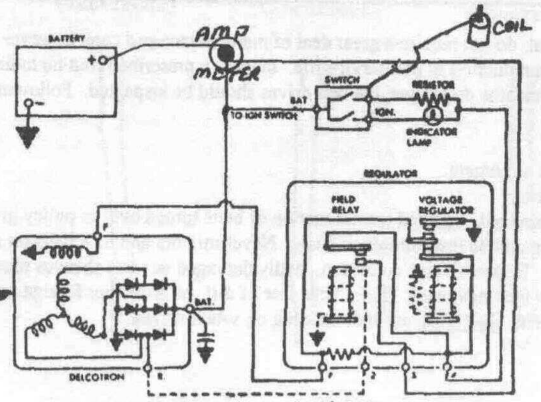
MAINTENANCE **AND OPERATING PRACTICES**

V-belt drives in general, do not require a great deal of maintenance and care, however complete lack of it will lead to marginal drive performance and a reduction in belt service life. Ideally, a prescribed routine maintenance schedule should be set up. It is also suggested, that on any machine downtime, the belt drives should be inspected. Following is a list of rules for proper V-belt drive maintenance: • • -

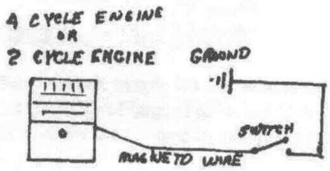
Maintain proper shaft and sheave alignment.
Make a periodic belt tension checks.
Check belt condition for badly damaged, ruptured tensile section or belts turned over in pulley grooves - new belts are necessary. Belts of different manufactures cannot be used simultaneously. Never mix old and new belts on a drive. Inspect sheaves for excessive wobble or eccentricity. Inspect sheave condition, badly damaged or worn sheaves must be replaced. Lubricate bearings of sheaves and idler shafts to ensure free movement. Keep belts free of dirt, oil and other foreign material. Use carbon tetrachloride or trichloretholene for cleaning V-belts. DO NOT use belt dressing on v-belt drives.

ELECTRICAL SYSTEMS

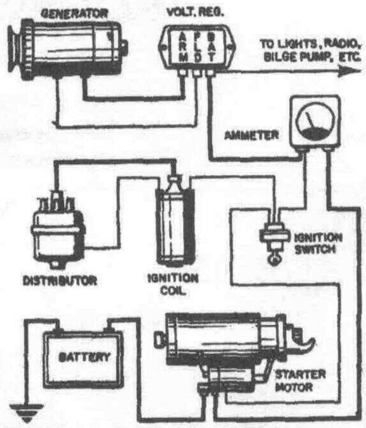
NOTE: WIRING DIAGRAMS ARE FOUND IN MITCHELLS MOTOR MANUAL AND OTHER MANUALS AT LARGE LIBRARYS.



ALTERNATOR SYSTEM

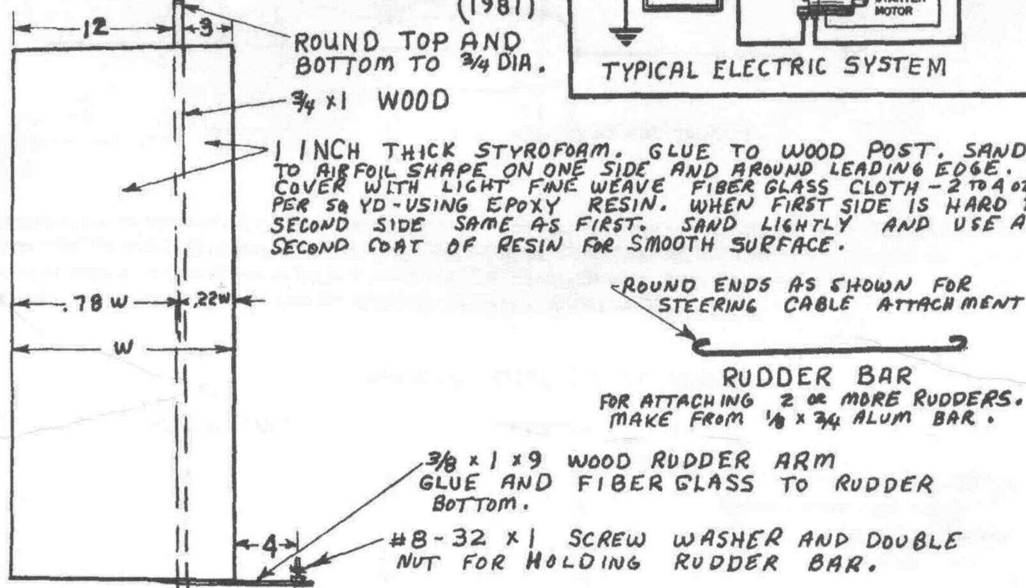


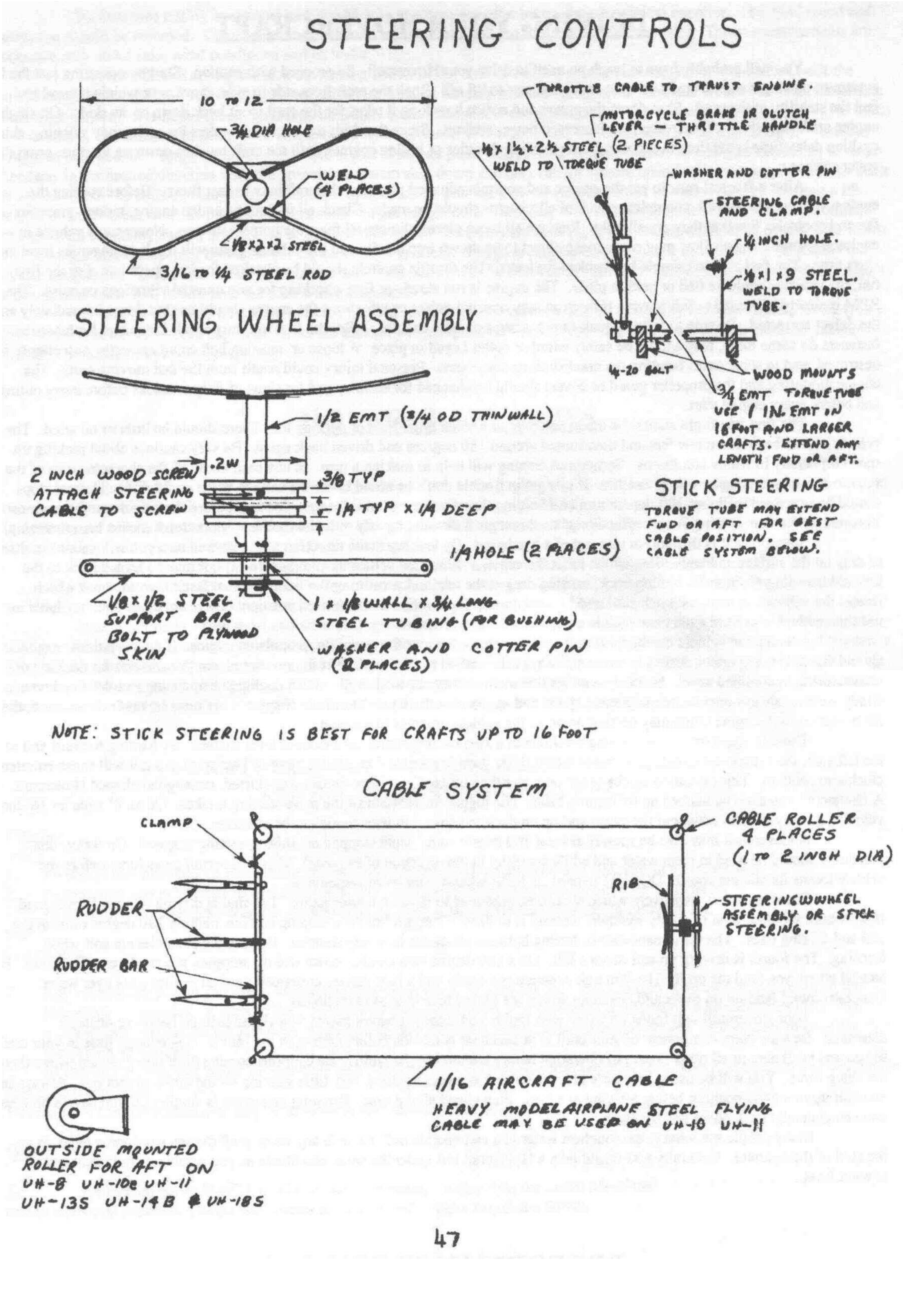
SMALL ENGINE KILL SWITCH



TYPICAL ELECTRIC SYSTEM

RUDDER CONSTRUCTION (1981)




STEERING CONTROLS
10 TO 12
3/4 DIA HOLE
WELD (4 PLACES)
1/8 x 2 x 2 STEEL
3/16 TO 1/4 STEEL ROD
STEERING WHEEL ASSEMBLY
THROTTLE CABLE TO THRUST ENGINE.
MOTORCYCLE BRAKE OR CLUTCH LEVER - THROTTLE HANDLE
1/4 x 1 1/4 x 2 1/2 STEEL (2 PIECES) WELD TO TORQUE TUBE
WASHER AND COTTER PIN
STEERING CABLE AND CLAMP.
1/4 INCH HOLE.
1/4 x 1 x 9 STEEL. WELD TO TORQUE TUBE
1/4-20 BOLT
WOOD MOUNTS
3/4 EMT TORQUE TUBE USE 1 IN. EMT ON 16 FOOT AND LARGER CRAFTS. EXTEND ANY LENGTH FWD OR AFT.
STICK STEERING
TORQUE TUBE MAY EXTEND FWD OR AFT FOR BEST CABLE POSITION. SEE CABLE SYSTEM BELOW.
1/2 EMT (3/4 OD THINWALL)
2 INCH WOOD SCREW
ATTACH STEERING CABLE TO SCREW
.2W
3/8 TYP
1/4 TYP x 1/4 DEEP
1/4 HOLE (2 PLACES)
1/8 x 1/2 STEEL SUPPORT BAR BOLT TO PLYWOOD SKIN
1 x 1/8 WALL x 3/4 LONG STEEL TUBING (FOR BUSHING)
WASHER AND COTTER PIN (2 PLACES)
NOTE: STICK STEERING IS BEST FOR CRAFTS UP TO 16 FOOT
CABLE SYSTEM
CLAMP
CABLE ROLLER 4 PLACES (1 TO 2 INCH DIA)
RUDDER
RUDDER BAR
RIB
STEERING WHEEL ASSEMBLY OR STICK STEERING.
1/16 AIRCRAFT CABLE
HEAVY MODEL AIRPLANE STEEL FLYING CABLE MAY BE USED ON UH-10 UH-11
OUTSIDE MOUNTED ROLLER FOR AFT ON UH-8 UH-10C UH-11 UH-13S UH-14B & UH-18S
47

DRIVING YOUR HOVERCRAFT

You will probably have to teach yourself to drive your Hovercraft So proceed with caution Start by operating just the lift system or on single engine crafts use just enough power to lift off Rock the craft from side to side, move your weight around and feel the stability of the craft Shut down the power and notice how long it takes for the craft to sit back down on its skids On single engine crafts this time will increase with increased power settings Since the skids are your best brakes for emergency stopping, this cushion delay time is the time in seconds from retarding throttles or killing engines until the craft touches down on its skids or on the water surface

After a few test runs to get the engine and controls adjusted properly, the craft may be test flown Before starting the engines on your Hovercraft a complete check of all systems should be made Check all fastenings on the engine, mount, propeller or fan and controls See that they are all tight Remove all loose pieces of material from the immediate area Never run a vehicle in an enclosed garage The air flow may cause loose object to be drawn into the fan and the exhaust gases will reach a dangerous level in a short time The fuel systems should be checked for leaks The throttle controls should be checked for free operation For the first run, the vehicle should be tied or held in place The engine is run slowly at first, checking for any unusual vibrations or noise The RPM is slowly increased to full power If there are any unusual noises or vibrations the engine should be shut down immediately and the defect corrected Be sure to follow break-in procedures on new engines After the first run, inspect all fastenings for looseness If fasteners do come loose, they should be safely wired or cotter keyed in place A loose or missing bolt could cause the propeller to be destroyed, and in some cases bending the crankshaft on the engine Personal injury could result from the fast moving parts The engine mounting and the propeller guard or covers should be checked for security and for signs of fatigue cracks before every outing and before every engine start

The first free flight should be made on water or a clean grass field or parking lot There should be little or no wind The vehicle should be driven a few feet and then turned around 180 degrees and driven back again Be very cautious about picking up speed especially in windy conditions Sometimes leaning will help in making a turn In any case know all the characteristics of the vehicle before operating in windy weather If you get in trouble don't be afraid to set the vehicle down on its skids Normal stops should be practiced by doing 180-degree turn and holding thrust power on until the vehicle stops before shutting down the engines You will notice that steering is only effective when thrust air is flowing rapidly over the rudders More thrust means better steering

Sometimes it is difficult to turn out of a headwind By leaning m the direction of the desired turn you will cause the skirt to drag on the surface and cause drag which turns the vehicle When the vehicle is sliding sideways, it may be turned back to the forward traveling position by leaning back, causing drag at the rear and permitting the front to travel faster than the back which rotates the vehicle It requires much skill and practice to stop the rotation at the desired position There are times you may have to use this method of control even on a vehicle equipped with good rudders

Leaning the vehicle can be used to move the vehicle without the use of the propulsion engine If the propulsion engine should fail or if the operator desires to move sideways this method can be used It is important to learn this method for docking or maneuvering in confined areas In windy weather this method may not work well When docking or operating in a confined area m windy weather always operate below planing speed and approach a dock into the wind If approaches must be made down wind, the lift power on twin-engine crafts may be shut down so the vehicle operates like a boat

There is also a method of turning a vehicle in a zero turning radius on a smooth level surface By leaning forward and to the left side, the vehicle will rotate clockwise or turn right Leaning forward and to the right or backward and left will cause counter-clockwise rotation This operation works better on water than on land and better with a bag skirted, rectangular shaped Hovercraft A Hovercraft can even be backed up by leaning back The bigger the Hovercraft the more leaning it takes On an 8' wide by 16' long vehicle you may have to crawl out the cabin and up on deck to cause it to lean enough to be effective

A Hovercraft may also be spun in several 360 degree turns while stopped or while operating at speed On water, this maneuver should be tried in calm water and while traveling in the direction of the wind This will permit more turns before the vehicle looses its planing speed DO NOT exceed 25 MPH when trying these maneuvers

There are a few maneuvers which should be practiced to develop coordination The first is driving in a circle over land, first in calm weather, then m windy weather Second is to drive a straight line on a sloping surface, making 180 degree turns at the end and driving back The third maneuver is driving between obstacles in windy weather Be sure the obstacles are soft while learning The fourth is driving up and down a hill Do a 180 degree rum coming down and try stopping at a predetermined point Be careful where you land the craft The thin hull is punctured easily and a hole can go unnoticed until an engine quits over water Generally avoid landing on rocks and obstacles which are higher than your skid thickness

Your Hovercraft will travel on rivers with rapids and standing waves two to four times cushion height or obstacle clearance Be sure every component of your craft is in excellent condition before getting in the rapids Log enough time in your craft to become proficient in all other phases of operation before attempting the rapids Be cautious coming back down stream where there are sharp turns You will be using very little propulsion and as a result getting very little steering on the down stream run Always set yourself up in a good position before arriving at a turn Plan ahead all the time Running up stream is simpler If you have a problem you can generally back down and try again

Many people ask what is the roughest water you can operate on? As with any water craft the sea worthiness depends on the skill of the operator Generally you would take a Hovercraft out under the same conditions as you would an equivalent size average boat

PERFORMANCE TESTING

Performance testing is optional and should only be attempted after becoming a proficient operator. The wind speed and direction should be recorded. The engines should be run at full power and the RPM and thrust recorded. Thrust measurements are accurate only under calm wind conditions and on water.

When conditions are right check the turning ability of the craft at various speeds into and out of the wind. Check the speed capability of the craft on rough water and in severe weather running into the wind, down wind and crosswind. Test for getting maximum payload over hump speed (planning) on water. Determine maximum payload from this formula: Payload = A V (T/.05L) - W where A = cushion area in sq. ft. or length times width of the skirt contact lines, T = maximum thrust in pounds, L = cushion length in feet, and W = empty weight. Test to see if your craft can plane this payload on deep water. Check your capability to make headway in the desired direction with the propulsion system shut down and only the lift system operating by leaning the craft to make it move. Check the cushion delay time during a lift system failure and the plow in characteristics on water. Before shutting a lift engine down at speed over land be sure the skirt will not get caught under the skids. If it will this part of the test should be omitted. The gradient capability should be checked at zero forward speed. If no hills are available it may be determined by dividing the thrust by the weight and multiplying by 100 to get the percentage gradient. Rough ground operation should be checked to determine the obstacle capability. Be careful not to puncture the hull. The last item to be checked is maximum speed into the down wind. Measure a course of at least 300 ft. and time the craft with a stopwatch.

Be sure the craft and all components are in good condition. Downwind could be limited by the skirt tucking under (Plow in). In any case do not exceed the speed for which the hull was designed on water. Plow in at higher speeds can result in damage to the hull and possible injury to occupants.

HOVERCRAFT LAWS

A Hovercraft can travel over any relatively level surface, but it is generally operated over water, snow and ice. To operate on water a Hovercraft must be licensed or registered as a boat. It must comply with all coast Guard or State Boating Laws. These include the use of Life Preservers, Fuel Vents, A fire Extinguisher and Lights (For Night Use Only). A copy of the boating laws should be obtained from your state and local Coast Guard office.

Operating over ice and snow poses no problems other than being considerate of others in regard to noise.

Insurance is difficult to obtain for hovercrafts because the insurance companies are not familiar with the Hovercraft. But the Hover Club of America is working on this problem now and may have a solution by the time you read this.

Hovercrafting is a new sport and we must regulate ourselves at this time to avoid making these machines a nuisance to other people. If we don't regulate ourselves now someone else who knows nothing about hovercrafts will regulate us out of existence. Always keep noise and spray to a minimum when in the presence of other people. For your own safety carry a 2 way radio or notify someone if you are going to remote places. Have a second craft go along in case one has a problem. Hovercrafts can get to places where rescue may not be possible. Plan ahead! Think ahead! Don't take chances with your life!

SAFETY REQUIREMENTS AND RECOMMENDATIONS FOR RECREATIONAL HOVERCRAFTS

Purpose:

1. To ensure that recreational Hovercrafts are designed, constructed, maintained and operated in a safe manner.
2. To minimize any possibility of accidents or effects of such accidents on operators, crew, or bystanders.
3. To minimize any changes needed to comply with the laws of the Hoverclub of America for races and rally.

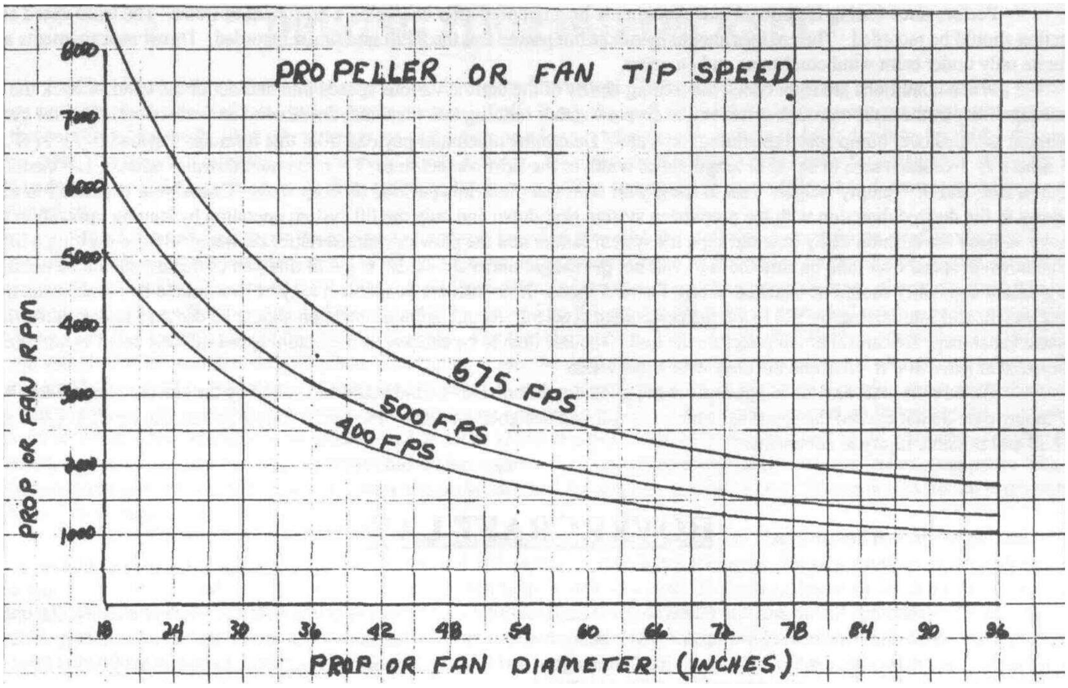
Compliance:

1. Any craft taking part in any event sanctioned by the Hoverclub of America inc., must comply with all the latest rules of the Hoverclub of America. A copy of the Hoverclub of America's safety and competition rules should be purchased ($5), The requirements here are for the Hovercraft builder only and although nearly the same in part are not the complete rules of the Hoverclub of America.
2. At Hoverclub races and rallies by technical inspectors who will determine compliance by calculations, judgment, and experience and good engineering practices.

Hovercraft not in full compliance may be allowed to operate (not race) for the purpose of demonstration at a rally.

Design:

1. All rotating assemblies should be designed to prevent failure over the entire life of the components and machine. Design for stresses imposed at 50% above maximum RPMs.



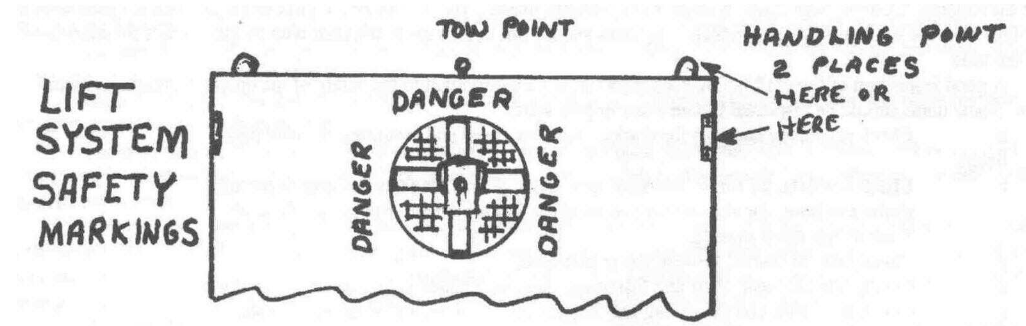
2. The maximum tip speed of a propeller should not exceed 675 FPS and lift fans should not exceed 500 FPS. Multiwing fens should not exceed 400 FPS. Lower fan-prop speed lowers noise to a greater extent.
3. Materials for fans and propellers should be carefully selected. Wood blades should be laminated (2 or more laminations - The more laminations the better) and continuous through the hub. Blade cross sectional area should increase from tip to root. Wood used for prop and fans should have a straight grain running length wise.
4. Props and fans must be replaced before they reliable to fail due to fatigue, erosion, rot or cracking.
5. Positive locking devices (cotter pins, safety wire, etc.) should be used on engine mounting bolts, air filters, exhaust systems, props and fans, or where ever loose parts could fall into the fan or propeller. Mount structures should be of the fail safe type (if any part breaks or comes loose the remaining parts will take the maximum load without failing. In the case of rubber vibration isolator mounts extra mounts may have to be used to meet this requirement (Note: All critical parts must be inspected before every run. Otherwise it is of no use to have fail-safe parts if you don't find the broken part before another part fails.)
6. Engine exhaust gases should not enter skirt or cushion area. (Build up of unburned gases when engine starting is difficult can cause explosion)
7. Exhaust piping must not be closer than 2 inches from flammable parts (wood, fiberglass, etc.). Hot parts must be shielded from contact by people or equipment during normal and emergency craft operations.
8. Fuel systems should comply with U. S. Coast Guard standards. Tanks should be chosen, mounted or located to prevent spillage during operation and in event of a crash. Fuel lines should be located far away from hot parts. The driver should be able to cut off fuel feed to the engines.
9. Electrical systems should comply with U. S. Coast Guard standards. Kill switches should be installed to quickly kill engines and stop the craft in an emergency. On racing crafts the throttle must return to idle when released. A deadman ignition switch which shuts down the thrust engine if the pilot is thrown out must be used.
10. Craft must float off cushion with 150% of max. payload. Craft must float with a punctured hull and full payload. Additional widely spaced flotation should be used in cold weather to keep all occupants completely dry.
11. Safety glass or transparent plastic (plexiglass-Iexan, etc.) shall be used for glazing. Do not use standard window glass.
12. All crafts shall have clearly obvious and adequate handling points on front, sides and aft which may be used to pull it from water, to tow craft or for general handling.
13. Provisions must be made for restarting engines when on water.
14. Adequate all around vision shall be provided from the drivers seat either directly or by use of mirrors.
15. Noise level should be as low as possible inside and out and should not exceed 87 DBA for racing and 80 DBA for cruising, (measured 50 ft. from craft) Damage to hearing can result from exposure to loud noise. Some primary sources of noise on Hovercraft which should be considered during design are:
    - A. high tip speed on fans and props.
    - B. High horsepower on small fans and props.
    - C. Obstructed Air flow to fans-props.
    - D. Lack of vibration isolator mounts on machinery (Engines, mounts, bearings, gear boxes, etc.)
    - E. Poor or no exhaust silencers.
    - F. High revving engines especially air cooled engines.
    - G. Lack of intake silencers.

H. Lack of sound absorptive materials at critical places.
16. A fire extinguisher of at least 2 Ib. capacity should be carried.
17. Electrical components in the ignition system (coil, distributor, etc.) should be protected from water spray (wrap in plastic or rubber) especially for salt water operation.

Structure:
1. The hull of the craft must have strength enough to withstand plowing into the water at maximum speed and at any angle.
2. It must be capable of being towed at reasonable speed on water.
3. The hull must also be capable of floating on rough water without taking on water from waves splashing over sides, front or back.
4. Positive flotation in the form of styrofoam, urethane foam or flotation air bags (inner tubes or empty plastic milk jugs) should be used on all crafts especially when traveling over cold water. In this case, positive flotation should be capable of supporting gross weight (craft & passengers) plus 50%.
5. The lower edge of the hull should be angled to provide a planning surface in event of skirt collapse at speed over land or water.
6. Craft components shall be positioned so that if they break loose they are unlikely to cause injury to the occupants or else they must be capable of withstanding a 6 G deceleration.
7. The interior should be free of shaper edges.
8. The cabin should be strong enough to protect passengers if craft should overturn.

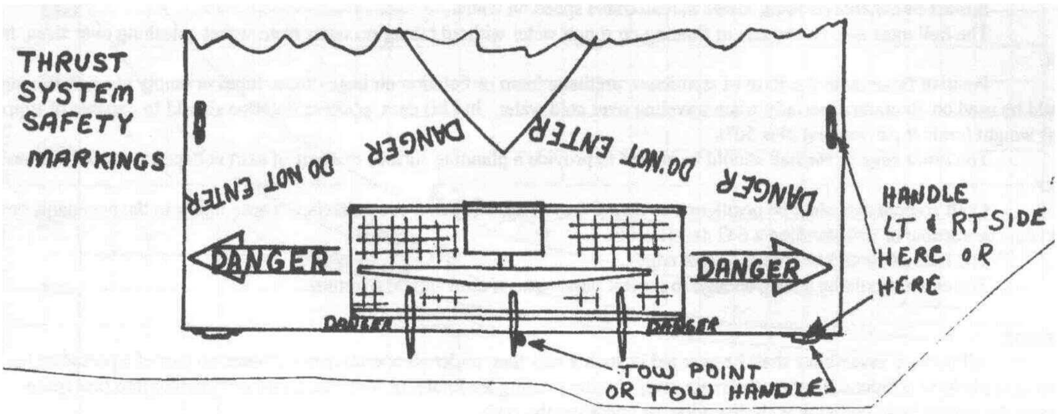
Guarding:
1. All rotating assemblies shall be guarded in such a way that, under all operating conditions, no part of a person or his clothing is likely to accidentally enter the space swept by the rotating assembly, or force the guard or structure into that space, whether the person be in collision with, handling, or operating the craft.
2. Prop and fan perimeter (tip) guard should enclose the entire sweep volume on 54 inches and less diameters at least 5 inches in front and behind the rotor and have no openings larger than 1/4 x 1/4 inches if within 1 inch of blade tips; 1/2 x 1/2 inches if within 1-6 inches of tips and 2 x 2 1/2 if beyond 6 inches. For large (over 54" dia.) cruising props, guards must go to 72 inches high when on cushion.
3. Inlets to lift fans and thrust systems must have no openings larger than 1/4 x 1/4 inches if within 1 inch of rotor or 1/2 x 1/2 if within 1-6 inches of rotor or 2 x 2 1/2 if within 30 inches of rotor of 12 x 12 if beyond 30 inches.

4. Outlet guards must have no openings wider than 1/4 inch if within 1 inch of rotor back; 1/2 inch for 1-6 inches. Two inches wide for 6 to 12 inches of rotor back and 14 inches if beyond 12 inches from rotor. Outlet guards not required on lift systems.
NOTE: An appropriate rudder or rudder and trim wing arrangement can meet this requirement for the outlet guard. On 48 inches through 54 inches diameter props and fans a trim wing within 14 inches of the top of the duct and 3 rudders spaced 12 inches on 48 inches ducts or guards and 14 inches for 54 inch props can meet these requirements.
5. The guard or structure must not deflect into the swept volume of the rotating device when a force of 100 Ibs. is applied over an area 3.5 sq. ins. at any critical area of the guard. This is to guard against the case of a person falling onto the guard and taking the impact load on one hand.
6. Consideration must be given in the design of the guard to provide for containment of the pieces, should the blade fail. Heavy blades running at high RPMs will require considerably stronger guard material than would be indicated by the test. Lift fans should be guarded to prevent broken blades from entering cabin area. Usually 1/32 in. steel or 1/16 in. aluminum or 1/4 in. plywood extending halfway around duct 3 ins. above and 3 ins. below the plane of rotation of the fan is adequate for most slow turning fans (3600 RPMs & Less).



NOTE: To meet these requirements some additions will have to be made to the minimum guards shown in most Hovercraft plans.
7. The most important aspect of safety around fans and propellers and Hovercraft in general is the attitude of persons, driver, crew, and others in areas where machines are running. All persons should be advised that if nuts, bolts, and other parts should come loose they can be thrown out at the speed of a bullet, generally in the plane of rotation of props and fans. Persons should be advised of

the unusual characteristics of the craft especially in turning and stopping. The craft operator should not use full power when near spectators or when spectators are in the plane of rotation of propellers and closer than 200 ft Operators should stop and shut down craft well in advance of spectators. The markings shown here should be used on all hovercrafts.



Safety:

1. Crash helmets must be worn during races.
2. Life preservers must be worn over water operation during races and should be worn during any water operation.
3. Sensible dress should be worn by crew and occupants. No long scarves or loose clothing, hats, etc. No heavy boots which are hard to remove for overwater operation.
4. A tow rope and good paddle should be carried.
5. Any craft which experiences excessive vibration must be shut down immediately
6. The use of the handling points and the danger signs shown in section on guarding will result in fewer accidents.
7. Strong winds have many adverse effects on hovercrafts. Generally running into the wind improves control, but running in all other directions is more difficult. Down wind running results in some loss of steering control At low speed a strong tail wind can result in a complete loss of steering. Downwind running also tends to cause plowing over water. Running in windy conditions should be done by experienced operators and then only with caution.
8. Driving a Hovercraft in the winter can present many unforeseen hazards for the inexperienced drivers. When snow, ice, and water are drawn into the carburetor (even through the filter) the carburetor will ice up on the inside and prevent fuel flow causing loss of power and then stopping the engine. This ice may melt after about S minutes from engine heat rising into the carburetor and permitting restarting of the engine. Carburetor ice can be minimized by drawing dry air from inside the hull (keep the air filter in the system). Proper driving technique to minimize snow and water spray will be very helpful. A carburetor heat system can be made by heating air on the exhaust manifold before it enters the carburetor.
9. Hovercrafts do run very well on rapids. The size of standing waves which can be negotiated depend on many factors and should be determined gradually by your own experience. Start with small waves and work up to larger ones. Don't take changes on drowning the engine with water. Only machines in excellent mechanical condition should be run on rapids. A failed engine or other component could result in destruction of the craft and personal injury. Control going up the rapids is very good due to the thrust air flow over the rudders. Coming back down is much more difficult because the fast water current carries the craft at speed with little thrust air flow over the rudders. Only experienced operators should run in the rapids and then with proper respect for conditions. Plan ahead all the time.
10. A good inspection of the craft before each days run is very important to the safety of the operator, passengers and spectators. Some items should be inspected before every engine start.
    a. Check propellers and fans for cracks, chips, rot, wear and mounting security (tight bolts).
    b. Check mufflers, air filters, bearings, gear units, guards, engines and engine mounts, shafts and hubs, for signs of fatigue cracking and looseness. Repair, Replace or Tighten any items in need.
    C. Check hull for cracks, broken ribs or punctures.
    d. Check skirt for wear, tears and fastening, especially inside across back on bag skirts.
    e. Check fuel lines, electric wiring and kill switches, throttle and steering controls.
    f. Check fan and propeller tip clearances.

NOTE: All the above items should be checked before each days running. Items A & B should be checked before each engine start.

11. Most regulations found above concern the machine. But the most important aspect of safety is the Human aspect, the person; whether driver, crew or spectator. Just because you might be a driver doesn't mean its O.K. for you to stand in the plane of rotation of your own or someone else's propeller. Develop a safety conscious attitude and help others to do the same.

The biggest safety hazards for recreational vehicles in general are

a Driving too fast for conditions (Best way to reduce turn rate and stopping distance is to simply reduce speed)

b Driving unfamiliar areas without caution

c Mechanical failure

NOTE Most serious injuries involve the head and neck

HOVERCRAFTS CODE OF ETHICS

1 Be a good sportsman People judge all Hovercraft owners by your actions Use your influence with other hovercrafters to promote sportsman like conduct

2 Do not litter or pollute lakes, rivers or camping areas

3 Do not damage living trees, shrubs, or other natural features

4 Respect other peoples rights and property Make as little noise as possible when near homes or close to other people Turn lift and thrust systems down or off when approaching or departing others

5 Do not interfere or harass fishermen, boaters or wildlife Avoid areas posted for protection or feeding of wildlife

6 Obey all federal, state and local laws and when possible make your vehicle available to assist search and rescue parties

Abiding by this code will insure that our sport will not be legislated out of existence by people who know little or nothing about hovercrafting

IMPROVING HOVERCRAFT PERFORMANCE

Good performance in a Hovercraft is the result of many factors being correct It is difficult to say which items are most important because there are several items where, if anything is wrong, the craft will perform poorly

The first and maybe the most important, is the skirt It is absolutely essential that the skirt is adjusted so the apparent contact line is (where skirt would first touch the ground) is even (at the same height all around) The best way to check this adjustment is in 2 to 3 feet of water, just in case the lift engine quits

Put a normal load in the craft and run the lift at 1/2 power or more Have someone hold the front down, so the craft is hovering level with air escaping on both sides at front, and in the rear Then duck under one side of the craft, avoid coming up under the lift fan' It would be helpful to have a diving mask to keep spray out of your eyes You will be able to see every high and low part of the skirt easily now

The skirt must be adjusted so the air gap is the same everywhere Mark the high and the low areas, adjust the skirt, recheck and readjust until the skirt is correct Notice how small a proper air gap is - probably 1/4 to 1/2 inches So, if one place has a 1 inch gap, some other place may have no air gap and be dragging on the surface causing skirt wear and reducing speed

While you are under there, see where the lift air is hitting the water and digging a hole and wasting energy More on this later

Often a skirt needs more adjustment than just taking up or letting out material You may need to take down a whole side on the inside of a bag skirt to adjust out a long wrinkle To get the skirt in the correct place, it may be necessary to shortcut a corner (to get the extra material needed) Adjust the skirt so there are no wrinkles as you are attaching it to the inner tack strip If there is extra material, distribute it equally along the tack strip There will always be extra material on the inside of a curve

A good aid to installing the skirt correctly the first tune is to put chalk lines perpendicular (at 90 degrees) to the outer edge and spaced about 2 feet apart These lines go all the way across the skirt Then put corresponding lines under the hull perpendicular to the outer tack strip and extending from the outer across the inner tack strip Fasten to the outer tack strip first and then fasten the inner skirt, so the lines on the skirt and hull match This method should result m the need for little or no adjustment

Be sure skirt corners are glued, sewn and glued over the thread Gluing or sewing alone will not last long A think coat of urethane glue worked into the thread is best

Dram holes should be 2-4 inches behind the contact line and "T" shaped to proved fast drainage when the skirt has a lot of water in it without scooping in more water

The next area to check out is weight and balance Heavy craft push more water into the hump so they use a lot more thrust to crawl over it They have a lot less thrust left for acceleration This problem is compounded on a tail-heavy (or otherwise out-of-tnm) craft by causing more skirt draft aft

Acceleration -- not top speed - is the most important performance parameter in a Hovercraft especially on a racing craft Acceleration is proportional to thrust minus drag divided by total weight So you want maximum thrust, minimum drag and minimum weight Notice that the weight enters this formula twice The second time as the largest factor in planning drag because planning drag is (total weight divided by cushion area) squared times a constant times the cushion length

Planning Drag = (W/Ac) squared x C x L, or approximately 04 x (pc) squared X L, where pc = cushion pressure = W/Ac

So, Accel = (Thrust-Total Drag)/Total Weight, where total drag is planning drag plus skirt drag plus air drag (plus water spray drag, which is small at low speeds and will be omitted here) Air drag and skirt drag become very important above 40 MPH

Most items on a Hovercraft are aft, so craft that are overweight are usually also tail heavy Rudders, trim wings and guards and ducts and reduction drives are usually the overweight items Rudder and trim wings should be made from styrofoam and very light fiberglass cloth with a minimum of resin (just enough to wet out the fiberglass) A strong 18 inches x 48 inch rudder can weigh as little as 1 1/2 pounds complete Guards should be made from conduit not pipe Thrust ducts should be primarily made from foam and light fiberglass A very light weight reduction drive can be made using wood and epoxy for the large sheave and aluminum for the engine sheave

The next item to look at is the lift system. The most important item in the lift system is the tip clearance, the gap between the fan tip and the lift duct wall. A clearance of 1/8 inches or less is desirable. Reduce the clearance by gluing a piece of 1/8 inch plywood x 3 inch wide to the duct wall as needed. Use several pieces to fill up larger clearances.

A large smooth inlet radius is desirable especially at the front of the duct. Minimize any obstructions in the duct. Keep items above the engine instead of inside the duct. Larger diameter ducts are more efficient and leave more room for the lift engine and the air flow. Keep the leading edge of the lift fan blades in good condition with a small round leading edge radius.

The lift system's efficiency can also be improved by sloping the lift duct back and raising the floor behind the lift duct to allow smooth easy air flow into the plenum. This avoids slamming the air straight down into the surface.

Each of the above items make the lift system more efficient thereby providing more air flow and more air gap under the skirt. This reduces the possibility of skirt drag and wear (even on a skirt that may not be perfectly adjusted). No skirt is perfectly adjusted unless GOD did it!

The last item is the thrust system. More thrust always means more acceleration and speed.

Since most thrust systems require a reduction drive to match the (slower) prop to the (faster) engine, choosing the correct drive ratio is important on all engines. But it is extremely critical on 2-cycle engines especially liquid cooled 2 cycles. So drive ratios must be selected to get the engine up to its peak torque range which is 5500-7000 RPMs for most two cycle engines.

Two cycle engines are very fussy about what is at their inlet and exhaust ends. If you are not an expert on 2 cycle engines always use the stock factory exhaust and muffler and the stock intake box with a filter on or outside the box. Failure to do so could result in burned pistons or very poor power output.

With the engine in stock trim if you don't get full power and speed you can increase the drive ratio until the engine comes to within 500 RPMs of redline speed at full power while standing still. This way when the craft is running at high speed the engine will reach redline.

On some high performance liquid-cooled two cycle engines, you may have to raise the drive ratio higher so the engine does not struggle up to its peak torque RPMs range, the engine may go a little beyond redline at full throttle. You might also consider a clutch that engages at a relatively high RPM on this type of engine.

The shape of the propeller leading edge is very important in achieving maximum thrust. Keep a small smooth leading edge radius especially out near the tip. Keep the blade surfaces smooth also. The same things apply to lift fans and even to the rudders.

DRIVING TECHNIQUES TO IMPROVE PERFORMANCE

Achieving correct lateral (side to side) and Longitudinal trim (forward and aft balance) is necessary to reach maximum speed in a Hovercraft assuming all the above items are correct. Trim the craft by moving weight forward until the skirt just starts tucking under. You will feel the extra drag when this happens. Now move weight slightly aft. Do this with the trim wing level leaving some ability to retrim nose up or down to meet changing conditions of wind and waves or passenger movement.

Adjust lateral trim by moving people or fuel tanks or battery until the best speed is achieved at that power setting. Notice that in a cross wind more weight is needed on the side the wind is coming from. Also when running a tail wind craft will have to be trimmed more tail heavy and running into the wind will permit moving more weight forward to achieve the best speed.

Longitudinal trim will change with a change in power setting. Trim should be rechecked by moving weight forward until the skirt starts tucking and then slightly aft. Experience will help you in loading your passengers correctly and setting the movable seats for best trim. In windy conditions you may have to ask passengers to help slide seats forward or aft or to slide to one side or the other for correct trim. But on a very short trip you may elect to work with an out of trim craft and operate at lower speeds. Correct trim also reduces water spray. This is very important on salt water where salt spray can cause engines to quit and rust exhaust systems quickly.

SUGGESTIONS FOR WINTER OPERATIONS

Operators and passengers should be dressed to match conditions. A snowmobile suit is usually best as it is light and comfortable and should have a tight-fitting collar to prevent snow and wind getting to your body. Standard snowmobile boots are very warm. A warm hat or helmet is also recommended.

EQUIPMENT

A paddle and about 50 ft. of rope could be more useful in the winter than in the summer if you have engine problems. The paddle could be used to break ice in front of the craft if the lift system failed or to move the craft up on the ice if the thrust system failed. It can also test ice before you step on it.

Matches are useful if you become stranded and need to keep warm. You can also start a fire by dipping a stick in gas and shorting a battery near the stick to spark and light the fire. A CB radio or cellular phone would be best for winter emergency communication.

CRAFT CONDITION

When operating over thin ice and water or in desolate areas your craft should be in perfect operating condition. Ignition systems should be protected from ice, snow and water Carburetors should have filters in place and should draw dry air from inside the craft especially on 4-cycle engines to reduce the risk of carb icing at a critical time. The carb heating system found on most auto engines should be used, air is drawn over the exhaust manifold before going into the carb making it warm enough to prevent ice from forming in the carb throat. Carb ice may melt in about S minutes if the engine is shut down and heat allowed to rise from the engine to the carb.

Most important in prevent icing is the ability of the operator to control lift power and reduce snow and water spray.

Inspect all hardware on the craft before starting engines to go where you can't get back without the Hovercraft. Cracked mounts, guards and loose bolts could destroy the prop or fan at a critical time.

Run at reduced power to increase reliability. Remove all loose ice around engines and mounts before starting. Also, remove all snow and ice from the hull. This could change trim and add weight to the craft.

Plenty of positive flotation is very important for winter operation.

OPERATION

When going from ice to water slow down to 20 MPH or less because you don't know the condition of the skirt. A large tear could go unnoticed on ice but could stop the craft rapidly on water and increase the damage to a point where it may be difficult to get back up on the ice.

When coming back up on the ice it is safest to approach the ice at 15 MPH. If you have a lift engine failure at this time you decrease the chance of damage to the craft at this low speed but you stay over planning speed to avoid spray.

Always plan way ahead so you don't have to do a 180 degree turn on water or on thin ice. Thin ice (1/4 to 1") may be broken by the craft at low speeds and thrown up against the hull causing damage to the hull or skirt. If you must operate slowly on thin ice then operate at 1-3 MPH to minimize damage. If an engine quits on thin ice it will be very difficult to make headway by paddling through the thin ice. A small 2 way radio should be carried to call for help. A Hovercraft can carry you to remote places inaccessible to most rescue vehicles. These things should be considered before setting out on such an adventure.

On rough ice operated very slowly to minimize damage to skirt and hull. Put a flap over the drain holes in the skirt to prevent rough ice from entering and tearing the skirt. It is best to avoid rough ice whenever possible.

A Hovercraft will operate in deeper snow than a snowmobile. For best results power up the thrust first then just a little lift until you reach 10 MPH. This way you prevent digging a hole in the snow and making visibility impossible. Driving in heavy wet snow or snow that has been on the ground for a long time does not cause any of these problems. But wet snow as well as wet ice (with temperatures over 32 degrees f, 0 degrees c) will cause a thin water film to develop between the skirt and the surface resulting in an increase in drag. On wet ice this drag is more than on water and can result in plowing the skirt under the craft just as on water. So on wet ice increase lift and/or reduce speed in a turn especially at high side slip angles.

On dry ice a craft can go faster than on water. Craft with over 50 HP, 2-cycle engines can easily go fast enough to lift off especially in a turn and roll while airborne. Keep the craft straight at high speeds and limit side slip angles at moderate speeds.

Be sure steering system will not fail at high speeds. 60 MPH can easily cause liftoff and roll over in a turn. 70 MPH could lift the craft off the surface while running straight ahead. If the nose of your craft starts lifting trim more weight forward or use the trim wing to trim nose down and very slowly reduce thrust. If thrust is cut off too quickly the loss of nose-down pitching movement (from thrust) may permit the nose to go even higher and blow completely over the top. To reduce speed from a high speed run trim nose down and slowly reduce thrust. Then when speed is under 50 mph you may start a little side-to-side swing. At 40 mph you may turn up to 90 degrees to increase drag and reduce speed. In an emergency you may cut lift power and slide to a stop although on smooth ice this may take much longer than other methods. Below 40 mph you may turn 180 degrees and apply full thrust to stop but be sure your rudders and guards are firm and in good condition as this puts high loads on them.

What tools will you need ?

All craft need:

3/8" Drill, Jig saw, Hammer, Screw driver set, Wrench set, Scissors, Utility knife, Chalk, Sanding pad, Drill bit set, Spade bits, Vice grips, Hand saw, Hack saw, Access to Table saw, Glue brushes.

***16T, ITT*, 19P, 18SP, 16S, 14S, 20C, 26S need additional tools:**

Pipe bender, Calking gun, Welder, Metal file

Optional (to speed things up):

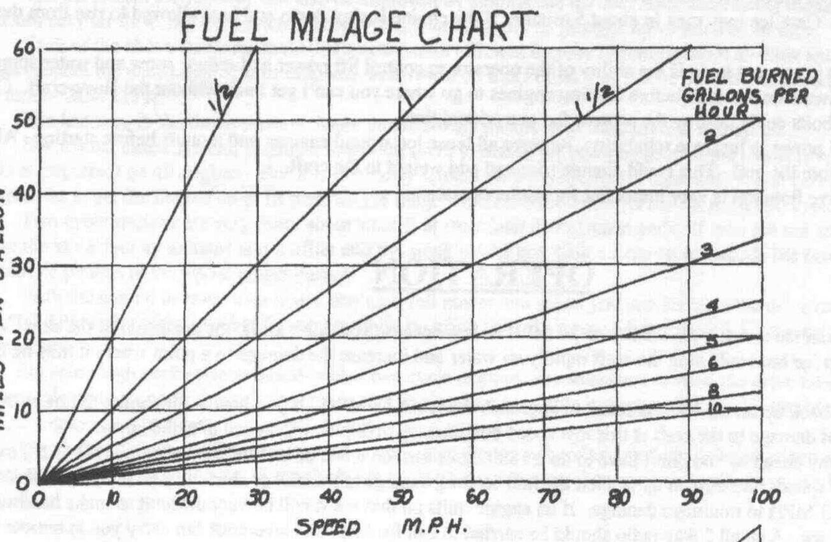
Orbital sander, Cordless drill, Socket set, Grinder, Band saw, Table saw or Radial arm saw, Hot wire & voltage regulator, Sure form file, Pneumatic stapler, 4 -7 inch grinder

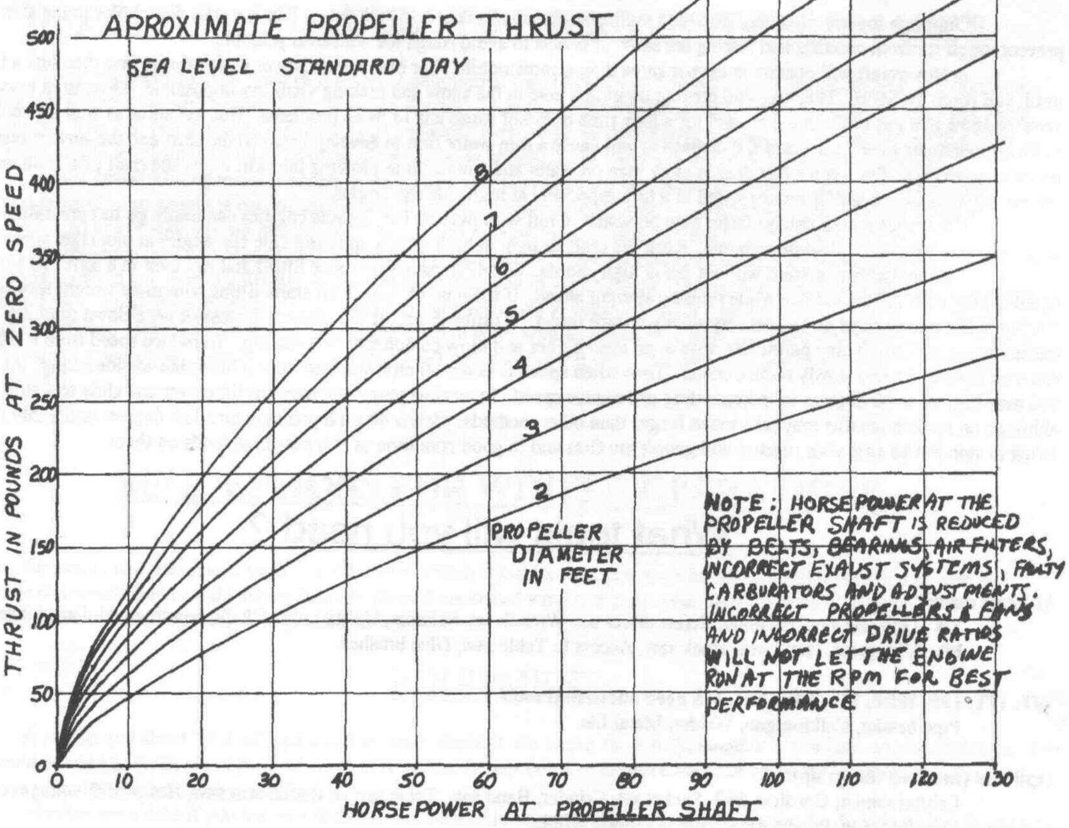
6F, 10F, 13P, 12R:

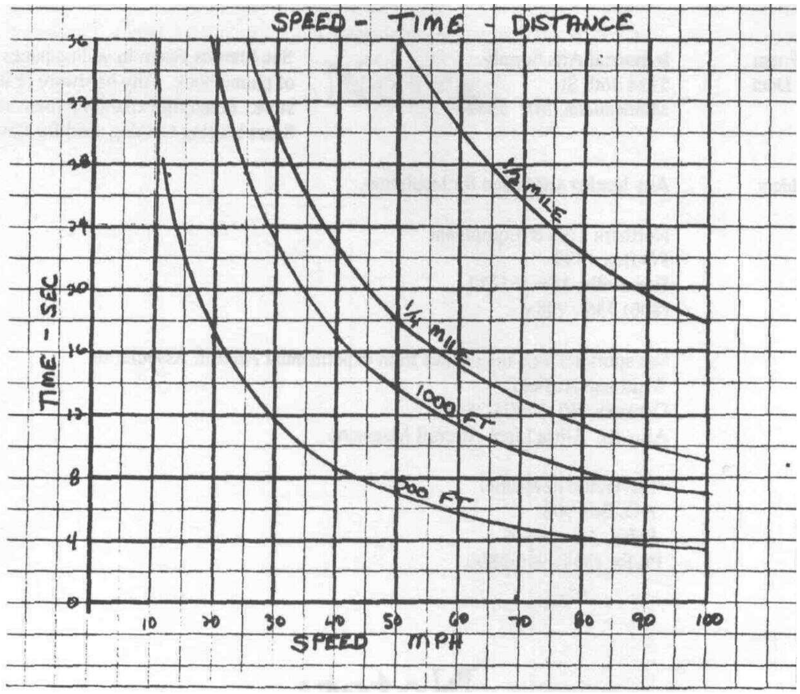
Require no welding or pipe bender, Minimal tools required

10F, 13P, 16S, 18SP

Use vacuum bagging to laminate wood & foam Materials include 3 - 5 mil plastic tarpon, Packaging tape, 1 - 3 inch diameter plastic tube, Shop vacuum or vacuum pump, Blankets (old household), See "Foam Hull Construction"







SUPPLY SOURCES

NOTE: Sources are current as of this printing (2000)

Props & Fans Alum (rough cut). Hubs
Sheaves, Skirt material,
Rubber mounts

Universal Hovercraft - Cordova
P.O. Box 281
Cordova, Il. 61242
(309) 654 - 2588

Finished props, Fans, Full Kits, Engines, Epoxy
Fiberglass, Plywood, Foam, Hardware, Skirt Material
Bearings, Shafting, Belts

Universal Hovercraft - Woodstock
1236 Blakely Street
Woodstock, IL 60098
(815)338-8832

Books

Janes Surface Skimmers
and other books on
Hovercraft at large
Libraries

Zenith Aviation Books
Box l
Osceola, WI 54020
1-800-826-6600

Snowmobile
Engines

Central Snowmobile Salvage
Box 13188
Greenbay WI 54307
1-800-558-6778

Gear Boxes

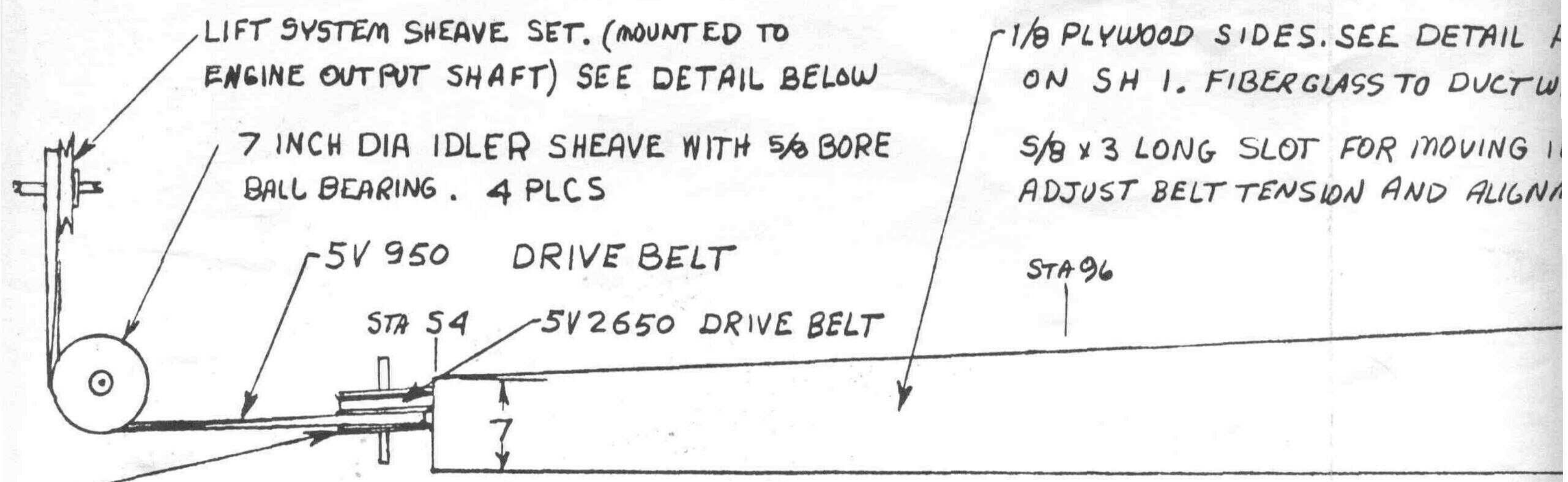
Von Ruden Mfg. Co.
Box 507
Owatonna, MN 55060

Auto Lift System
Components

Salisbury Co.
1010 E. 62nd St.
Los Angeles, CA 90001

Two Part Mixing Foam 2 Ib/cu ft for Lift Duct	Industrial Arts Supply 5724 36th St Minneapolis, MN 55416	See Piastres-Foam in yellow pages of phone book Any hardware or dept store Foam fill expanding foam sealant Sears boating Catalog used for flotation
Styrofoam for Rudders	Any lumber yard used for insulation	
Trailer Parts	Northern Tool & Equipment PO Box 1499 Burnsville, MN 55337 (800) 556 - 7885	
Misc Information	See sport aviation magazines from experimental Aircraft Association Whittman Airfield Oshkosh, WI 54903-2591 Also see Ultra Light Aircraft Magazine Hoverclub newsletter PO Box 908 Foley. AL 36536 Ph/Fx (334)-946-3800	

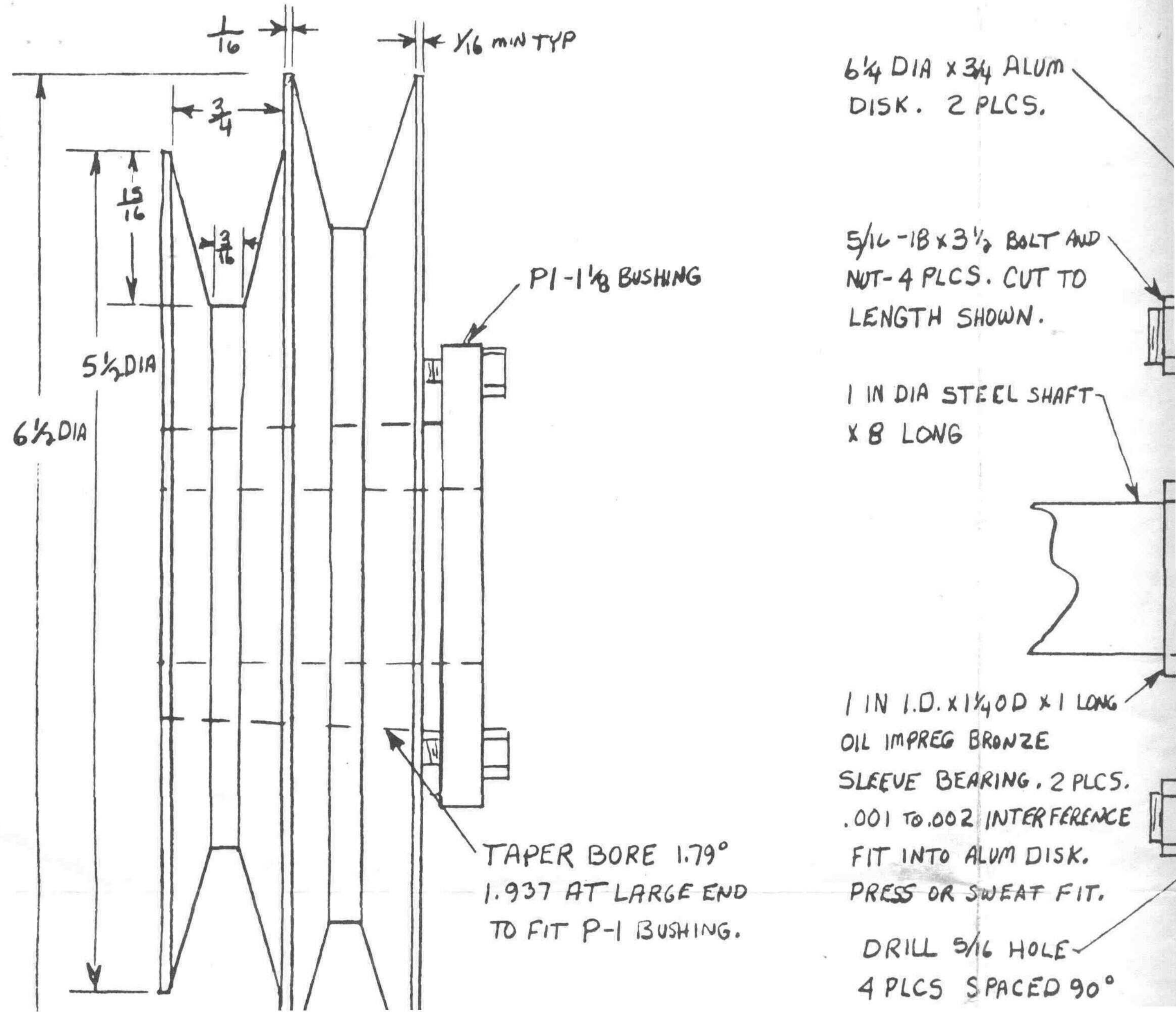
Notes:

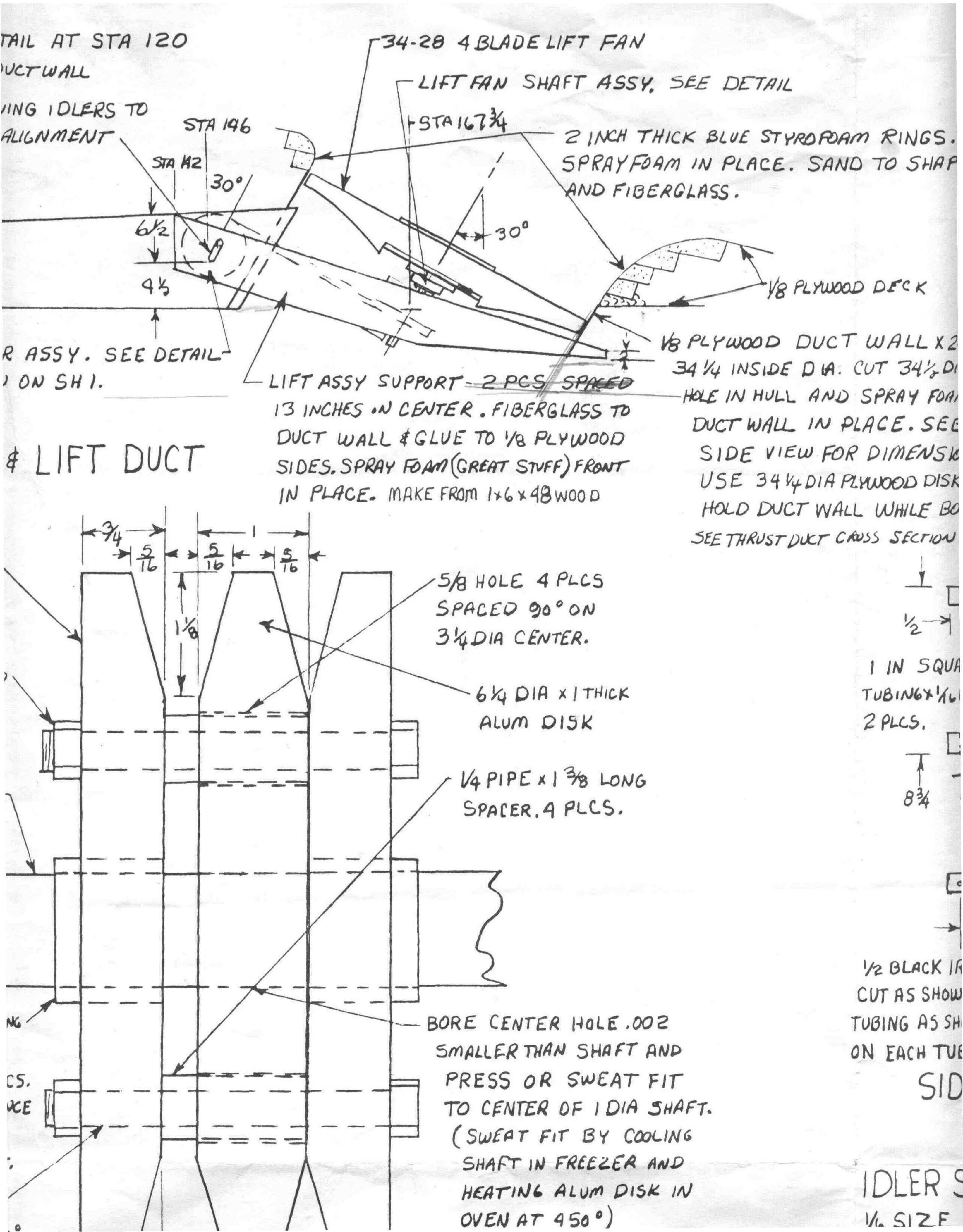


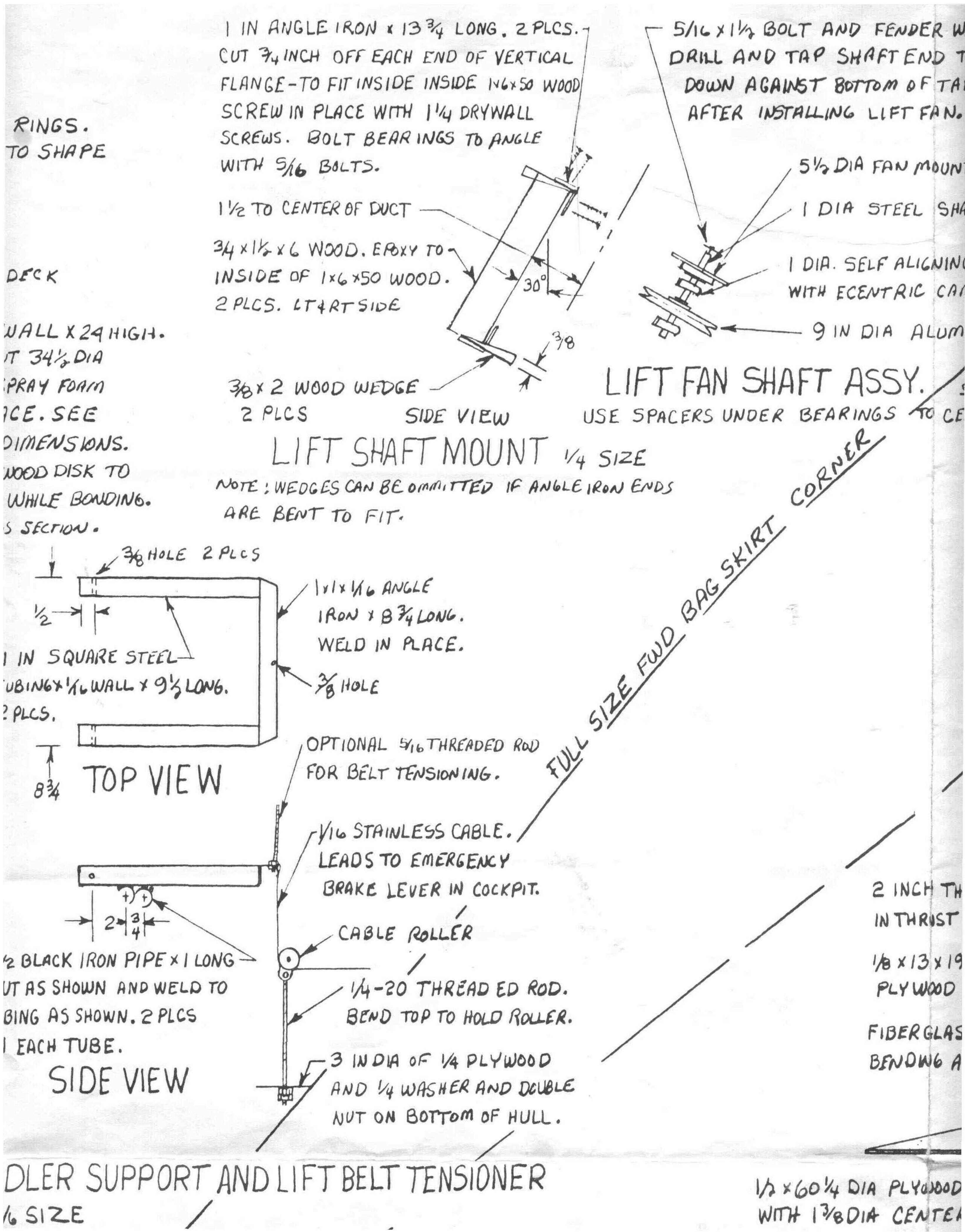
OPTIONAL VARIATOR - TO CHANGE LIFT FAN SPEED RATIO. SEE DETAIL BELOW.
IF NOT USING A VARIATOR USE A 5V 3350 BELT AND MOVE LIFT
SYSTEM SHEAVE SET FWD 1½ INCHES ON SHAFT. ALSO MOVE IDLERS
IDLER MOUNT FWD 1½ INCHES. WHOLE ENGINE MAY BE MOVED FWD
OR AFT TO ADJUST LIFT BELT.

FWD IDLER ASS
IN TOP VIEW ON

LIFT SYSTEM DRIVE ASSY. & LI




TAIL AT STA 120
UCT WALL
VING IDLERS TO
ALIGNMENT
STA 146
STA 142
30°
6½
4½
34-28 4 BLADE LIFT FAN
LIFT FAN SHAFT ASSY. SEE DETAIL
STA 167¾
2 INCH THICK BLUE STYROFOAM RINGS. SPRAYFOAM IN PLACE. SAND TO SHAP
AND FIBERGLASS.
30°
1/8 PLYWOOD DECK
R ASSY. SEE DETAIL
ON SH 1.
LIFT ASSY SUPPORT 2 PCS SPACED 13 INCHES ON CENTER. FIBERGLASS TO DUCT WALL & GLUE TO 1/8 PLYWOOD SIDES. SPRAY FOAM (GREAT STUFF) FRONT IN PLACE. MAKE FROM 1x6x48 WOOD
1/8 PLYWOOD DUCT WALL x 2
34¼ INSIDE DIA. CUT 34½ DI
HOLE IN HULL AND SPRAY FOA
DUCT WALL IN PLACE. SEE
SIDE VIEW FOR DIMENSI
USE 34¼ DIA PLYWOOD DISK
HOLD DUCT WALL WHILE BO
SEE THRUST DUCT CROSS SECTION
& LIFT DUCT
¾
1
5/16
5/16
5/16
1⅛
5/8 HOLE 4 PLCS SPACED 90° ON 3¼ DIA CENTER.
6¼ DIA x 1 THICK ALUM DISK
¼ PIPE x 1⅜ LONG SPACER. 4 PLCS.
BORE CENTER HOLE .002 SMALLER THAN SHAFT AND PRESS OR SWEAT FIT TO CENTER OF 1 DIA SHAFT. (SWEAT FIT BY COOLING SHAFT IN FREEZER AND HEATING ALUM DISK IN OVEN AT 450°)
NG
CS.
CE
½
1 IN SQUA
TUBING x 1/16
2 PLCS.
8¾
½ BLACK IR
CUT AS SHOW
TUBING AS SH
ON EACH TUB
SID
IDLER S
1/1 SIZE


RINGS.
TO SHAPE
DECK
WALL X 24 HIGH.
T 34½ DIA
SPRAY FOAM
ACE. SEE
DIMENSIONS.
WOOD DISK TO
WHILE BONDING.
S SECTION.
1 IN ANGLE IRON x 13¾ LONG. 2 PLCS.
CUT ¾ INCH OFF EACH END OF VERTICAL
FLANGE-TO FIT INSIDE INSIDE 1x6x50 WOOD
SCREW IN PLACE WITH 1¼ DRYWALL
SCREWS. BOLT BEARINGS TO ANGLE
WITH 5/16 BOLTS.
1½ TO CENTER OF DUCT
¾ x 1½ x 6 WOOD. EPOXY TO
INSIDE OF 1x6x50 WOOD.
2 PLCS. LT & RT SIDE
30°
3/8
3/8 x 2 WOOD WEDGE
2 PLCS
SIDE VIEW
LIFT SHAFT MOUNT ¼ SIZE
NOTE: WEDGES CAN BE OMMITTED IF ANGLE IRON ENDS
ARE BENT TO FIT.
5/16 x 1½ BOLT AND FENDER W
DRILL AND TAP SHAFT END T
DOWN AGAINST BOTTOM OF TA
AFTER INSTALLING LIFT FAN.
5½ DIA FAN MOUN
1 DIA STEEL SHA
1 DIA. SELF ALIGNIN
WITH ECENTRIC CA
9 IN DIA ALUM
LIFT FAN SHAFT ASSY.
USE SPACERS UNDER BEARINGS TO CE
FULL SIZE FWD BAG SKIRT CORNER
3/8 HOLE 2 PLCS
½
1x1x1/16 ANGLE
IRON x 8¾ LONG.
WELD IN PLACE.
1 IN SQUARE STEEL
TUBING x 1/16 WALL x 9½ LONG.
2 PLCS.
3/8 HOLE
8¾
TOP VIEW
OPTIONAL 5/16 THREADED ROD
FOR BELT TENSIONING.
1/16 STAINLESS CABLE.
LEADS TO EMERGENCY
BRAKE LEVER IN COCKPIT.
2
¾
CABLE ROLLER
½ BLACK IRON PIPE x 1 LONG
CUT AS SHOWN AND WELD TO
TUBING AS SHOWN. 2 PLCS
1 EACH TUBE.
SIDE VIEW
¼-20 THREAD ED ROD.
BEND TOP TO HOLD ROLLER.
3 IN DIA OF ¼ PLYWOOD
AND ¼ WASHER AND DOUBLE
NUT ON BOTTOM OF HULL.
DLER SUPPORT AND LIFT BELT TENSIONER
½ SIZE
2 INCH TH
IN THRUST
1/8 x 13 x 19
PLYWOOD
FIBERGLAS
BENDING A
½ x 60¼ DIA PLYWOOD
WITH 1⅜ DIA CENTER

IND FENDER WASHER (OVER 1¼ DIA)-SAFETY BOLT
SHAFT END TO A DEPTH OF 1/2 INCH. TIGHTEN
BOTTOM OF TAPED HOLE SO WASHER IS STILL LOOSE
NG LIFT FAN.

DIA FAN MOUNTING HUB. SEE DETAIL SH 2

IA STEEL SHAFT WITH ¼ KEYSLOT x 12 LONG.

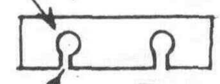
. SELF ALIGNING PILLOW BLOCK BALL BEARING
ECENTRIC CAM LOCKING COLLAR. 2 PLCS

IN DIA ALUM SHEAVE FOR 5V BELT

ASSY. SIDE VIEW

ARINGS TO CENTER FAN IN DUCT.

1⅝ DIA HOLE 2 PLCS. SPACED 6 INCHES ON CENTER AT AFT SUPPORT AND 6¾ AT FWD SUPPORT.



5/8 SLOT FOR INSTALLING OVER BELT. 2 PLCS

BELT GUIDE SUPPORT

MAKE FROM 1X4X12 WOOD. 2 REQD.

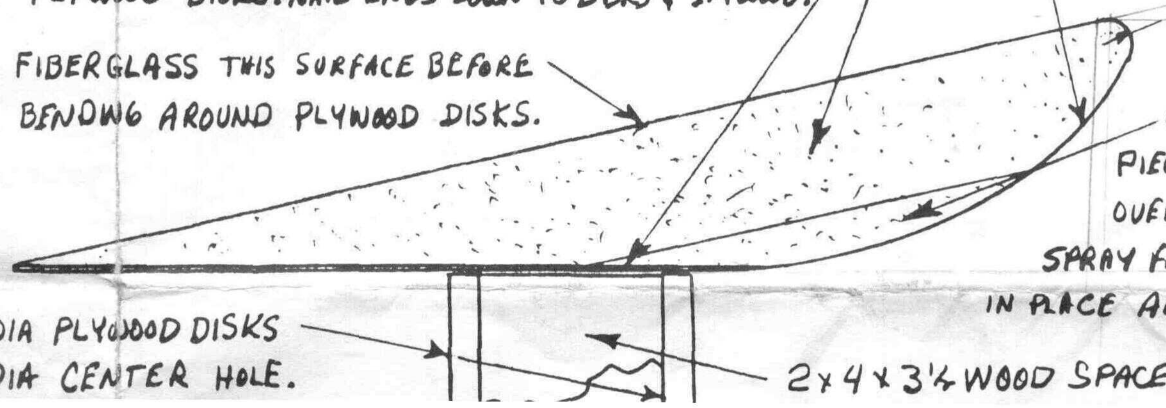
NER

FULL SIZE AFT BAG SKIRT CORNER

2 INCH THICK BLUE OR PINK STYROFOAM AS SHOWN IN THRUST DUCT FOAM LAYOUT BELOW.

SAND TO SHAPE SHOWN AND FIBER GLASS AFTER WRAPPING IN PLACE.

1/8 x 13 x 191 PLYWOOD WRAPPED TIGHT AROUND PLYWOOD DISKS. NAIL ENDS DOWN TO DISKS & 2x4 WOOD.



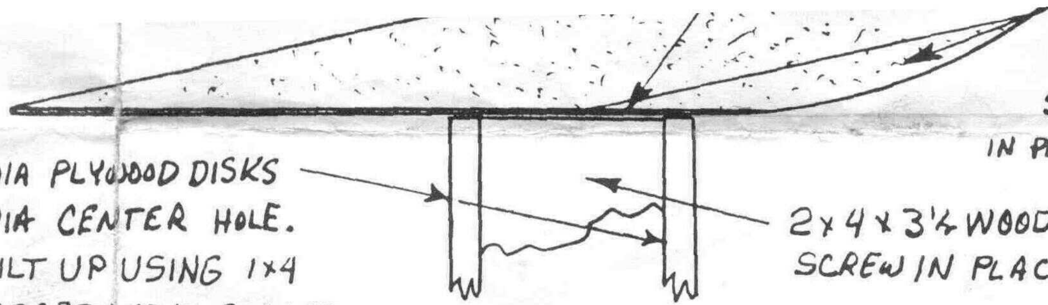
3/4 RADIUS.

FIBERGLASS THIS SURFACE BEFORE BENDING AROUND PLYWOOD DISKS.

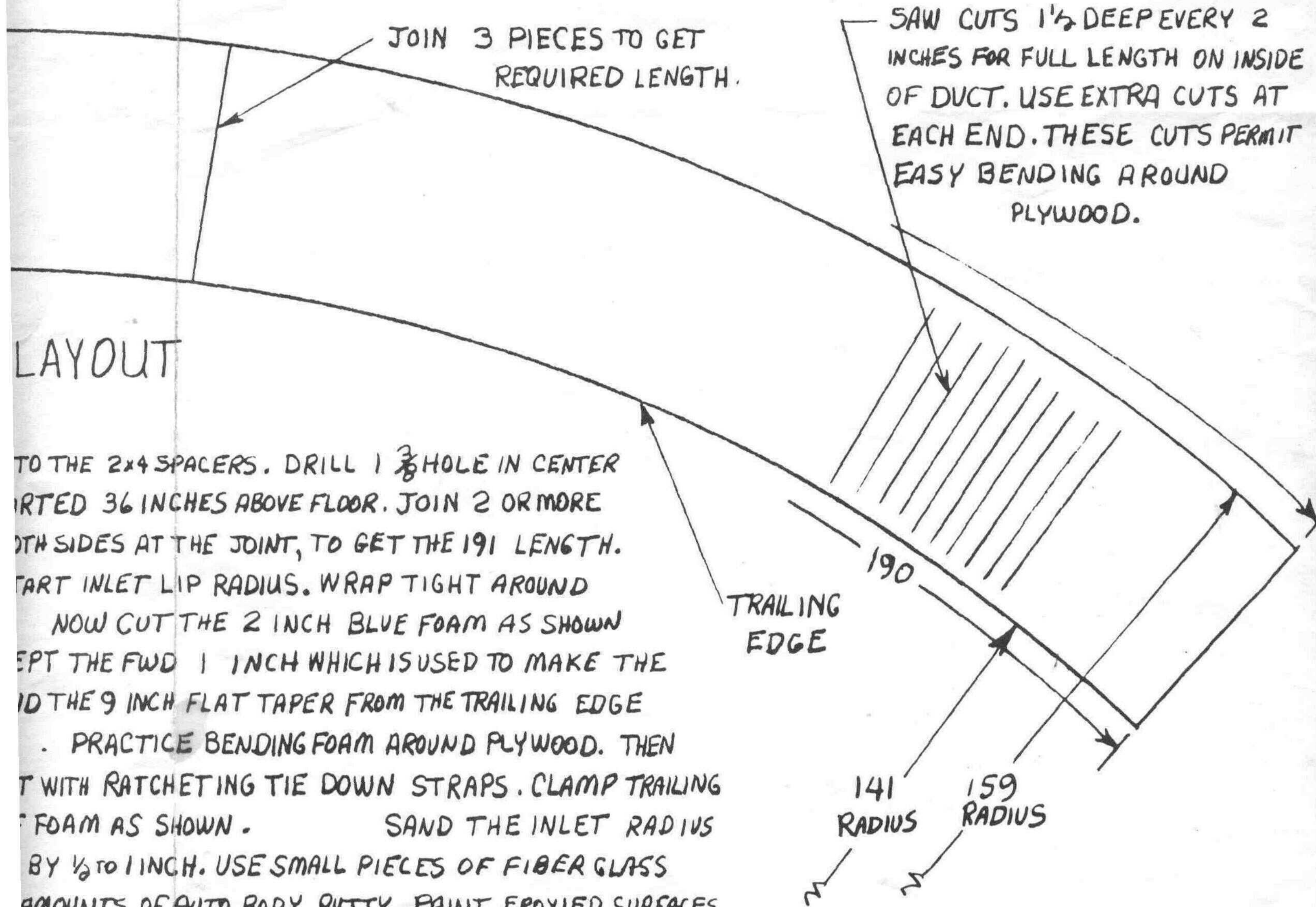
ADD THIS FOAM IN SMALL PIECES AFTER WRAPPING OVER 1/8 PLYWOOD. USE SPRAY FOAM SEALANT TO HOLD IN PLACE AND FILL ALL VOIDS.

¼ DIA PLYWOOD DISKS
3/8 DIA CENTER HOLE.

2x4x3¼ WOOD SPACERS. 6 PLCS



THRUST DUCT CROSS SECTION 1/3 SIZE.



LAYOUT

TO THE 2x4 SPACERS. DRILL 1 3/8 HOLE IN CENTER
RTED 36 INCHES ABOVE FLOOR. JOIN 2 OR MORE
OTH SIDES AT THE JOINT, TO GET THE 191 LENGTH.
TART INLET LIP RADIUS. WRAP TIGHT AROUND
NOW CUT THE 2 INCH BLUE FOAM AS SHOWN
EPT THE FWD 1 INCH WHICH IS USED TO MAKE THE
ID THE 9 INCH FLAT TAPER FROM THE TRAILING EDGE
. PRACTICE BENDING FOAM AROUND PLYWOOD. THEN
T WITH RATCHETING TIE DOWN STRAPS. CLAMP TRAILING
FOAM AS SHOWN. SAND THE INLET RADIUS
BY ½ TO 1 INCH. USE SMALL PIECES OF FIBER GLASS
AMOUNTS OF AUTO BODY PUTTY. PAINT EPOXIED SURFACES

T ON BOTTOM OF DUCT SO INSIDE OF DUCT IS 2½
FECTLY CENTERED, UP RIGHT AND FLUSH WITH
IDES AND OR STRING FROM DECK TO SHOP CEILING
USING 2 PART POURING (FAST) URETHANE FOAM
TO THE HULL. PUT WEIGHTS IN DUCT TO SUPPORT
LACE. LEAVE DISKS IN PLACE TO LINE UP PROP

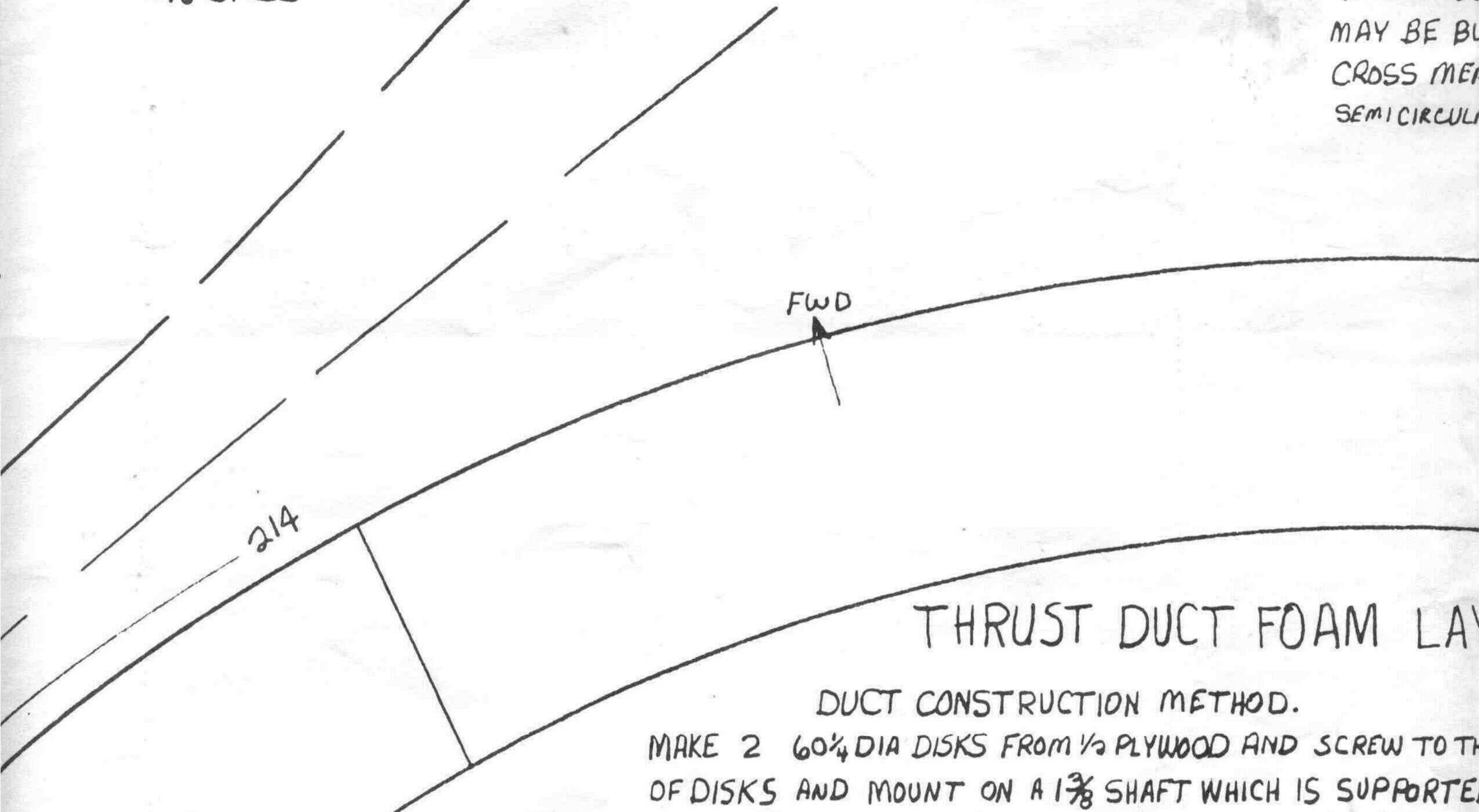
UH-18SP	SCALE 1/12 UNLESS NOTED
SHEET 2 MAY 1999	BY R.J. WINDT
UNIVERSAL HOVERCRAFT BOX 281 CORDOVA IL 61242	

NUT ON BOTTOM OF HULL.

IDLER SUPPORT AND LIFT BELT TENSIONER

1/6 SIZE

1/2 x 60 1/4 [...]
WITH 1 3/8 [...]
MAY BE BU[...]
CROSS ME[...]
SEMICIRCUL[...]



THRUST DUCT FOAM LA[...]

DUCT CONSTRUCTION METHOD.

MAKE 2 60 1/4 DIA DISKS FROM 1/2 PLYWOOD AND SCREW TO TH[...]
OF DISKS AND MOUNT ON A 1 3/8 SHAFT WHICH IS SUPPORTE[...]
PIECES OF 1/8 x 13 WIDE PLYWOOD, WITH FIBERGLASS ON BOTH S[...]
SAND AND FEATHER FWD EDGE OF 1/8 PLYWOOD TO START [...]
60 1/4 DISKS AND NAIL ENDS DOWN WITH 3/4 WIRE NAILS. N[...]
ABOVE. FIBERGLASS ONE SIDE WITH 6 OZ CLOTH EXCEPT [...]
LEADING EDGE RADIUS. NOW CUT OR HOT WIRE AND SAND T[...]
FORWARD, AS SHOWN IN THRUST DUCT CROSS SECTION, [...]
EPOXY FOAM AND PLYWOOD AND WRAP. PULL DOWN TIGHT WI[...]
EDGE WITH CLOTHES PINS. ADD THE FILLER PIECES OF FOA[...]
AS SHOWN AND FIBERGLASS. OVERLAP 1/8 PLYWOOD BY [...]
AND OVERLAP. SAND AND FILL LOW SPOTS WITH SMALL AMO[...]
A LIGHT COLOR TO PROTECT FROM SUNLIGHT.

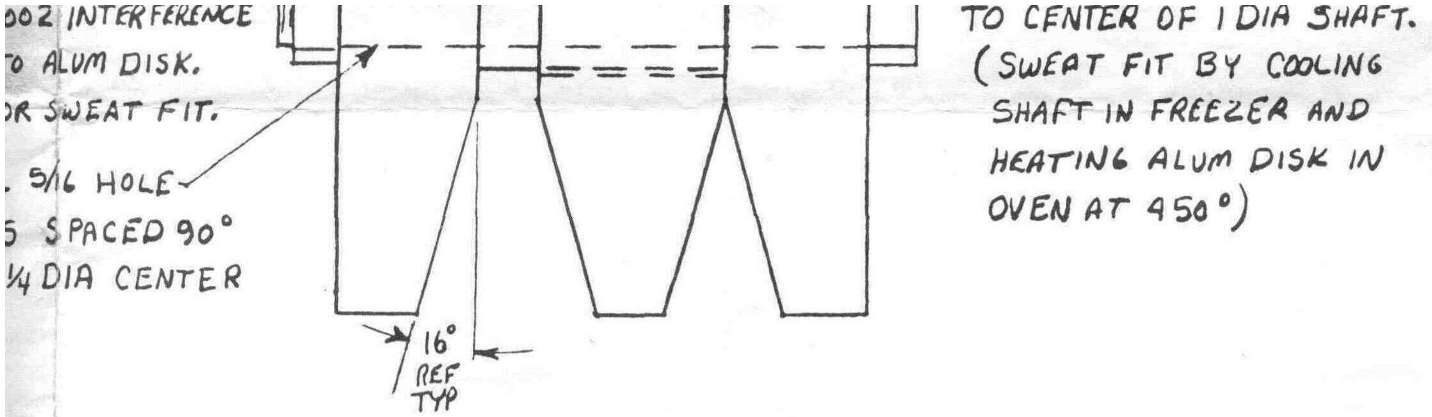
MOUNTING DUCT TO DECK: CUT A FLAT SPOT O[...]
INCHES ABOVE DECK. PRACTICE FIT DUCT SO IT IS PERFEC[...]
THE BACK OF THE CRAFT. SCREW DOWN SOME WOOD GUIDES [...]
TO QUICKLY POSITION DUCT CORRECTLY AFTER FOAMING. USI[...]
OR SPRAY FOAM SEALENT (SLOW) TO BOND THE DUCT TO [...]
UNTIL FOAM SETS. FIBERGLASS SUPPORT FINS IN PLA[...]
SHAFT. THEN DISASSEMBLE AND REMOVE DISKS.

[...]HRUST HUB
[...]T
[...]ST
[...]T

BORE 1.79° (3/4 INCH PER FOOT ON DIA)
AT LARGE END.

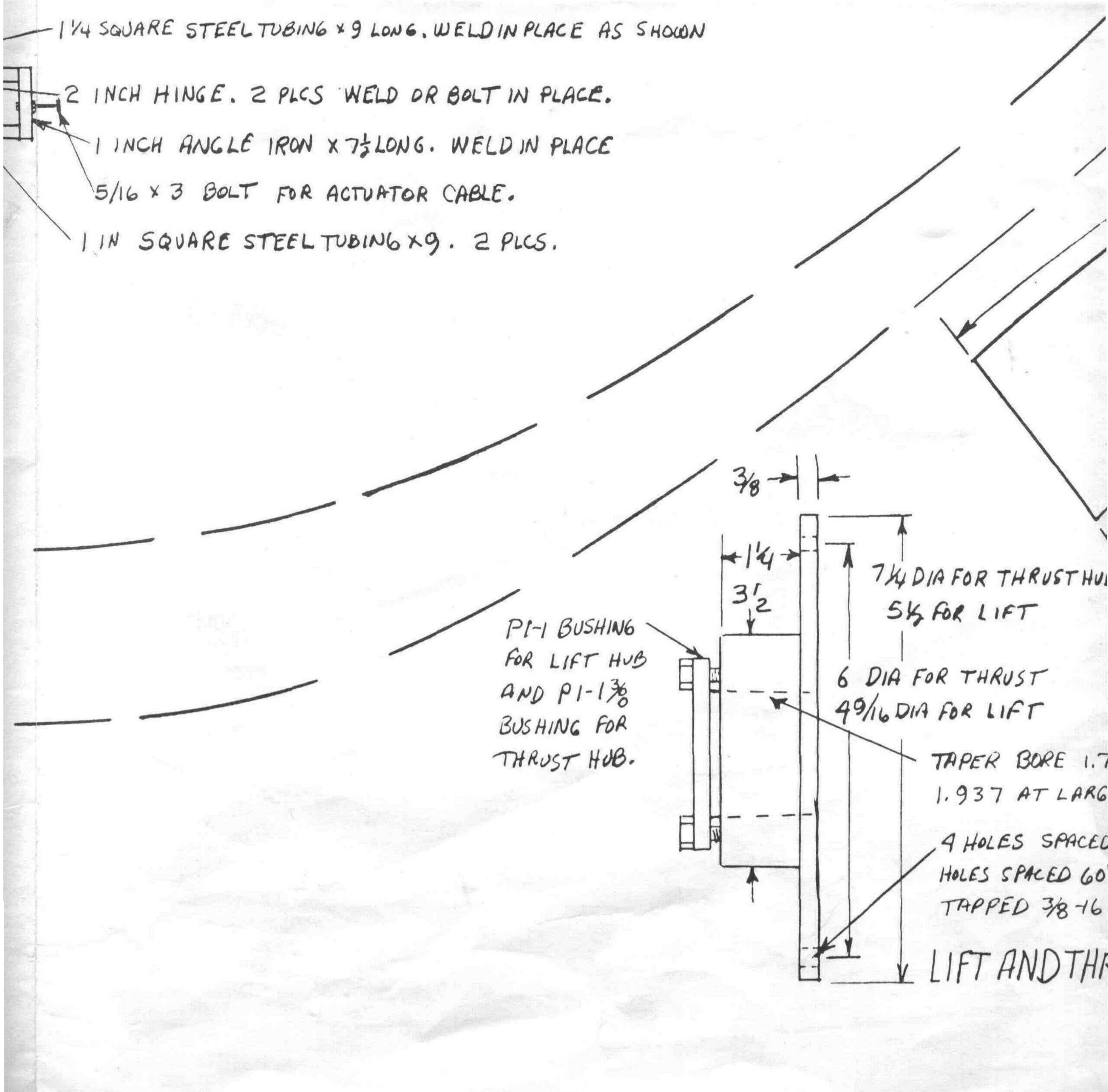
[...]S SPACED 90° FOR LIFT HUB AND 6
[...]PACED 60° FOR THRUST. ALL 5/16 HOLES
[...]D 3/8-16.

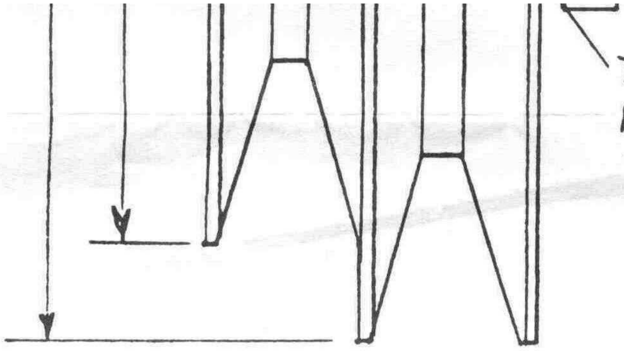
[...]ND THRUST HUBS MAKE FROM ALUM.



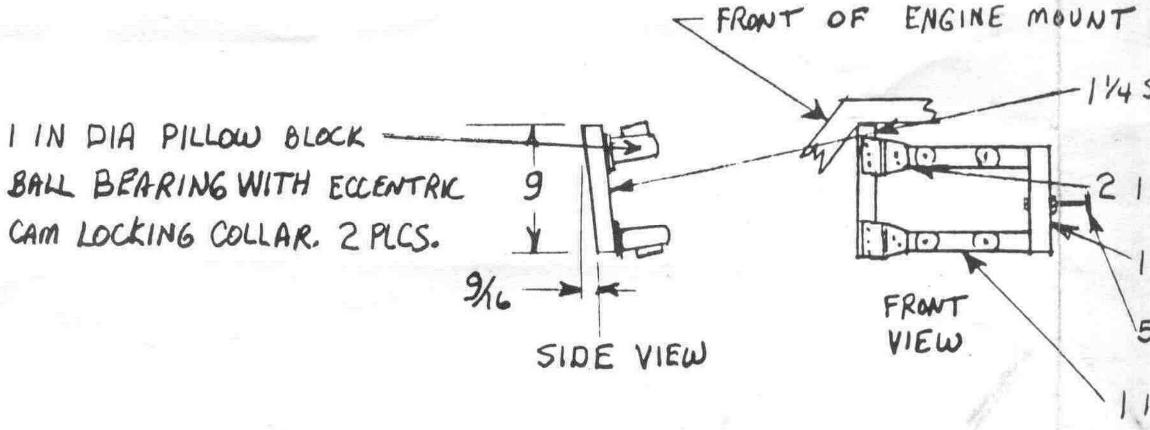
LIFT SYSTEM VARIATOR ASSY. FULL SIZE

VARIATOR IS OPTIONAL. IT GIVES LIFT CONTROL FOR HEAVY LOADS & WINDY CONDITIONS. AND HIGH SPEEDS.

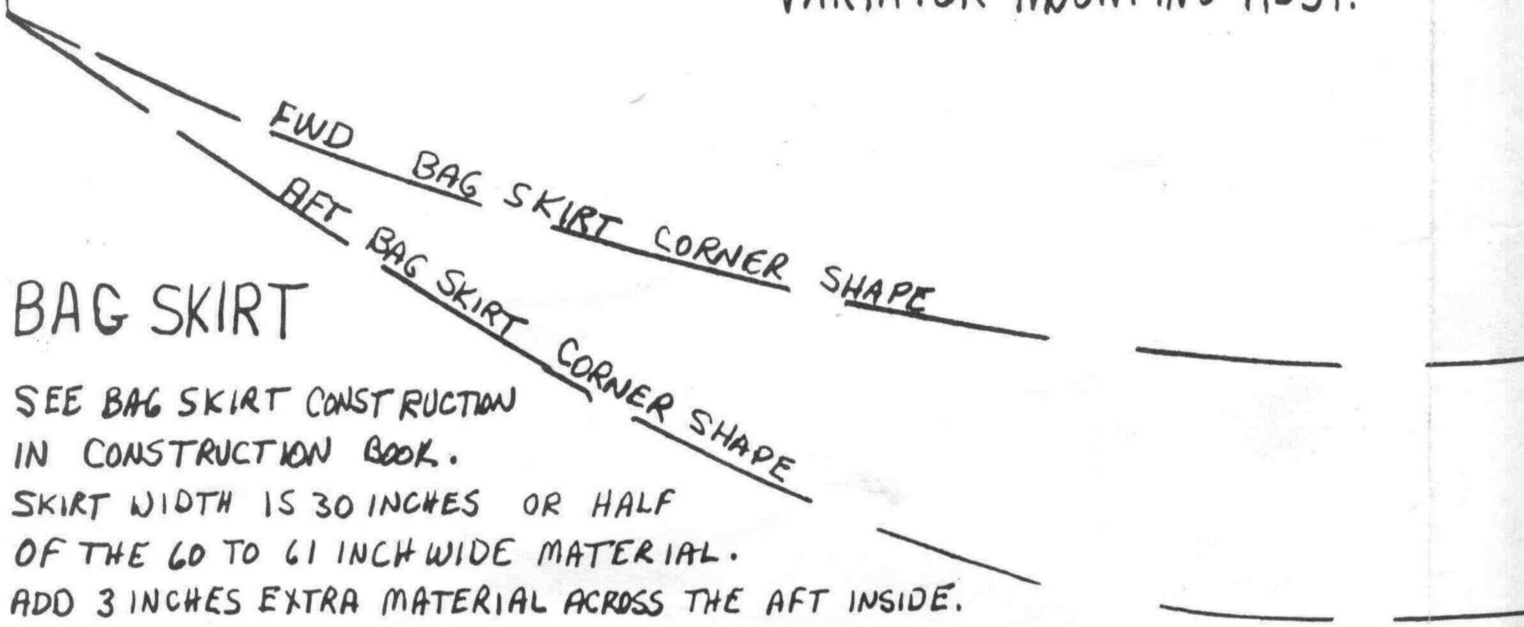




LIFT DRIVE SHEAVE SET. FULL SIZE
MAKE FROM 6½ DIA x 2 ALUM



VARIATOR MOUNTING ASSY.



BAG SKIRT

SEE BAG SKIRT CONSTRUCTION
IN CONSTRUCTION BOOK.
SKIRT WIDTH IS 30 INCHES OR HALF
OF THE 60 TO 61 INCH WIDE MATERIAL.
ADD 3 INCHES EXTRA MATERIAL ACROSS THE AFT INSIDE.
(THE AFT INSIDE SKIRT ATTACH STRIP IS HIGHER THAN THE SIDE
INSIDE STRIPS.)
TRANSFER THE SKIRT PATTERNS TO 2 OTHER PIECES OF PAPER
BY POKING A PIN OR NEEDLE THRU AND INTO THE OTHER PAPER ALL
ALONG EACH PATTERN.

universal hovercraft

THE *WORLD LEADER IN HOVERCRAFT* ***TECHNOLOG Y***

404 W. Front Street
Harvard, IL USA 60033
Ph: (815) 943-1200
Fx: (815} 943-1800

Instructions for Finishing Your Pre-shaped Propeller or Fan

Welcome to Universal Hovercraft—the worlds largest supplier of hovercraft plans, kits, and parts. UH has been designing and building hovercraft for over 35 years, and our designs and components have stood the test of time and endurance. This instruction manual is intended to be a ready reference and guide for homebuilders in finishing their own propeller or fan. Care should be given in the finishing process to make sure proper fiberglassing techniques are used. Note: All products made from UH plans are intended for private non-commercial use by the purchaser; and there is no warranty express or implied as to their performance, reliability, or safety. UH is not responsible in any respect for part non-performance, failure, or any losses incurred, whether direct, contingent or collateral. UH plans are for the exclusive use of the purchaser, and purchase does not constitute a license granted by UH to manufacture or sell any product. Purchase price of plans does not include technical support, but we will provide reasonable help, time permitting, to all our customers.

Step 1 -Surface preparation/sanding

The pre-shaped propeller or fan you received has already been cut to the correct diameter and pitch. Any dents or gouges will need to be filed with wood putty, automotive body filler (bondo), or epoxy filler. The next step is to sand all the blades smooth. The leading edge should be sanded round, and the trailing edge should be sanded to a sharp point (see figure 1 below). Although many precautions are taken to prevent propeller or fan damage during shipping, sometimes trailing edges will be cracked or chipped. Simply gluing the trailing edge back on with epoxy or filling with your choice of epoxy filler can easily repair this.

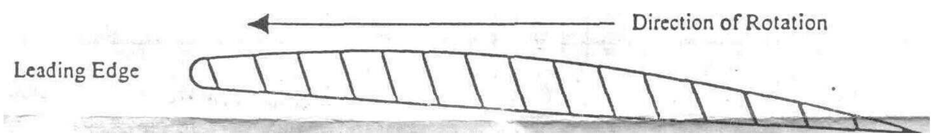


Figure 1 - Prop/Fan blade cross-section view. Note the smooth radius on the leading edge and the sharp point on the trailing edge.

Step2-Drilling the center bore hole

Your prop/fan will have a 1/8" or 5/32" pilot hole drilled in the center. Using a drill press and this pilot hole as your guide, drill a hole that is the same size as the shaft your prop/fan will be mounted to.

Step 3 - Drilling the propeller/fan bolt holes

Before drilling the bolt holes that will mount your prop or fan to the hub, it is important to make sure that the holes will be centered with the center bore hole. You can center the bolt holes by tightening your bushing and prop hub onto the correct diameter shaft and then sliding your prop/fan onto the same shaft (see figure 2 below). Using a center punch, mark the correct location of the holes. Once all holes have been located and marked pre-drill the holes in a drill press with a 1/8" drill bit. Next, drill the bolt holes using a 3/8" drill bit.

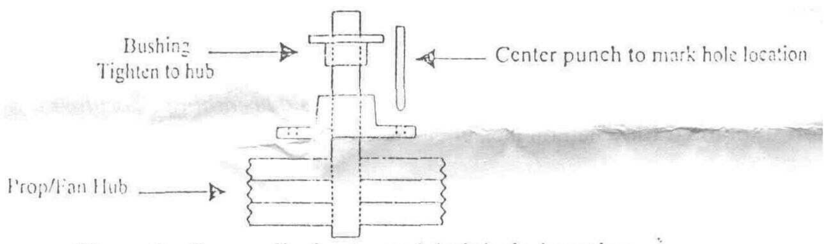


Figure 2 – Proper aligning to mark bolt hole location.

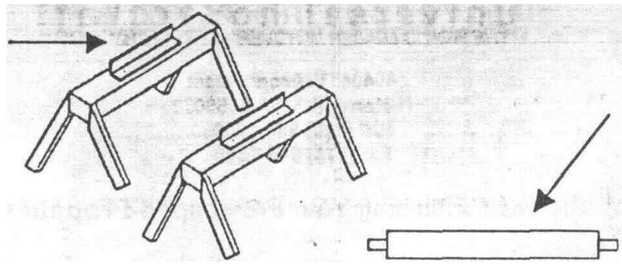
Step4-Fibreglassing&balancing

Fiberglassing and balancing may appeal daunting, but it is actually quite simple. Simply observe which blade falls towards the ground when it is on the balance (see below). In our experience, \\e have found that it is easiest to balance your prop or fan during the fiberglassing process. This will enable you to get your prop or fan very close to balanced while you are still able to add extra material Once your glue has dried, all that remains is trimming off the excess fiberglass, finish sanding, and rechecking the balance.

-The first step is to have a good prop/fan balancer. This balancer can be homemade and be built very inexpensively. This balancer is essentially two pieces of angle iron with one edge on each sharpened to a point. These pieces of angle iron are spaced about 6-8 inches or greater apart depending on the width of your prop or fan and should be mounted to a pair of sawhorses. Your shaft will not through your center bore hole on your prop/fan will rest on these sharpened edges of angle iron, allowing the heavier blade to fall towards the ground. Please refer to the diagram below to build a very basic balancer that you can make with sawhorses.

Angle iron screwed to the top of a sawhorse. Top edge is sharpened to a point.

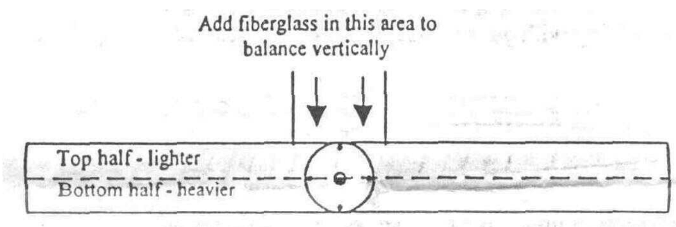
It is important to take a level and make sure the angle iron pieces are level.



Balancing shaft. Insert through prop/fan and rest on angle iron so the prop/fan is between the two sawhorses. Note. The smaller diameter ends arc optional for increased accuracy.

2-blade propellers

You will need steel or equivalent shaft material the same diameter as the center bore hole in your prop or fan. Slide the shaft through the center bore hole and rest the shaft across the two pieces of angle iron. Two bladed propellers must be balanced in two directions - horizontally and vertically. To balance horizontally, move the propeller blades so they are perfectly horizontal or parallel with the ground, release, and watch to see which blade falls to the ground. Add extra fiberglass to the lighter side to balance the weight until the propeller will no longer move from a horizontal position when you release your grip. Once you have balanced your prop horizontally, it must be balanced vertically. Note: this step is not always required. On the balancer, stand your prop on end vertically, or perpendicular to the ground. Release your grip, and watch to see which side falls to the floor. If the prop does not move, go ahead and move to the next step. If it moves, it must be balanced. The reason it falls is that the top half of your propeller is heavier than the bottom half (see diagram below). To remedy this problem, many layers of fiberglass are added on top of the area where the bolt pattern is located. Add fiberglass, keeping it as close to the center of the prop as possible until prop no longer moves from a vertical position when you release it from your grip. The farther you add fiberglass toward the edges of the prop, the more you increase the chances of throwing it out of balance horizontally. Once you have your prop balanced vertically, check it's horizontal balance to make sure it is still in balance. If not, repeat the above steps for balancing horizontally.



4-blade fans

The easiest way to balance a 4-bladed lift fan is to first think of it as only having two blades. Pick one set of blades and balance horizontally just as if it were a 2-bladed propeller. Once you have balanced those two blades, rum the fan 90 degrees and repeat the same process. This will balance all four blades of your fan.

Recommended amount of fiberglass

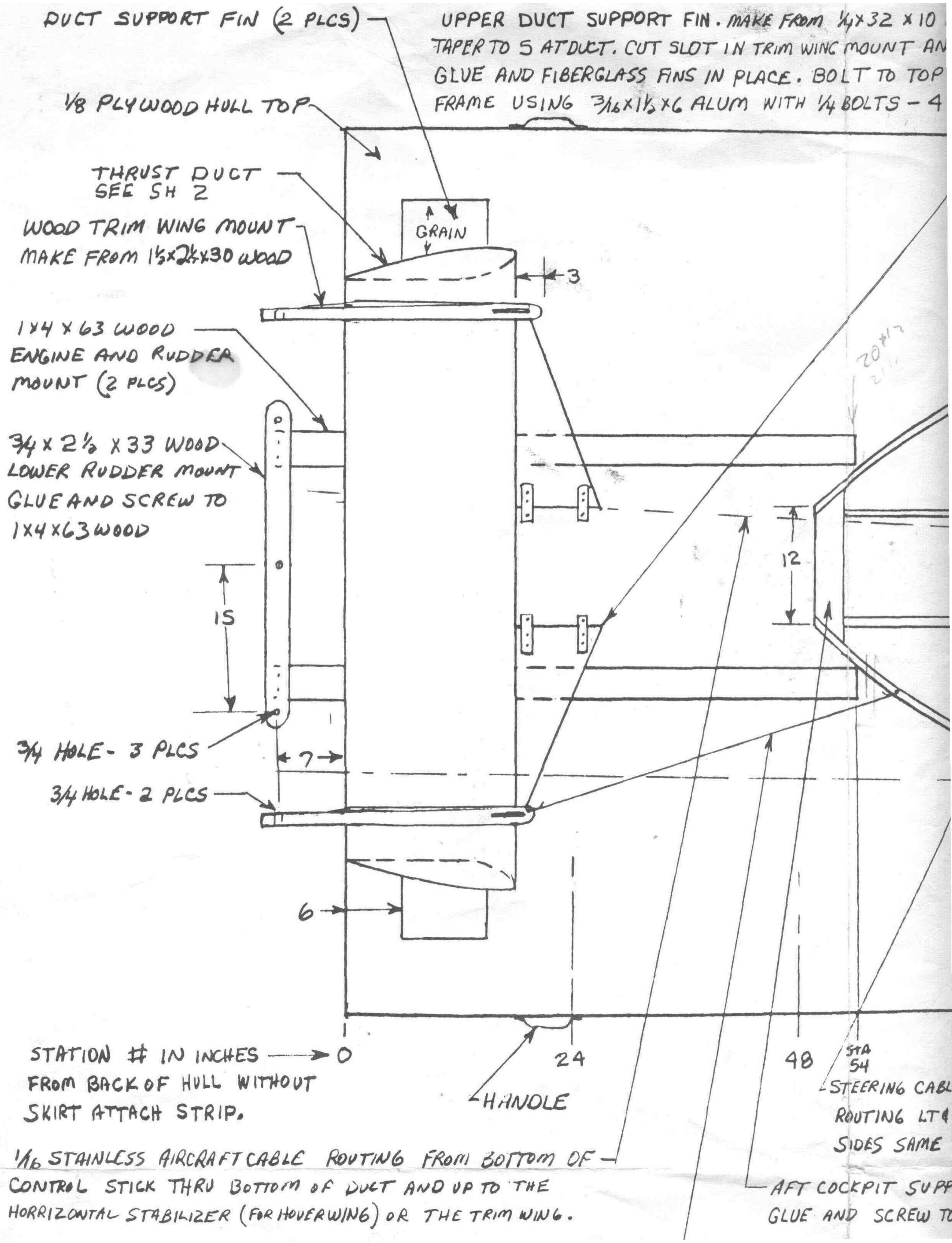
When fiberglassing your prop or fan, we recommend that you cover the entire blade surface with two layers of a 3-6 oz. fiberglass cloth. Then add an additional 2-3 layers on the leading edge to help prevent tip erosion. No fiberglass is required in the area where the bolt pattern is, or on the plywood discs of lift fans. Simply coat these areas with epoxy to seal the wood from moisture.

Step 5 - Finish sanding

Once your fiberglass has cured, trim all excess fiberglass that does not cover the surface of your prop or fan with a razor knife. Using a power sander, sand the prop or fan smooth. Recheck for balance after finish sanding is complete *Warning - breathing fiberglass dust is hazardous to your health Take all necessary precautions to avoid breathing fiberglass dust and getting fiberglass dust on you skin. The* prop can be left unpainted for a natural look or painted to your desire.

Propelleri Maintenance

Your prop or fan can last a long time if maintained properly. It is natural for hovercraft propellers and fans to become worn over time because they are constantly operating in harsh conditions compared to an airplane. Dents and gashes up to 1/8 the width of the blade can be filled with epoxy filler or bondo and fiberglassed over to restore your prop or fan to new condition. When your hovercraft is not being used, rotate your thrust propeller so it is horizontal with the ground. This will prevent the moisture in the wood from running to one side of your prop causing it to go out of balance. Check to make sure your prop/fan bolts are properly torqued before operation 3/8" diameter bolts used in Universal Hovercraft hubs should be torqued to 8 foot-pounds Do not torque bolts beyond \ here the \\ood starts to compress Universal Hovercraft has aluminum propeller and fan backing plates available to prevent this problem from occurring

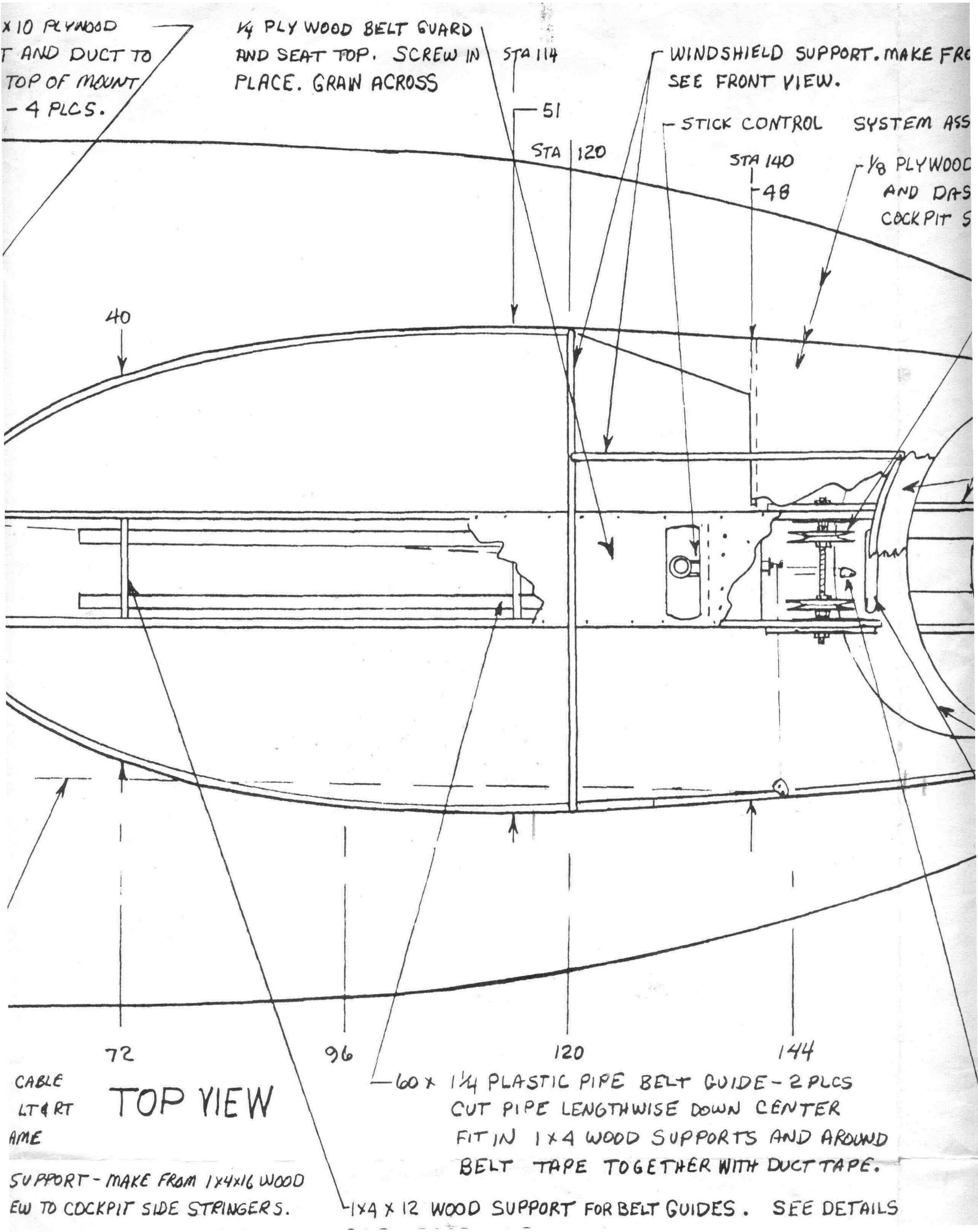


STATION # IN INCHES → 0
FROM BACK OF HULL WITHOUT
SKIRT ATTACH STRIP.

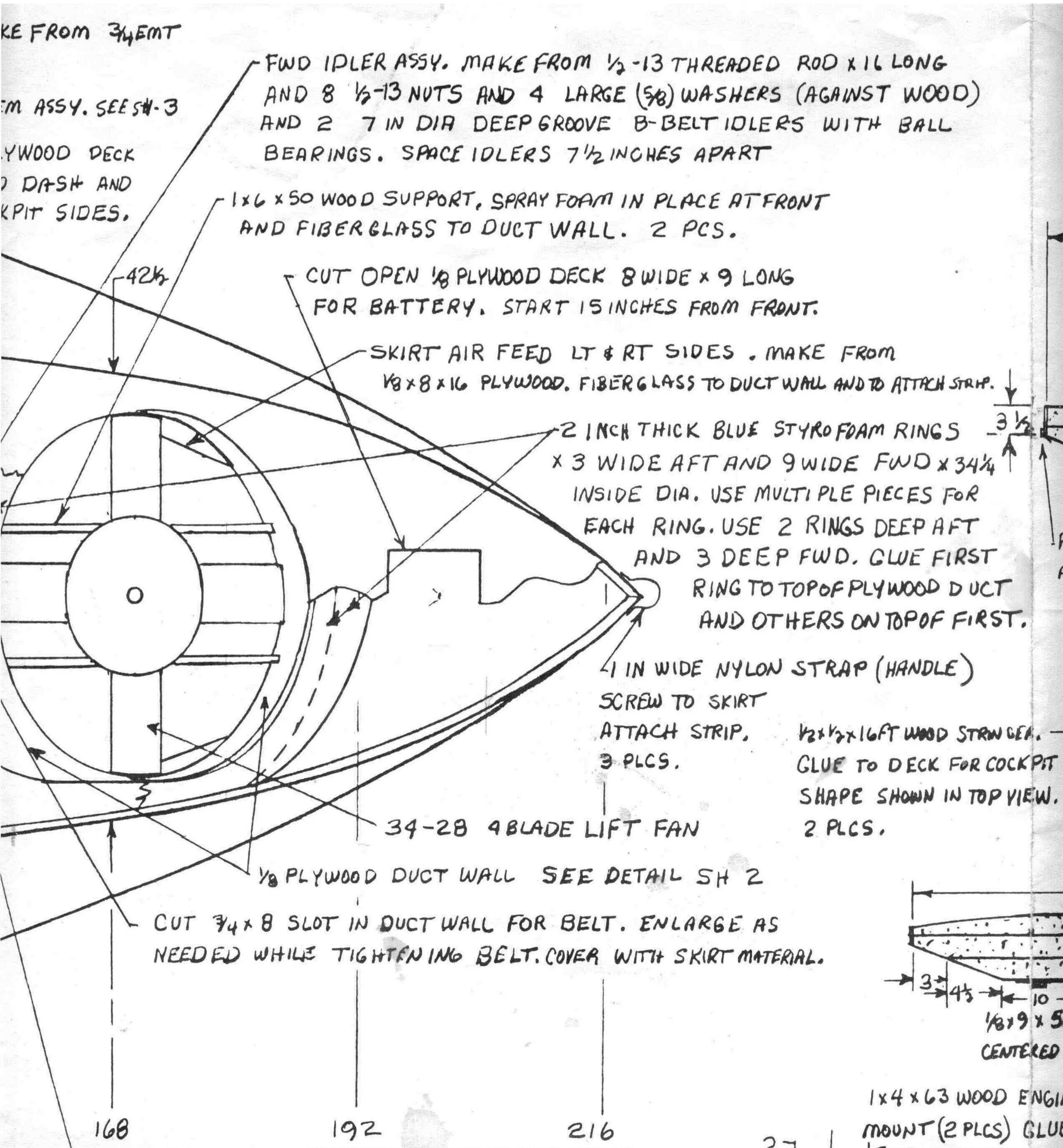
STEERING CABL
ROUTING LT &
SIDES SAME

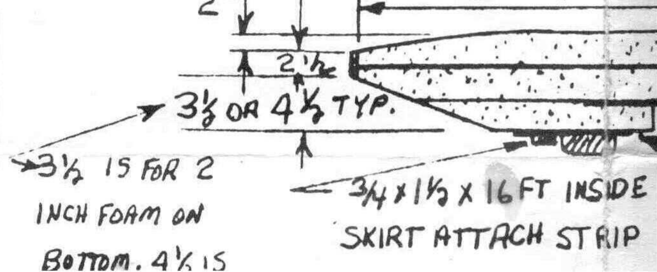
1/16 STAINLESS AIRCRAFT CABLE ROUTING FROM BOTTOM OF
CONTROL STICK THRU BOTTOM OF DUCT AND UP TO THE
HORRIZONTAL STABILIZER (FOR HOVERWING) OR THE TRIM WING.

AFT COCKPIT SUPP
GLUE AND SCREW T


X 10 PLYWOOD
T AND DUCT TO
TOP OF MOUNT
- 4 PLCS.
1/4 PLY WOOD BELT GUARD
AND SEAT TOP. SCREW IN
PLACE. GRAIN ACROSS
STA 114
51
STA 120
WINDSHIELD SUPPORT. MAKE FR
SEE FRONT VIEW.
STICK CONTROL SYSTEM ASS
STA 140
48
1/8 PLYWOOD
AND DAS
COCKPIT S
40
72
96
120
144
CABLE
LT & RT
AME
60 x 1 1/4 PLASTIC PIPE BELT GUIDE - 2 PLCS
CUT PIPE LENGTHWISE DOWN CENTER
FIT IN 1 x 4 WOOD SUPPORTS AND AROUND
BELT TAPE TOGETHER WITH DUCT TAPE.
SUPPORT - MAKE FROM 1x4x16 WOOD
EW TO COCKPIT SIDE STRINGERS.
1x4 x 12 WOOD SUPPORT FOR BELT GUIDES. SEE DETAILS

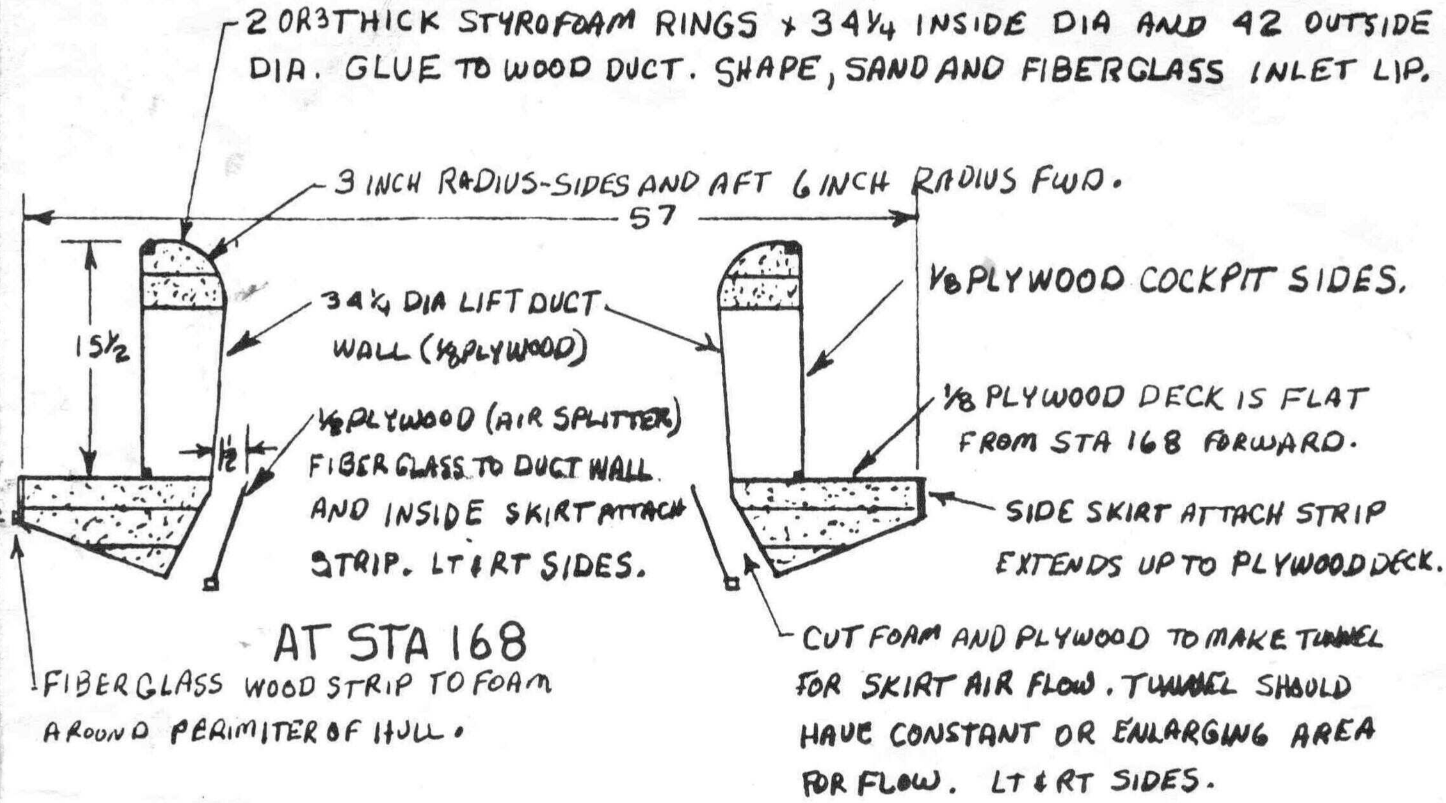
TOP VIEW

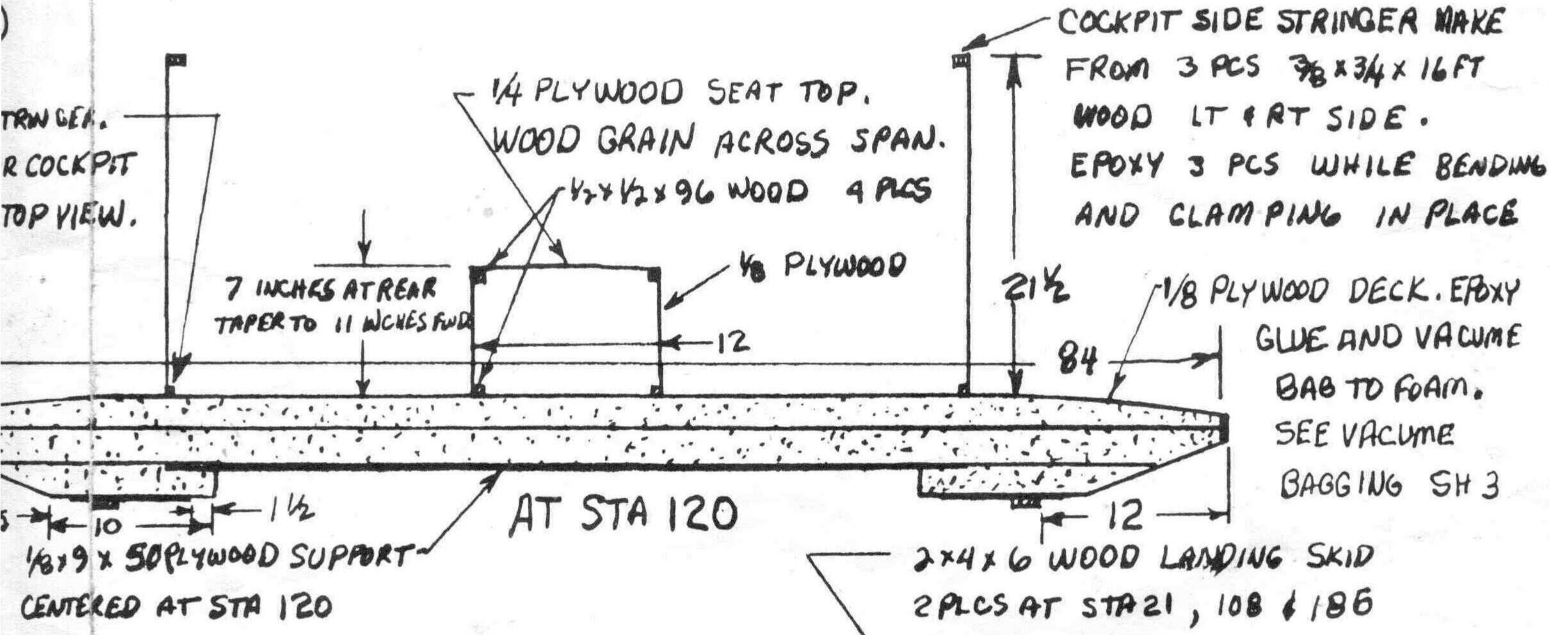


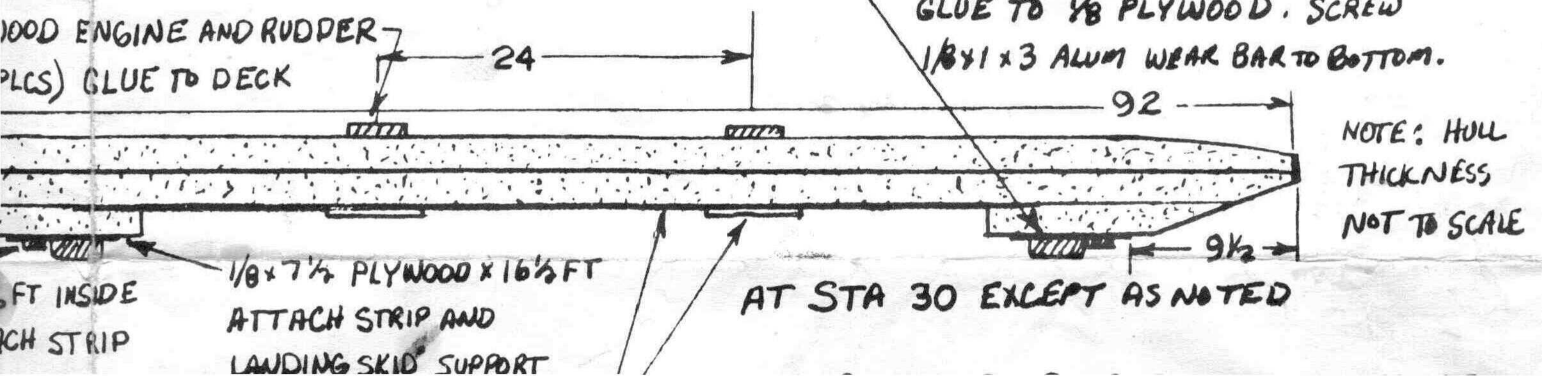


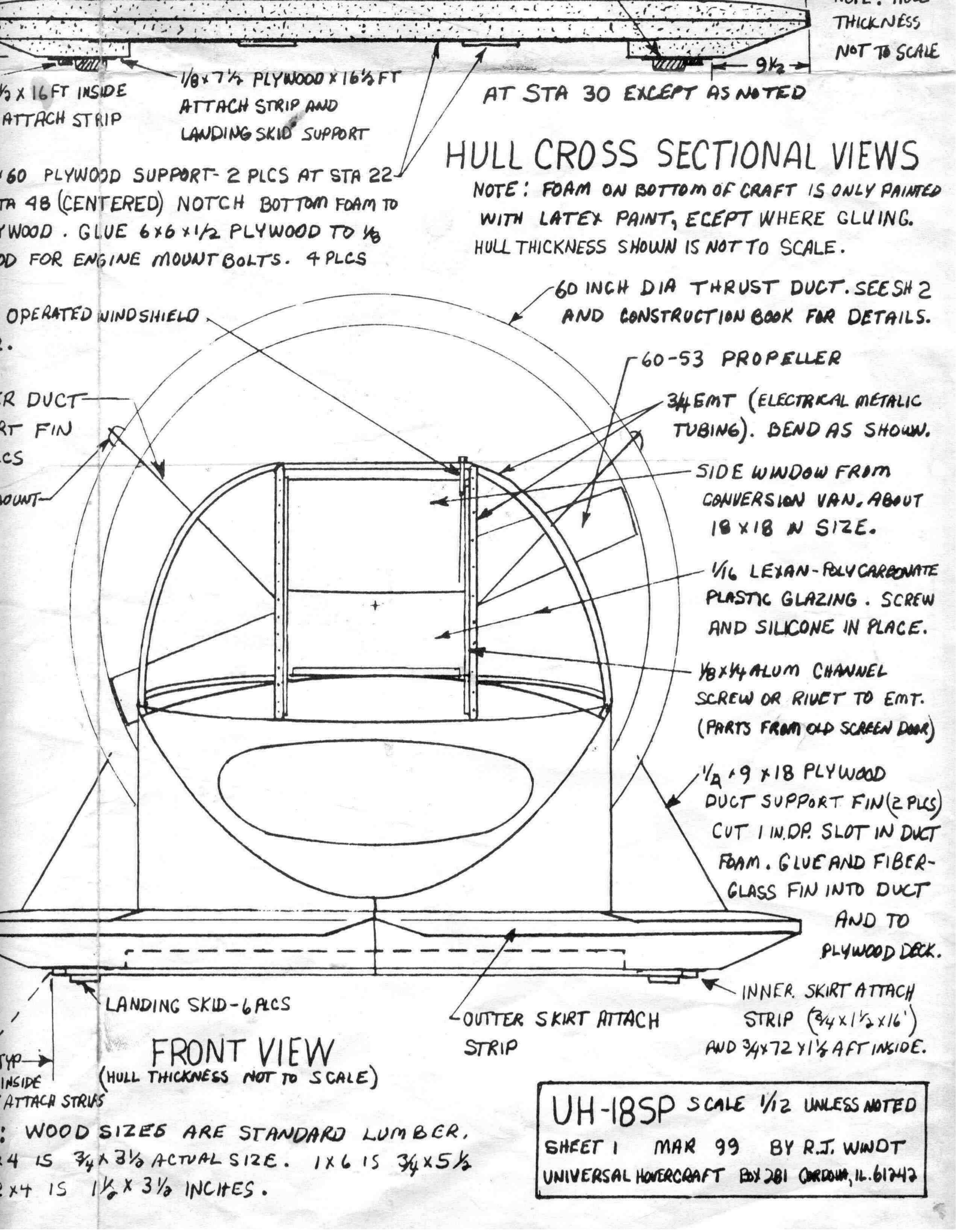
WIDTH OF FOAM HULL WITHOUT SKIRT ATTACH STRIP	
STATION # IN INCHES FROM BACK OF HULL	WIDTH (INCHES)
0	92
24	92

NOTE : HULL IS MADE FROM 2 PC OF 3 IN THICK EXTRUDED STYRENE FOAM OR 3 PC OF 2 IN THICK FOAM. THE BOTTOM PIECE ON EACH SIDE CAN BE 2 OR 3 IN THICK. ALL FOAM IS BONDED WITH EPOXY.








NOTE: HULL THICKNESS NOT TO SCALE
9½
½ x 16FT INSIDE ATTACH STRIP
1/8 x 7½ PLYWOOD x 16½FT ATTACH STRIP AND LANDING SKID SUPPORT
AT STA 30 EXCEPT AS NOTED
HULL CROSS SECTIONAL VIEWS
NOTE: FOAM ON BOTTOM OF CRAFT IS ONLY PAINTED WITH LATEX PAINT, ECEPT WHERE GLUING. HULL THICKNESS SHOWN IS NOT TO SCALE.
60 PLYWOOD SUPPORT- 2 PLCS AT STA 22
TA 48 (CENTERED) NOTCH BOTTOM FOAM TO
YWOOD. GLUE 6x6x1/2 PLYWOOD TO 1/8
OD FOR ENGINE MOUNT BOLTS. 4 PLCS
60 INCH DIA THRUST DUCT. SEE SH 2 AND CONSTRUCTION BOOK FOR DETAILS.
OPERATED WINDSHIELD
60-53 PROPELLER
R DUCT
RT FIN
CS
OUNT
3/4 EMT (ELECTRICAL METALIC TUBING). BEND AS SHOWN.
SIDE WINDOW FROM CONVERSION VAN, ABOUT 18 x 18 IN SIZE.
1/16 LEXAN-POLYCARBONATE PLASTIC GLAZING. SCREW AND SILICONE IN PLACE.
1/8 x 1/4 ALUM CHANNEL SCREW OR RIVET TO EMT. (PARTS FROM OLD SCREEN DOOR)
1/2 x 9 x 18 PLYWOOD DUCT SUPPORT FIN (2 PLCS) CUT 1 IN. DP. SLOT IN DUCT FOAM. GLUE AND FIBER-GLASS FIN INTO DUCT AND TO PLYWOOD DECK.
LANDING SKID-6 PLCS
OUTTER SKIRT ATTACH STRIP
INNER SKIRT ATTACH STRIP (3/4 x 1½ x 16') AND 3/4 x 72 x 1½ AFT INSIDE.
TYP
INSIDE
ATTACH STRIPS
FRONT VIEW
(HULL THICKNESS NOT TO SCALE)
: WOOD SIZES ARE STANDARD LUMBER.
4 IS 3/4 x 3½ ACTUAL SIZE. 1x6 IS 3/4 x 5½
x4 IS 1½ x 3½ INCHES.
UH-18SP SCALE 1/12 UNLESS NOTED
SHEET 1 MAR 99 BY R.J. WINDT
UNIVERSAL HOVERCRAFT BOX 281 CORDOVA, IL. 61242

R
AROUND
TAPE.

DETAILS

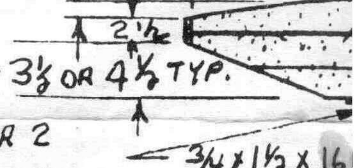
CONTROL CABLE

CENTER
2 PCS OF

DASH BOARD
48 WOOD SUPPORT.
THIS PLYWOOD IS
EPOXY OR SPRAY
TOP OF DUCT
AM.

WIDTH OF FOAM HULL WITHOUT SKIRT ATTACH STRIP

STATION # IN INCHES FROM BACK OF HULL	WIDTH (INCHES)
0	92
24	92
48	92
72	91
96	89
120	84
144	73
168	57
192	36 1/2
216	7
220	0



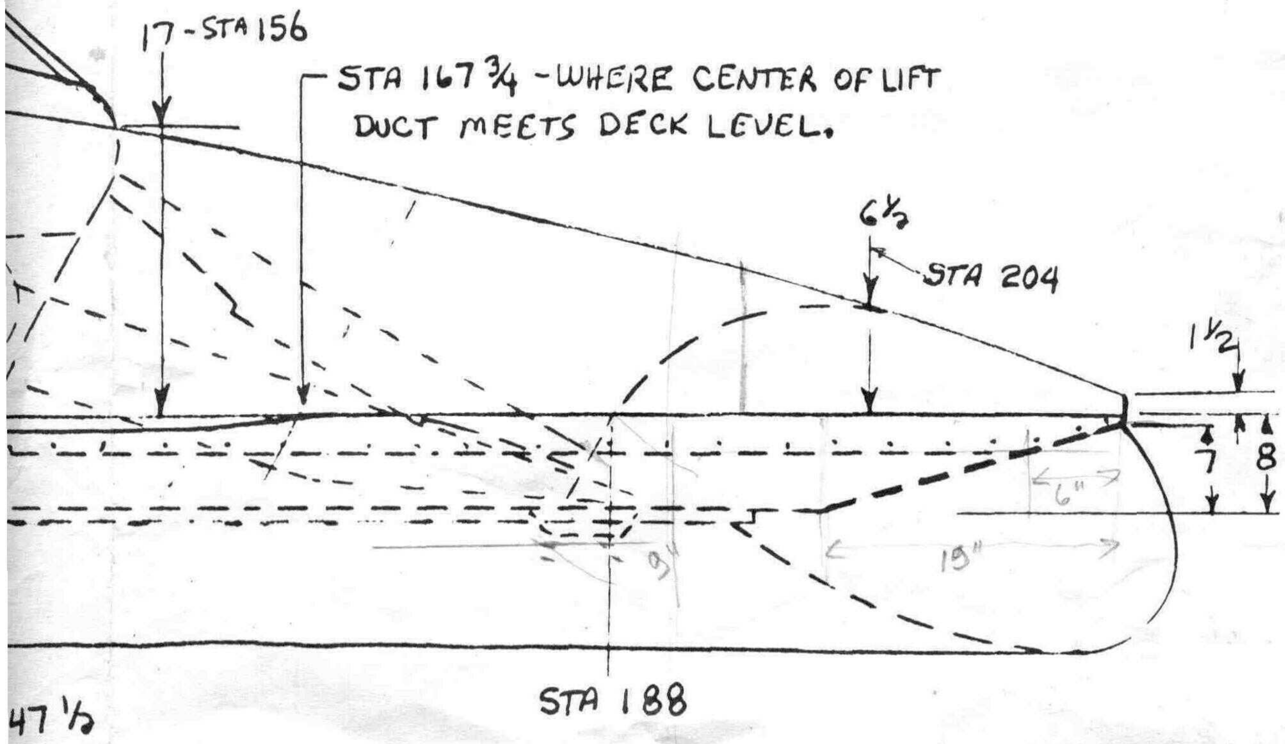
3 1/2 IS FOR 2 INCH FOAM ON BOTTOM. 4 1/2 IS FOR 3 IN FOAM

1/8 x 9 x 60 P
AND STA 48
FIT PLYWOOD
PLYWOOD FO

HAND OPER
WIPER.

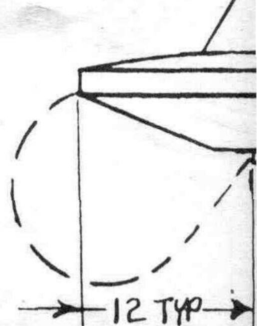
UPPER DU
SUPPORT F
2 PLCS

TRIM WING MOUNT—

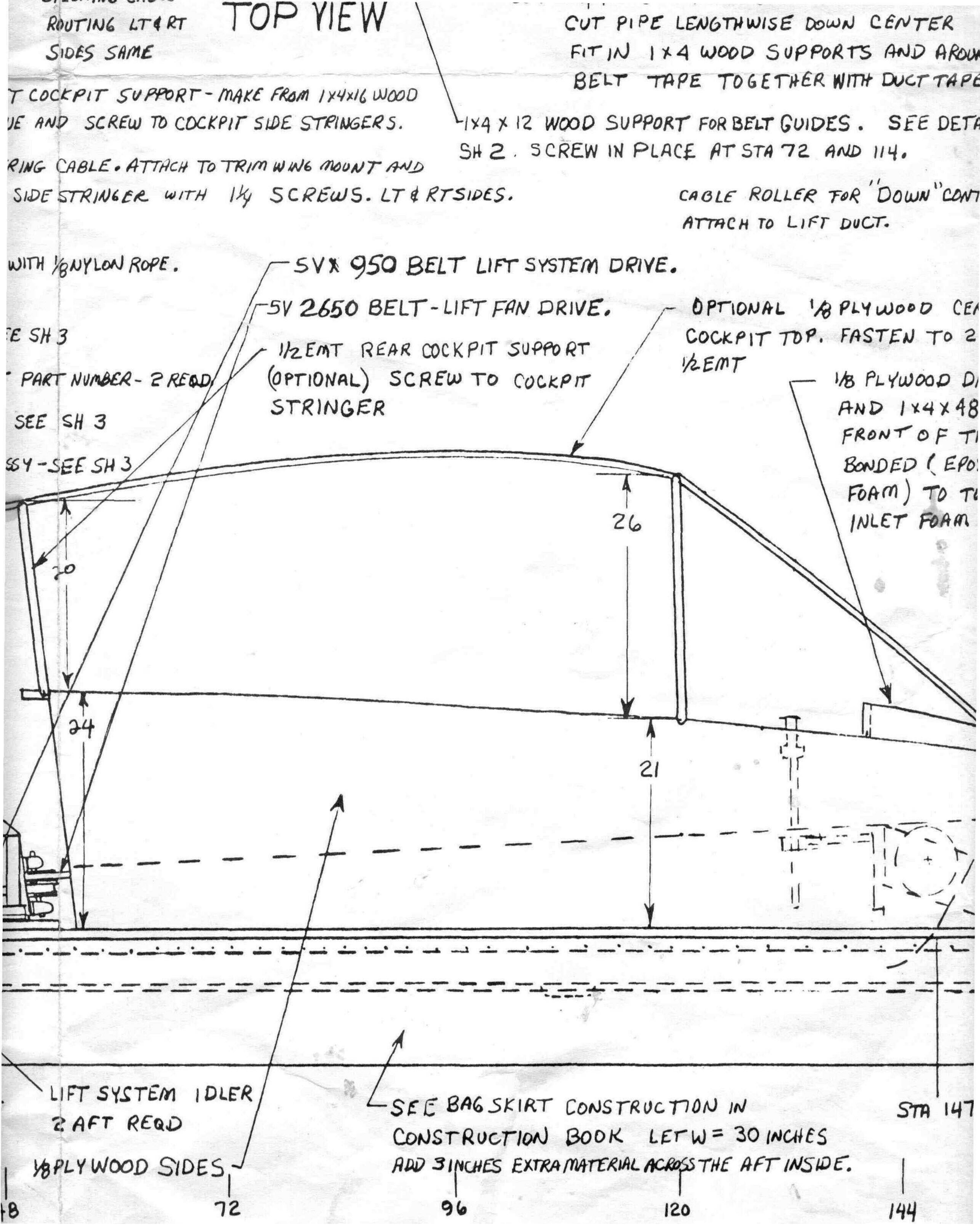


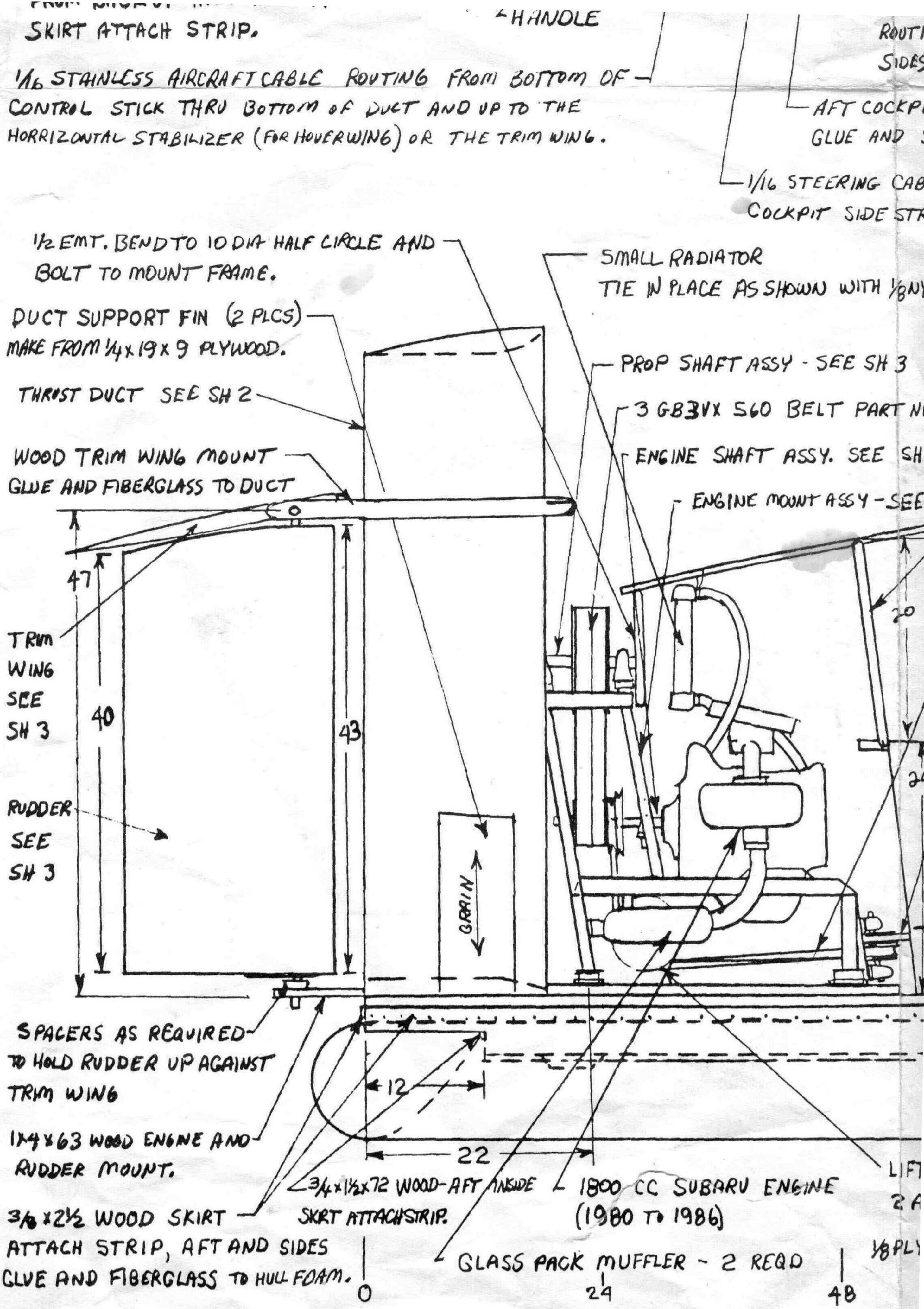
SIDE VIEW

168 192 216



NOTE: WO
SO 1x4 IS
AND 2x4 I


TOP VIEW
ROUTING LT & RT
SIDES SAME
CUT PIPE LENGTHWISE DOWN CENTER
FIT IN 1x4 WOOD SUPPORTS AND AROU
BELT TAPE TOGETHER WITH DUCT TAPE
T COCKPIT SUPPORT - MAKE FROM 1x4x16 WOOD
UE AND SCREW TO COCKPIT SIDE STRINGERS.
1x4 x 12 WOOD SUPPORT FOR BELT GUIDES. SEE DETA
SH 2. SCREW IN PLACE AT STA 72 AND 114.
RING CABLE. ATTACH TO TRIM WING MOUNT AND
SIDE STRINGER WITH 1¼ SCREWS. LT & RT SIDES.
CABLE ROLLER FOR "DOWN" CONT
ATTACH TO LIFT DUCT.
WITH 1/8 NYLON ROPE.
5V X 950 BELT LIFT SYSTEM DRIVE.
5V 2650 BELT - LIFT FAN DRIVE.
OPTIONAL 1/8 PLYWOOD CE
COCKPIT TOP. FASTEN TO 2
1/2 EMT
E SH 3
1/2 EMT REAR COCKPIT SUPPORT
(OPTIONAL) SCREW TO COCKPIT
STRINGER
PART NUMBER - 2 REQD
SEE SH 3
1/8 PLYWOOD D
AND 1x4x48
FRONT OF T
BONDED (EPO
FOAM) TO T
INLET FOAM
SSY - SEE SH 3
26
20
24
21
LIFT SYSTEM IDLER
2 AFT REQD
SEE BAG SKIRT CONSTRUCTION IN
CONSTRUCTION BOOK LET W = 30 INCHES
ADD 3 INCHES EXTRA MATERIAL ACROSS THE AFT INSIDE.
STA 147
1/8 PLYWOOD SIDES
48
72
96
120
144


SKIRT ATTACH STRIP.
HANDLE
ROUTIN
SIDES
1/16 STAINLESS AIRCRAFT CABLE ROUTING FROM BOTTOM OF CONTROL STICK THRU BOTTOM OF DUCT AND UP TO THE HORRIZONTAL STABILIZER (FOR HOVERWING) OR THE TRIM WING.
AFT COCKPIT
GLUE AND SC
1/16 STEERING CABL
COCKPIT SIDE STRI
1/2 EMT. BEND TO 10 DIA HALF CIRCLE AND BOLT TO MOUNT FRAME.
SMALL RADIATOR
TIE IN PLACE AS SHOWN WITH 1/8 NYL
DUCT SUPPORT FIN (2 PLCS) MAKE FROM 1/4 x 19 x 9 PLYWOOD.
PROP SHAFT ASSY - SEE SH 3
THRUST DUCT SEE SH 2
3 GB3VX 560 BELT PART NU
WOOD TRIM WING MOUNT GLUE AND FIBERGLASS TO DUCT
ENGINE SHAFT ASSY. SEE SH
ENGINE MOUNT ASSY - SEE
47
20
TRIM WING SEE SH 3
40
43
24
RUDDER SEE SH 3
GRAIN
SPACERS AS REQUIRED TO HOLD RUDDER UP AGAINST TRIM WING
12
1X4X63 WOOD ENGINE AND RUDDER MOUNT.
22
LIFT
2 A
3/4 x 1 1/2 x 72 WOOD-AFT INSIDE SKIRT ATTACH STRIP.
1800 CC SUBARU ENGINE (1980 TO 1986)
3/8 x 2 1/2 WOOD SKIRT ATTACH STRIP, AFT AND SIDES GLUE AND FIBERGLASS TO HULL FOAM.
GLASS PACK MUFFLER - 2 REQD
1/8 PLY
0
24
48

UH-18SP LIST OF MATERIALS

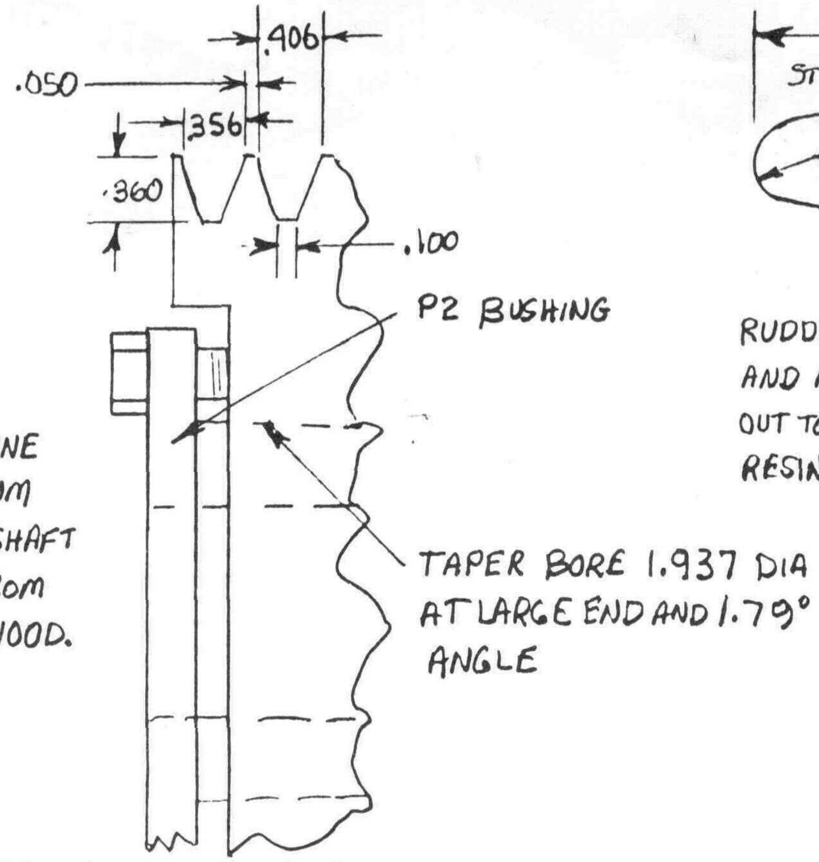
* 9 PC 4FT x 8 FT x 3 IN THICK EXTRUDED STYROFOAM FOR HULL. (NOT WHITE)
* 3 PC 4FT x 8FT x 2 IN THICK EXTRUDED STYROFOAM FOR DUCT. BLUE, PINK OR YELLOW
* 1 PC 4FT x 8FT x 1 IN THICK EXTRUDED STYROFOAM FOR RUDDERS & TRIM WING.
* 7 PC 4FT x 8FT x 1/8 PLYWOOD-EXTERIOR GRADE FOR HULL COVERING, COCKPIT SIDES AND LIFT AND THRUST DUCTS.

1 PC 4FT x 8FT x 1/4 EXTERIOR PLYWOOD - SEAT & BELT GUARD & FINS.
1 PC 4FT x 8FT x 1/2 PLYWOOD FOR LIFT AND THRUST DUCT DISKS.
1 PC 2x4 x 20 FT WOOD FOR CUTTING SKIRT ATTACH STRIPS, STRINGERS & SKIDS.
3 PC 1x4 x 16 FT WOOD FOR ENGINE MOUNT, DISK SUPPORT, INSIDE SKIRT ATTACH.
1 PC 1x6x10FT WOOD FOR LIFT SYSTEM SUPPORTS.

1 SH 48 x 48 x 1/16 CLEAR POLYCARBONATE (LEXAN OR TUFAK) WINDSHIELD
1 PC SIDE WINDOW ABOUT 18x18 FROM CONVERSION VAN FOR FRONT WINDSHIELD
1 PC HAND OPERATED WINDSHIELD WIPER.
16 FT 1 1/4 x .083 WALL SQUARE STEEL TUBING. FOR MOUNT.
12 FT 1/2 BLACK IRON PIPE-GAS PIPE. FOR MOUNT AND STEERING.
4 FT 1x1 x 1/8 ANGLE IRON
4 FT 1 x .083 WALL SQUARE STEEL TUBING.
2 PC 3/4 EMT x 10 FT LONG (ELECTRIC METAL TUBING) WINDSHIELD
3 PC 1/2 EMT x 10 FT - COCKPIT COVER.
1 PC 1/4 x 1 x 8 STEEL BAR - MOUNT SUPPORT
1 PC 1 x 1/8 x 32 ALUM BAR - RUDDER BAR
2 PC 1/4 x 2 x 4 STEEL PLATE - STEERING SYSTEM
4 PC 2 INCH INSIDE DIA PIPE x 1 1/4 LONG & 4 5/8 WASHERS FOR RUBBER MOUNT.
8 PC 2 INCH DIA x 3/4 THICK SOFT RUBBER. (OR MAKE FROM SILICONE)
3 FT 5/8-11 THREADED ROD FOR IDLER SUPPORTS.
4 FT 1/2-13 THREADED ROD. MOUNT
1 FT 1/4-20 THREADED ROD.
1 PC MOTORCYCLE THROTTLE HANDLE WITH 2 CABLES
* 2 PC SMALL GLASS PACK MUFFLERS UNDER 18 INCHES LONG.
* 90 FT 1/16 STAINLESS CABLE FOR STEERING AND TRIM CONTROL AND THROTTLE.
* 6 PC 1 1/4 TO 1 1/2 DIA CABLE ROLLERS.
* 4 PC 6 TO 7 IN DIA V BELT IDLER FOR 5V OR B BELT WITH 5/8 BORE.
* 1 PC 5VX 950 BELT & 1 PC 5V 2650 BELT FOR LIFT SYSTEM DRIVE. WITH NO VARIATOR MOVE LIFT DRIVESHEAVE FWD 3IN AND USE 5V 3350 BELT.

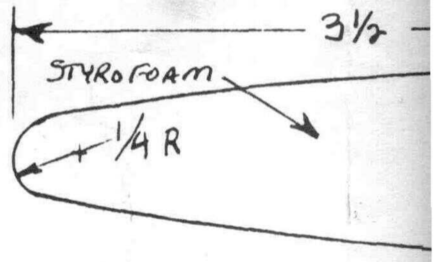
12 IN 1/8 COPPER TUBING - FOR STEERING AND TRIM CABLE CLAMPS.

1 PC 1 DIA STEEL SHAFT x 12 LONG WITH 1/4 KEY SLOT FOR LIFT SHAFT.
1 PC 1 1/8 DIA STEEL SHAFT x 16 LONG WITH 1/4 KEY SLOT FOR ENGINE SHAFT.
1 PC 1 3/8 DIA STEEL SHAFT x 18 LONG WITH 5/16 KEY SLOT FOR PROP SHAFT.
2 PC 1 INCH BORE BALL BEARING WITH LOCKING COLLAR AND CAST PILLOW BLOCK.

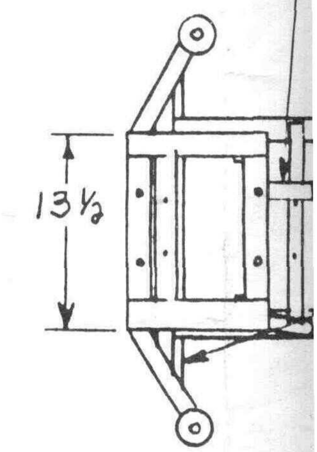


USE 6 GROOVES ON ENGINE AND PROP SHAFTS. MAKE ENGINE SHAFT SHEAVE FROM ALUM AND PROPSHAFT SHAFT SHEAVE FROM EPOXY COATED WOOD.

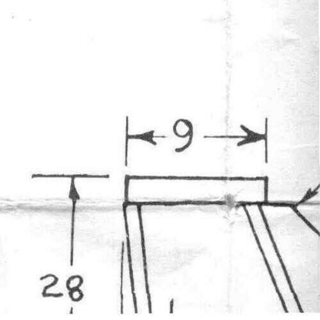
3V SHEAVE DIMENSIONS FULL SIZE.



RUDDER AND TRIM WING CON
AND AROUND LEADING EDGE
OUT TO EDGE AND RESIN INTO
RESIN SETS AND DO OTHER

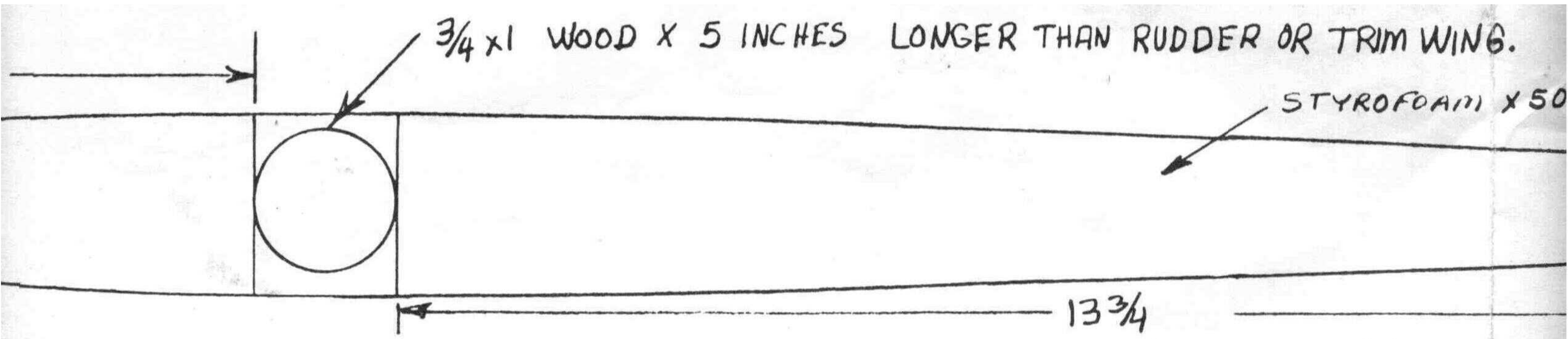


TOP



VACUME BAGGING TECHNIQUE

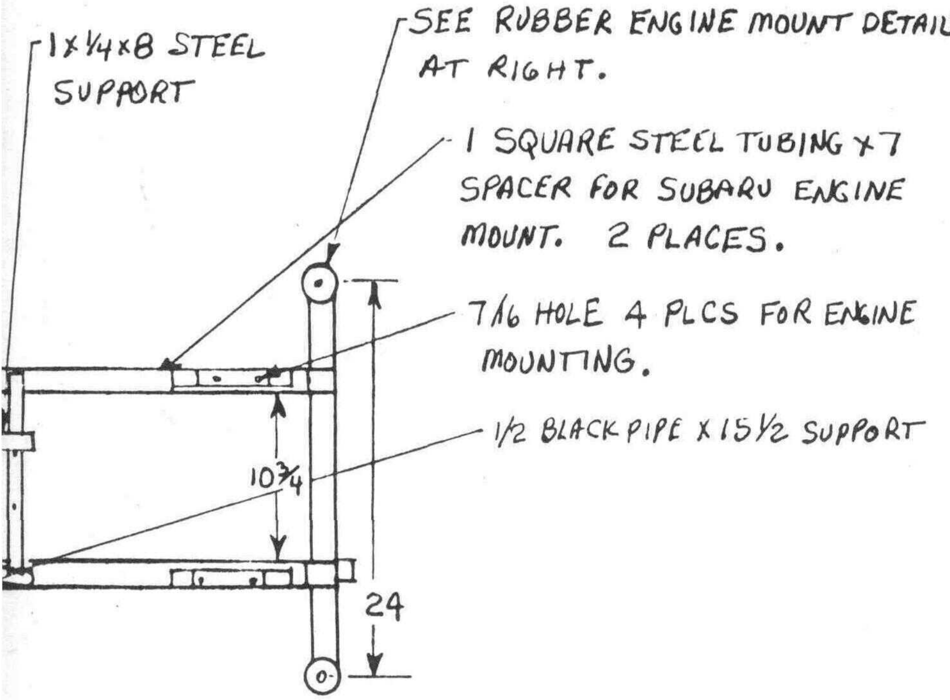
THIS METHOD IS USED TO HOLD FOAM AND WOOD PARTS TIGHT TOGETHER WHILE EPOXY GLUE SETS HARD. KEEP WORK AREA AT 60 TO 80°F AS HIGHER TEMPERATURE CAUSE FASTER CURE TIMES. MIX EPOXY 2-4 MINUTES AND APPLY AS FAST AS POSSIBLE. DO NOT LEAVE EPOXY IN MIXING CONTAINER MORE THAN 5 MINUTES. APPLY RAPIDLY WITH A 3-5 INCH WIDE ROLLER ALWAYS HAVE 1 OR MORE HELPERS; 1 FOR MIXING & 1 FOR APPLYING. USE ANY VACUME CLEANER, SOME EXTRA HOSE OR PLASTIC PIPE WITH BREETHER HOLES AND SEVERAL BLANKETS TO ACT AS BREETHERS TO REMOVE ALL AIR. CUT AND FIT ALL HULL PARTS. MAKE A PRACTICE RUN WITHOUT GLUE. THEN GLUE AS MANY PARTS AS YOU CAN IN 1 HR AT 70° OR LESS OR IN ½ HR UP TO 80°F. USE SLOW HARDENER. USE TEMPORARY #16 NAILS TO KEEP PARTS FROM SLIPPING. LAY PLASTIC OVER GLUED PARTS TO PREVENT STICKING TO BLANKETS. THEN SPREAD BLANKETS OVER EVERYTHING. WRAP PLASTIC AROUND EVERYTHING AND SEAL EDGES BY TAPING. (START WITH PLASTIC UNDER HULL) HOSE SHOULD GO AROUND SURFACE. TURN ON VACUME AND SEAL ANY LEAKS SO PLASTIC PULLS DOWN TIGHT EVERYWHERE. BE SURE VACUME HAS COOLING AIR FLOW OVER MOTOR. YOU MAY HAVE TO OPEN SOME OF THE BAG TO GET AIRFLOW FOR COOLING. LET RUN UNTIL EPOXY SETS - ABOUT 6-10 HRS. YOU MAY USE SAME BAG FOR 2 OR MORE



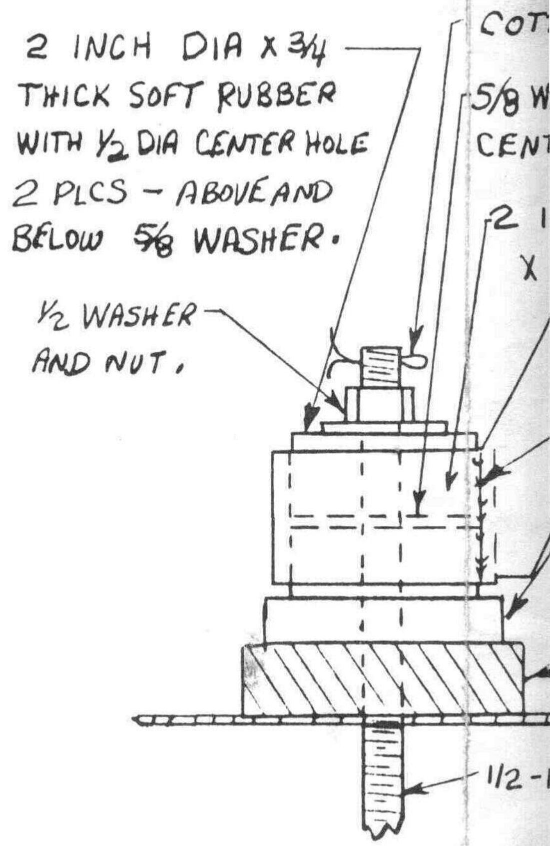
ONSTRUCTION METHOD: MAKE WOOD CENTER POST AND ROUND ENDS AS SHOWN. EPOXY GLUE STYRO FOAM TO
FIRST. THEN SWEEP AND VACUME UP ALL FOAM PARTICLES. SPREAD ON A THIN COAT OF EPOXY RESIN.
CLOTH. USE MINIMUM RESIN TO WET CLOTH. A SMOOTHER SURFACE CAN BE HAD BY LAYING WAX PAPER OVER
THE SAME. SAND AND APPLY A SECOND COAT OF RESIN IF PIN HOLES ARE PRESENT ESPECIALLY ON UPPE

RUDDER AND TRIM WING

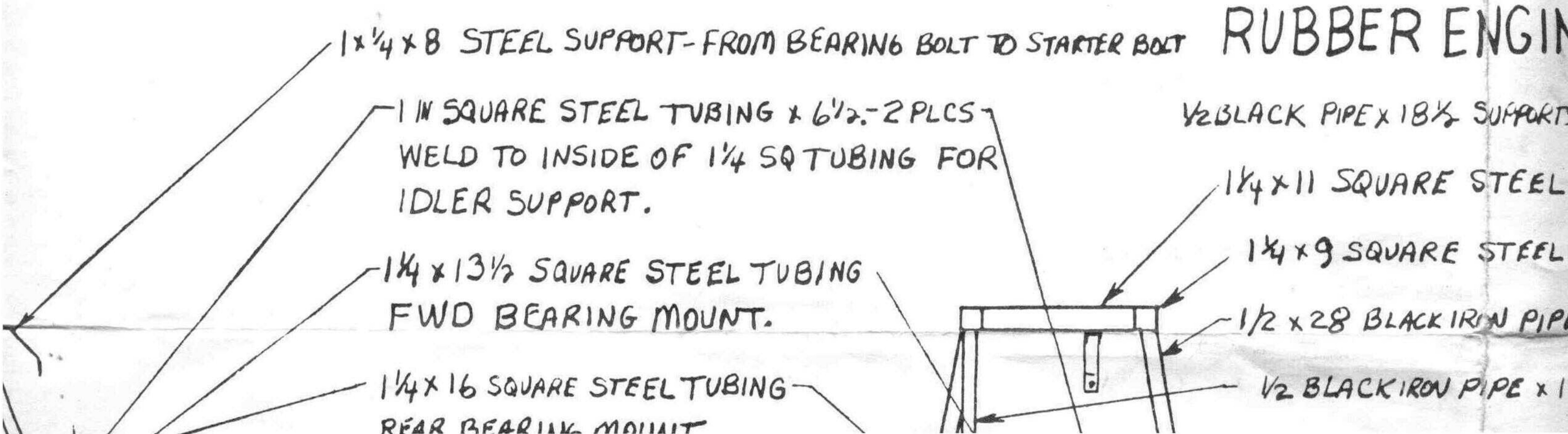
FULL SIZE CROSS SECTION. MAKE FROM 1 IN THICK BLUE
NOT FOR HOVERWING SEE SH 4



OP VIEW

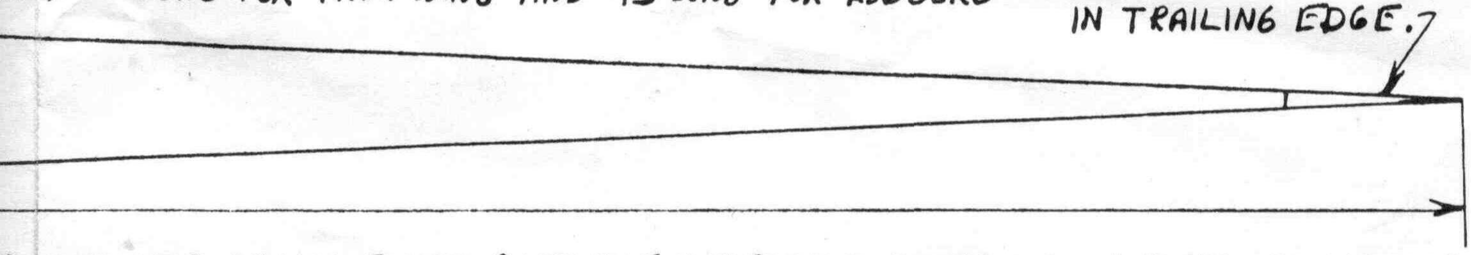


RUBBER ENGIN



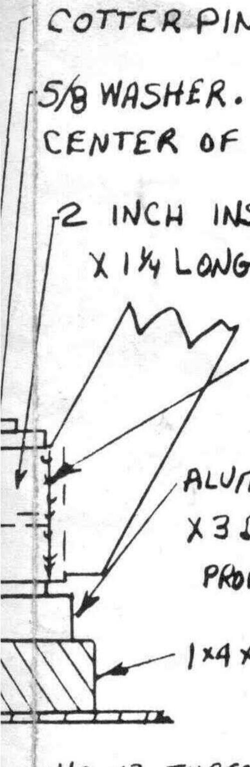
ING. ROUND LAST 2½ INCHES EACH END TO ¾ DIA.

... X 50 LONG FOR TRIM WING AND 43 LONG FOR RUDDERS

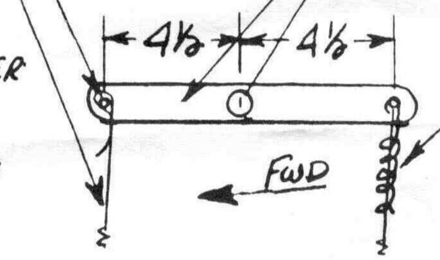


...OAM TO WOOD CENTER POSTS. CUT, FILE AND SAND TO SHAPE SHOWN ABOVE. DO ONE SIDE ...RESIN. THEN CAREFULLY LAY ON 2 TO 4 OZ/YD FIBERGLASS CLOTH (FINE WEAVE) AND WORK WRINKLES ...R OVER WET RESIN & CLOTH AND RUBBING TO SMOOTH SURFACE. REMOVE WAXPAPER WHEN ...ON UPPER SURFACE OF TRIM WING. PAINT WITH LIGHT COLOR.

...K BLUE OR PINK STYROFOAM. MAKE 3 RUDDERS AND 1 TRIM WING.

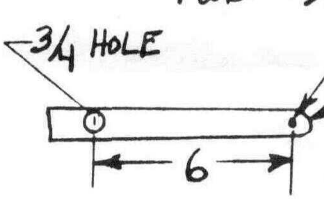


ENGINE MOUNT ½ SIZE
4 REQD.



TRIM WING CONTROL ARM 1/6 SIZE

EPOXY AND FIBERGLASS TO LEFT SIDE OF TRIM WING. NOT FOR HOVER WING SEE SH4.



RUDDER ARM 1/6 SIZE

MAKE FROM ¾×1×8 WOOD. MAKE 3 AND FIBERGLASS TO RUDDER BOTTOM

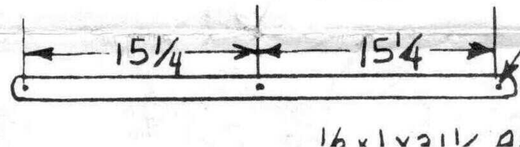
...L SUPPORTS FOR 1¼×29 TUBING.

... STEEL TUBING. 2 PLCS

...E STEEL TUBING. 2 PLCS

... IRON PIPE OR EQUIVALENT. 2 PLCS.

...I PIPE x 17 TO FIT.



1/6 x 1 x 31½ ALUM BAR

x9 SQUARE STEEL TUBING. 2 PLCS

x28 BLACK IRON PIPE OR EQUIVALENT. 2PLCS.

BLACK IRON PIPE x 17 TO FIT.

FRONT SUPPORT MAKE FROM 1¼x32
SQUARE STEEL TUBING.

1/2 BLACK IRON PIPE x 2¾

800 CC ENGINE.

x 17 LONG.

V BELT IDLER
(5/8 BORE) 2 PLCS

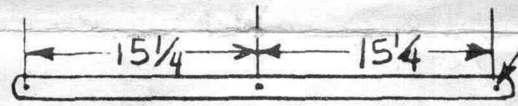
PLCS

x 10 THREADED ROD.

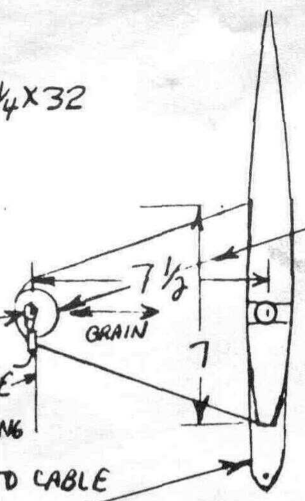
NUT. 4 PLCS

UCH DIA x 5/8 BORE
L BEARING IDLER
5V OR B BELT. 2 PLCS

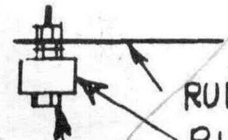
IDLER ASSY



RUDDER BAR

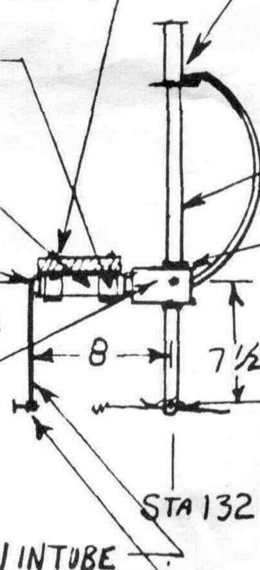


TOP VIEW
RT SIDE SHOWN



LOOKING AFT

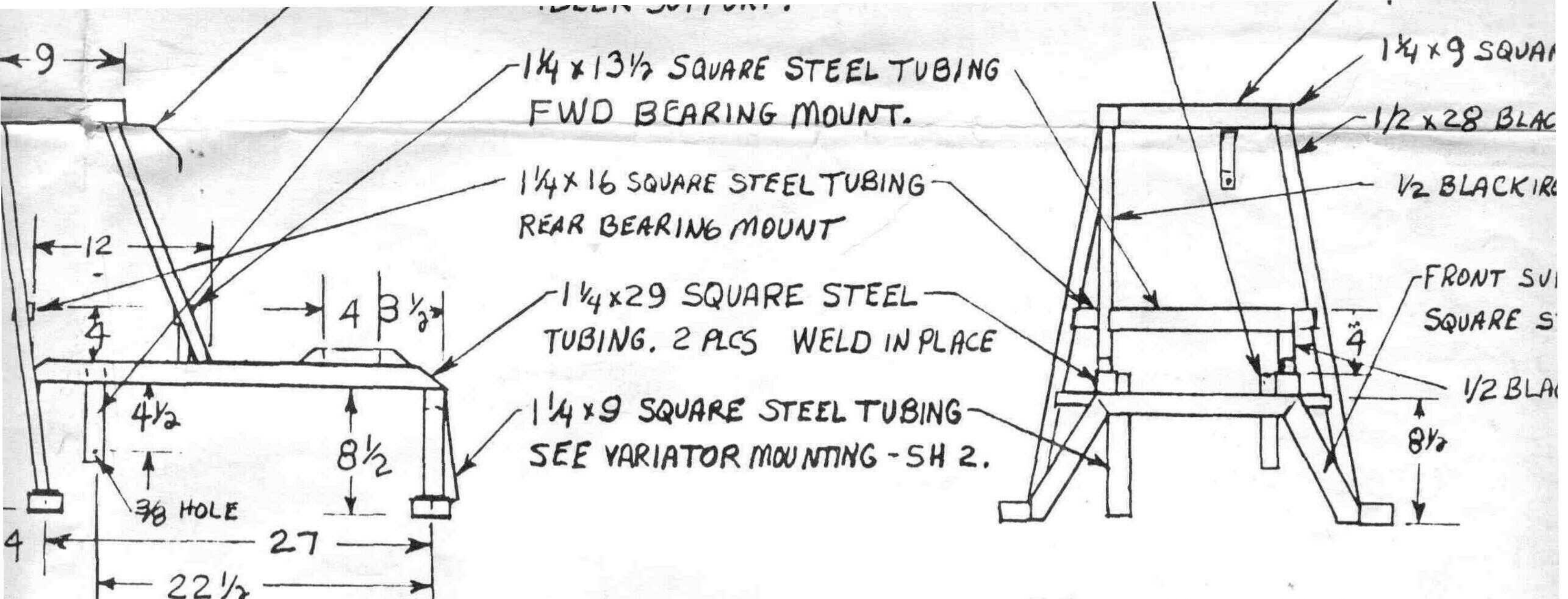
RUDDER BAR, ARM AND CABLE ASSY. 1/6 SIZE



STICK CONTROL SYSTEM. SIDE VIEW

NOTE: 1/16 STAINLESS STEERING CABLE ROUTES TO ROLLERS ON LT & RT SIDE OF COCKPIT AND BACK TO RUDDERS. (THRU COCKPIT WALLS)

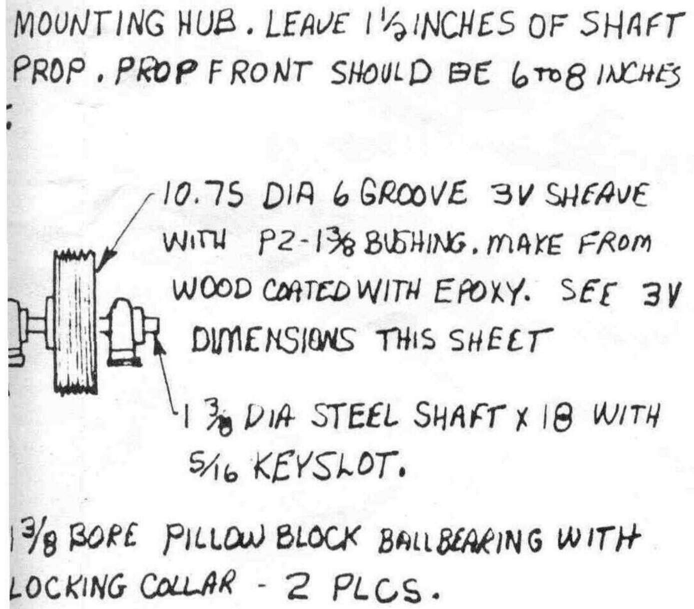
UH-18SP	SCALE 1/12 UNLESS NOTED
SHEET 3 JULY 99	BY R.J. WINDT
UNIVERSAL HOVERCRAFT BOX 281 CORDOVA, IL 61242	



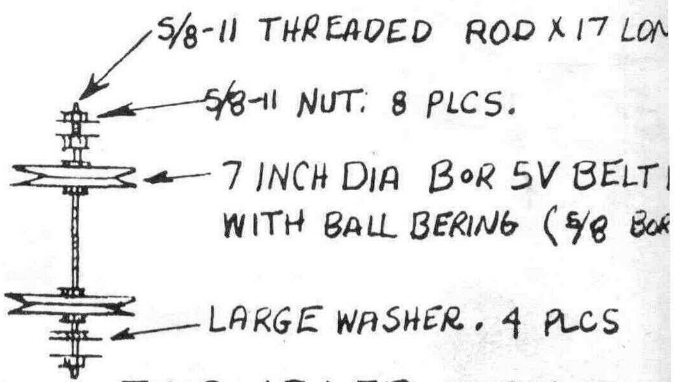
SIDE VIEW

FRONT VIEW

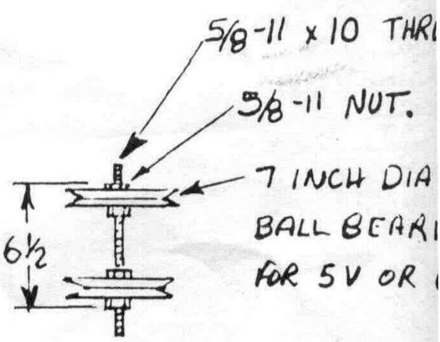
ENGINE MOUNT FRAME WELDED - FOR SUBARU 1800 CC EN



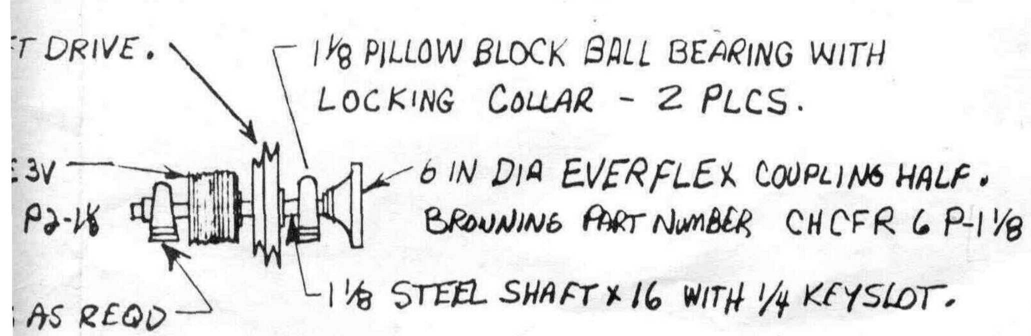
T ASSY BOLT TO MOUNT WITH 3/8 BOLTS.



FWD IDLER ASSY

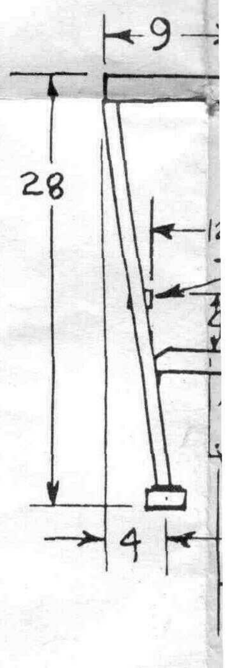


REAR IDLE

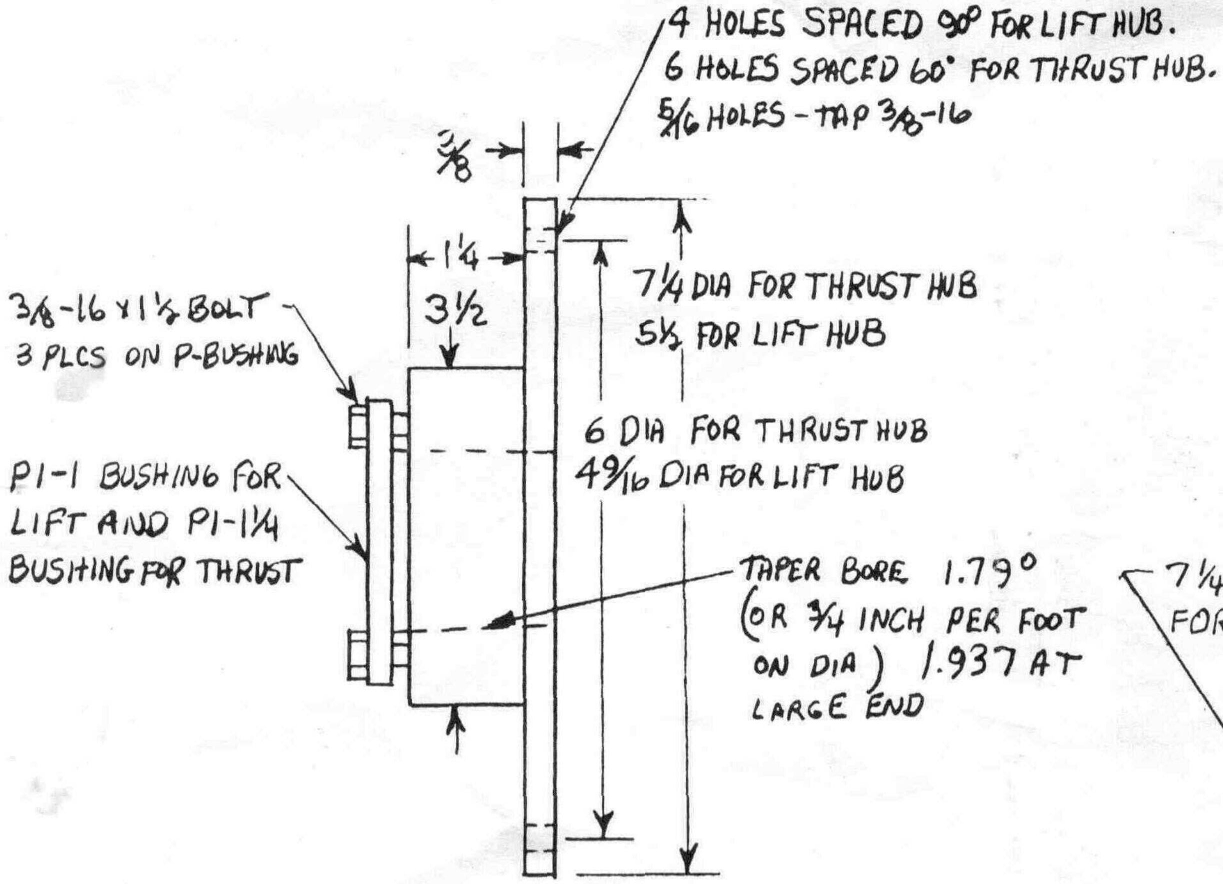


ENGINE SHAFT ASSY.

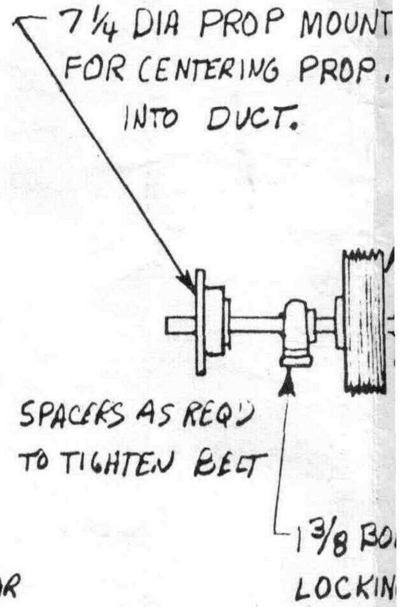
HULL) HOSE SHOULD GO AROUND SURFACE. TURN ON VACUME AND SEAL ANY LEAKS SO PLASTIC PULLS DOWN TIGHT EVERY WHERE. BE SURE VACUME HAS COOLING AIR FLOW OVER MOTOR. YOU MAY HAVE TO OPEN SOME OF THE BAG TO GET AIRFLOW FOR COOLING. LET RUN UNTIL EPOXY SETS - ABOUT 6-10 HRS. YOU MAY USE SAME BAG FOR 2 OR MORE BAGGING SESSIONS ON THE HULL.



SIDE



LIFT AND THRUST HUBS MAKE FROM ALUM



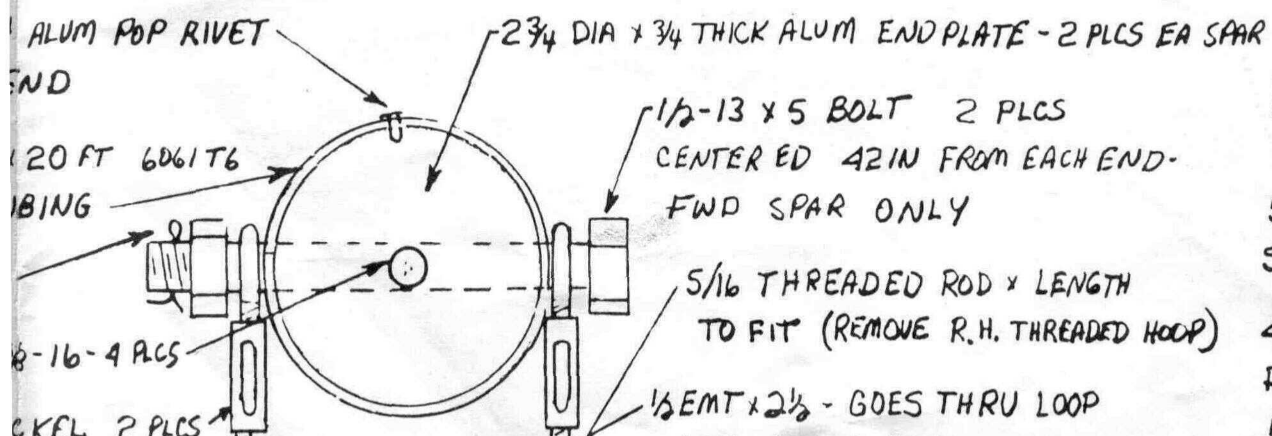
PROP SHAFT AS

5V SHEAVE FOR LIFT DRIV
SEE SH 2

4.75 DIA 6 GROOVE 3V
DRIVE SHEAVE WITH P2-1
BUSHING

SPACERS AS RE

E



ALUM SPAR OPTION SEE SH 4

	1 PC	1 DIA STEEL SHAFT X 12 LONG WITH 1/4 KEY SLOT FOR LIFT SHAFT.
	1 PC	1 1/8 DIA STEEL SHAFT X 16 LONG WITH 1/4 KEY SLOT FOR ENGINE SHAFT.
	1 PC	1 3/8 DIA STEEL SHAFT X 18 LONG WITH 5/16 KEY SLOT FOR PROP SHAFT.
	2 PC 25.4	1 INCH BORE BALL BEARING WITH LOCKING COLLAR AND CAST PILLOW BLOCK.
	2 PC 28.5	1 1/8 INCH BORE BALL BEARING WITH LOCKING COLLAR AND CAST PILLOW BLOCK.
	2 PC 35mm	1 3/8 INCH BORE BALL BEARING WITH LOCKING COLLAR AND CAST PILLOW BLOCK.
	1 PC	1/4 x 1/4 KEY STOCK x 12 AND 1 PC 5/16 x 5/16 x 6 KEY STOCK.
*	1 PC	6 INCH EVERFLEX COUPLING HALF. BROWNING PART# CH CFR 6 P-1 1/8.
*	1 PC	5 1/2 AND 6 1/8 DIA LIFT DRIVE SHEAVE SET WITH P1-1 1/8 BUSHING.
*	1 PC	9 INCH DIA ALUM, STEEL OR WOOD/EPOXY SHEAVE WITH P1-1 BUSHING FOR 5 V BELT.
*	1 PC	4.7 DIA 6 GROOVE ALUM SHEAVE FOR 3 V BELT WITH P2-1 1/8 BUSHING.
*	1 PC	10.75 DIA 6 GROOVE WOOD-EPOXY SHEAVE FOR 3V BELT WITH P2-1 3/8 BUSHING.
*	1 PC	34-28 4 BLADE LIFT FAN WITH 1 IN BORE.
*	1 PC	5 1/2 DIA ALUM FAN HUB WITH P1-1 BUSHING.
*	1 PC	60-53 THRUST PROPELLER WITH 1 3/8 BORE
*	1 PC	7 1/4 DIA ALUM PROP HUB & P1-1 3/8 BUSHING.
*	9 1/2 YDS	VINYL OR NEOPRENE COATED NYLON x 60 WIDE (16-18 OZ/YD) SKIRT MATERIAL.
*	300 PCS	1/2 X #6 SHEET METAL SCREWS - SKIRT ATTACH.
*	1/2 PT.	HH-66 VINYL OR NEOPRENE GLUE. NON LATEX CONTACT GLUE WORKS OK.
*	3 GAL	EPOXY GLUE.
	1 GAL	NON LATEX EXTERIOR PAINT.
*	2 PC	3 GB 3VX 560 BELT. 2 BANDS OF 3 BELTS x 56 LONG FOR PROP DRIVE.
	1 PC	1800 CC SUBARU ENGINE (1980 TO 1986) WITH STARTER, BELL HOUSING FLYWHEEL AND ALTERNATOR AND A SMALLER RADIATOR.
	1 PC	SMALL 12 VOLT CAR BATTERY
*	1 PC	6 GAL PORTABLE FUEL TANK.

NOTE: IF YOU ARE BUILDING THE HOVERWING, DO NOT BUILD THE RUDDERS AND TRIM WING SHOWN ON SH 3. GO TO SH 4

3/16 x 1/4 LENGTH ALU
4 PCS EACH END

3 O.D. x 1/8 WALL x 20
OR EQUIV ALUM TUBIN

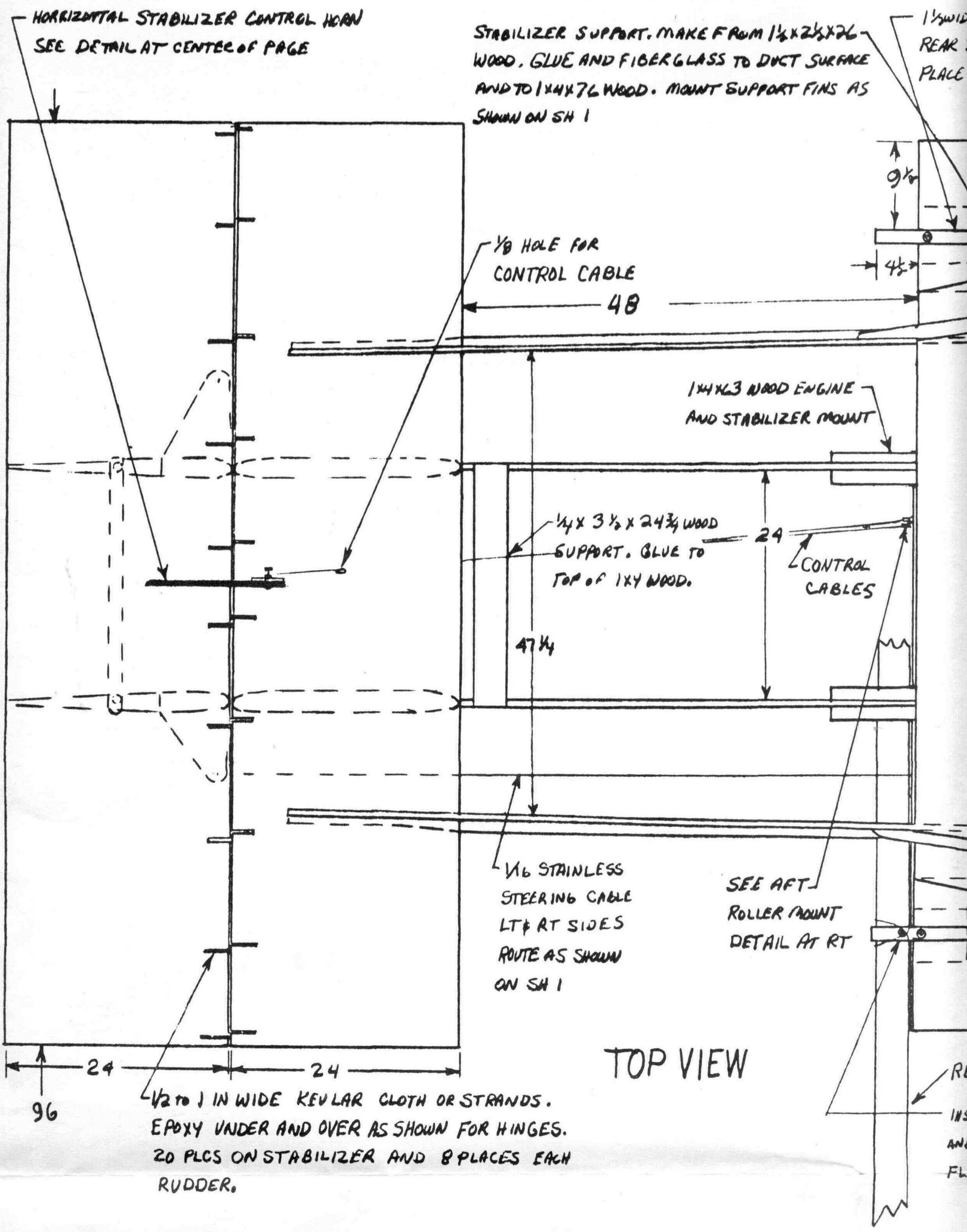
COTTER PIN

DRILL .326 TAP 3/8-16

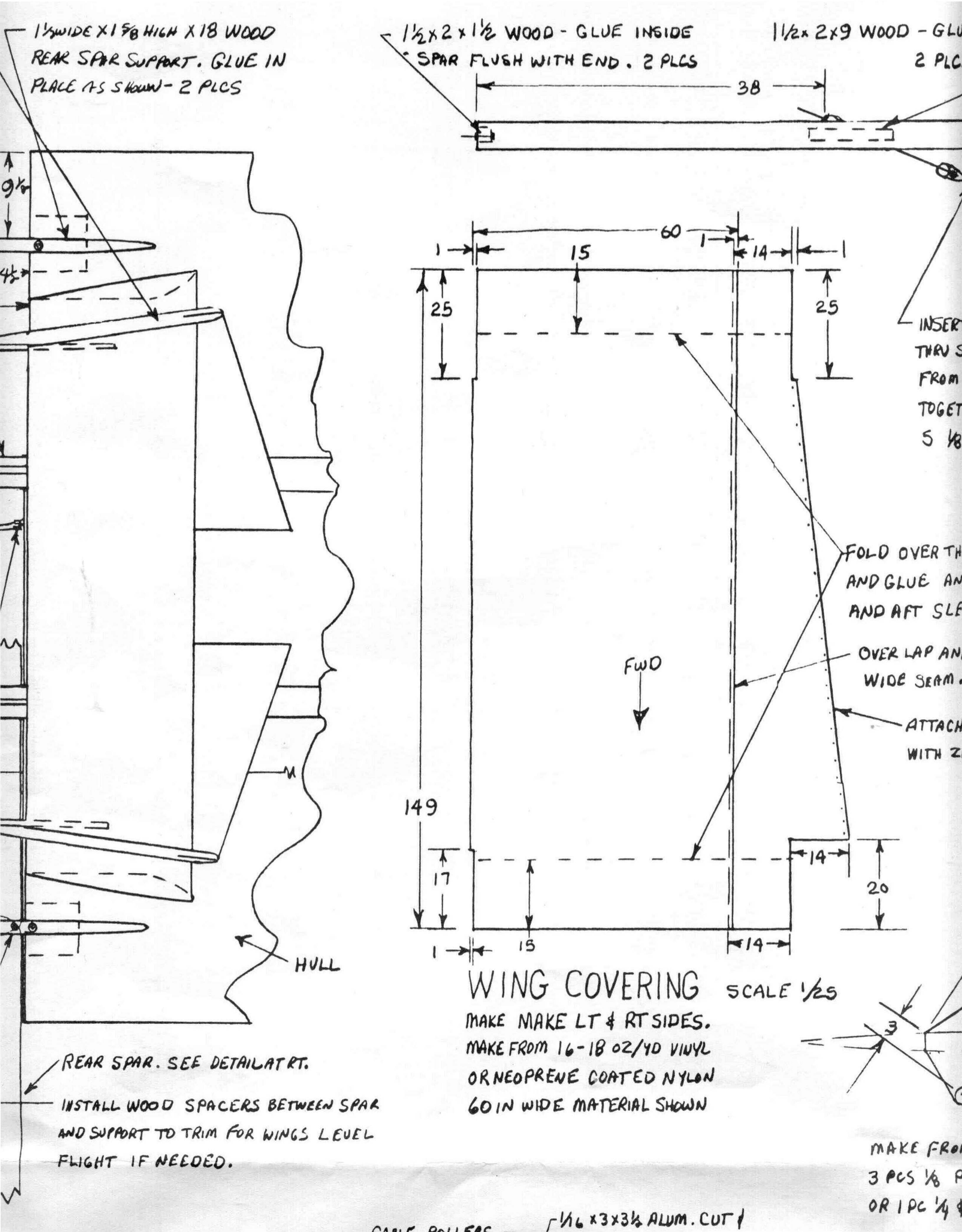
5/16 TURN BUCKE
EACH SIDE

BEND

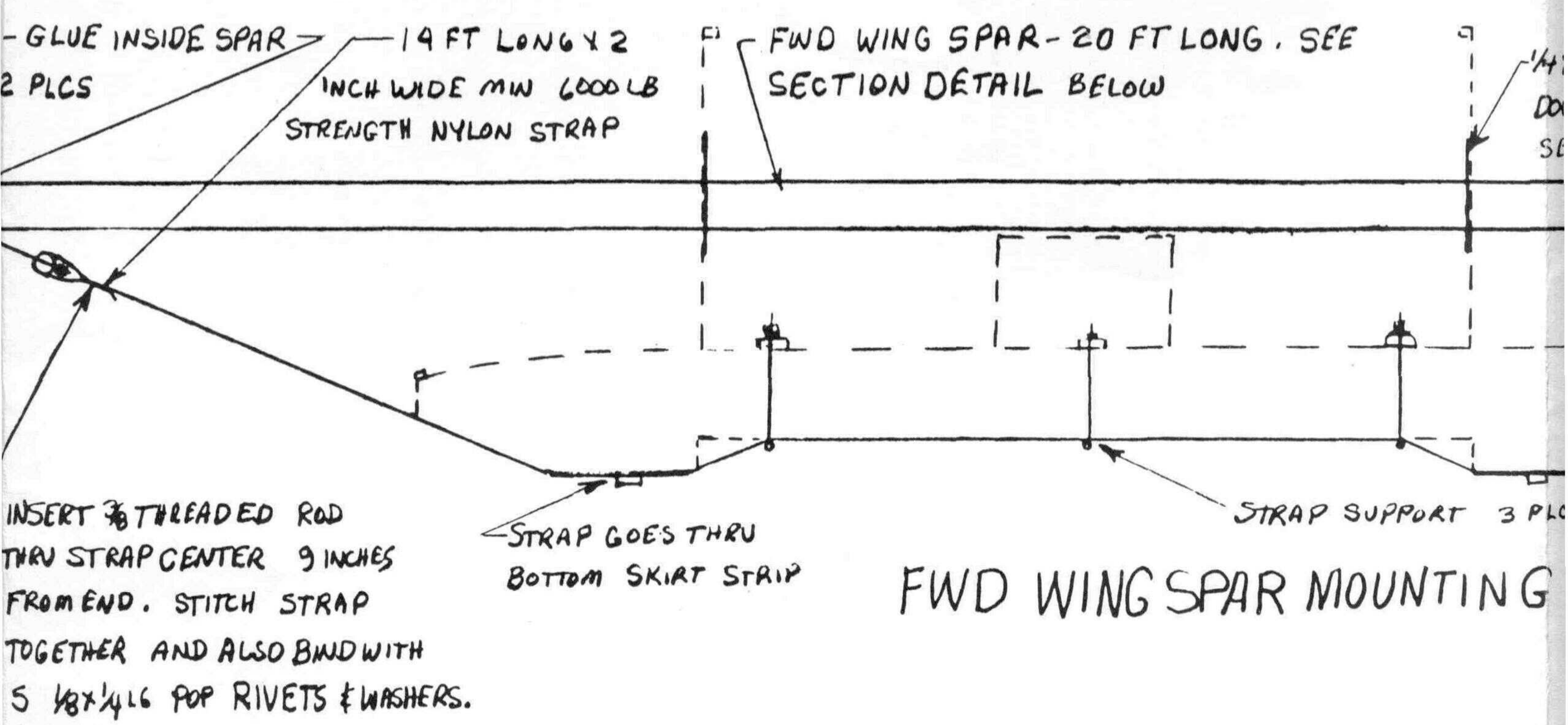
* - THESE ITEMS ARE AVAILABLE FROM UNIVERSAL HOVERCRAFT.



HORRIZONTAL STABILIZER CONTROL HORN
SEE DETAIL AT CENTER OF PAGE
STABILIZER SUPPORT. MAKE FROM 1¼ x 2½ x 26 WOOD. GLUE AND FIBERGLASS TO DUCT SURFACE AND TO 1x4x76 WOOD. MOUNT SUPPORT FINS AS SHOWN ON SH 1
9⅛
4½
1/8 HOLE FOR CONTROL CABLE
48
1x4x63 WOOD ENGINE AND STABILIZER MOUNT
¼ x 3½ x 24¾ WOOD SUPPORT. GLUE TO TOP OF 1x4 WOOD.
24
CONTROL CABLES
47¼
1/16 STAINLESS STEERING CABLE LT & RT SIDES ROUTE AS SHOWN ON SH 1
SEE AFT ROLLER MOUNT DETAIL AT RT
24
24
96
TOP VIEW
½ TO 1 IN WIDE KEVLAR CLOTH OR STRANDS. EPOXY UNDER AND OVER AS SHOWN FOR HINGES. 20 PLCS ON STABILIZER AND 8 PLACES EACH RUDDER.



1½ WIDE X 1⅝ HIGH X 18 WOOD REAR SPAR SUPPORT. GLUE IN PLACE AS SHOWN - 2 PLCS
1½ x 2 x 1½ WOOD - GLUE INSIDE SPAR FLUSH WITH END. 2 PLCS
1½ x 2 x 9 WOOD - GL
2 PLC
38
9½
4½
60
1
15
1
14
1
25
25
INSER
THRU S
FROM
TOGET
5 ⅛
FOLD OVER TH
AND GLUE AN
AND AFT SLE
OVER LAP AN
WIDE SEAM
FWD
ATTACH
WITH Z
149
17
14
20
1
15
14
HULL
WING COVERING SCALE 1/25
MAKE MAKE LT & RT SIDES.
MAKE FROM 16-18 OZ/YD VINYL
OR NEOPRENE COATED NYLON
60 IN WIDE MATERIAL SHOWN
3
REAR SPAR. SEE DETAIL AT RT.
INSTALL WOOD SPACERS BETWEEN SPAR AND SUPPORT TO TRIM FOR WINGS LEVEL FLIGHT IF NEEDED.
MAKE FRO
3 PCS ⅛ F
OR 1 PC ¼
1/16 x 3 x 3½ ALUM. CUT



FWD WING SPAR MOUNTING

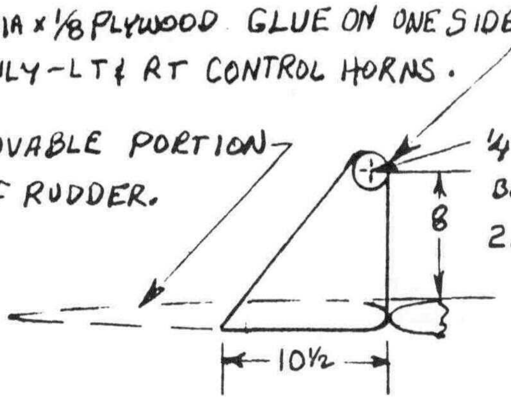
1/4-20 N
AND WASH

1/4 PIPE x 3

ER THE FWD & AFT 15 INCHES
E AND SEW TO FORM FWD
SLEVE TO SLIDE OVER SPARS.

AP AND GLUE AND SEW 1 INCH
SEAM.

TTACH THIS EDGE TO TO SIDE OF DECK
ITH ZIPPER OR 1/2 x #6 SCREWS.

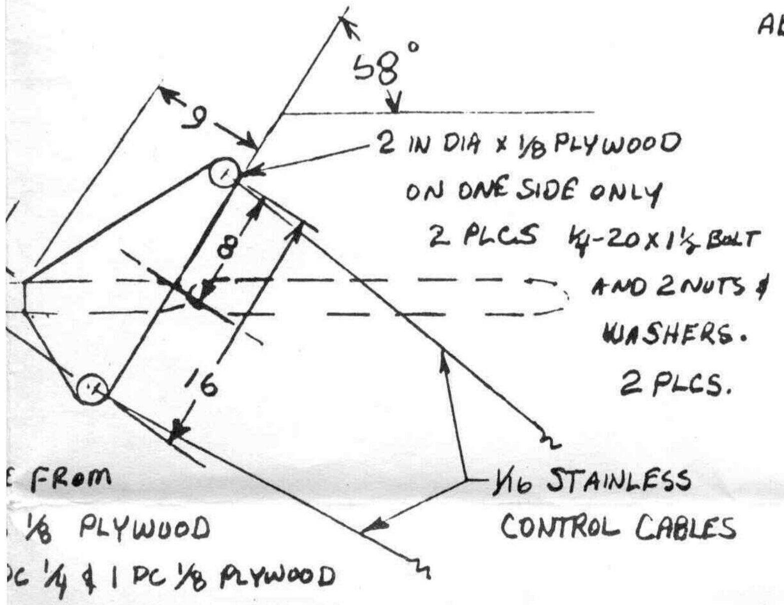


ST
S

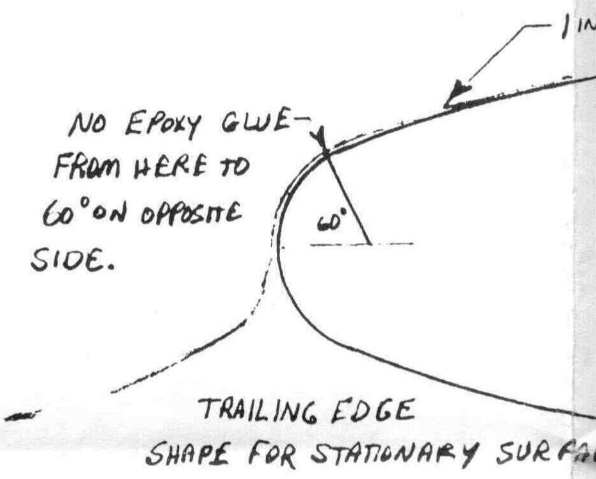
RUDDER CONTROL HORN

MAKE

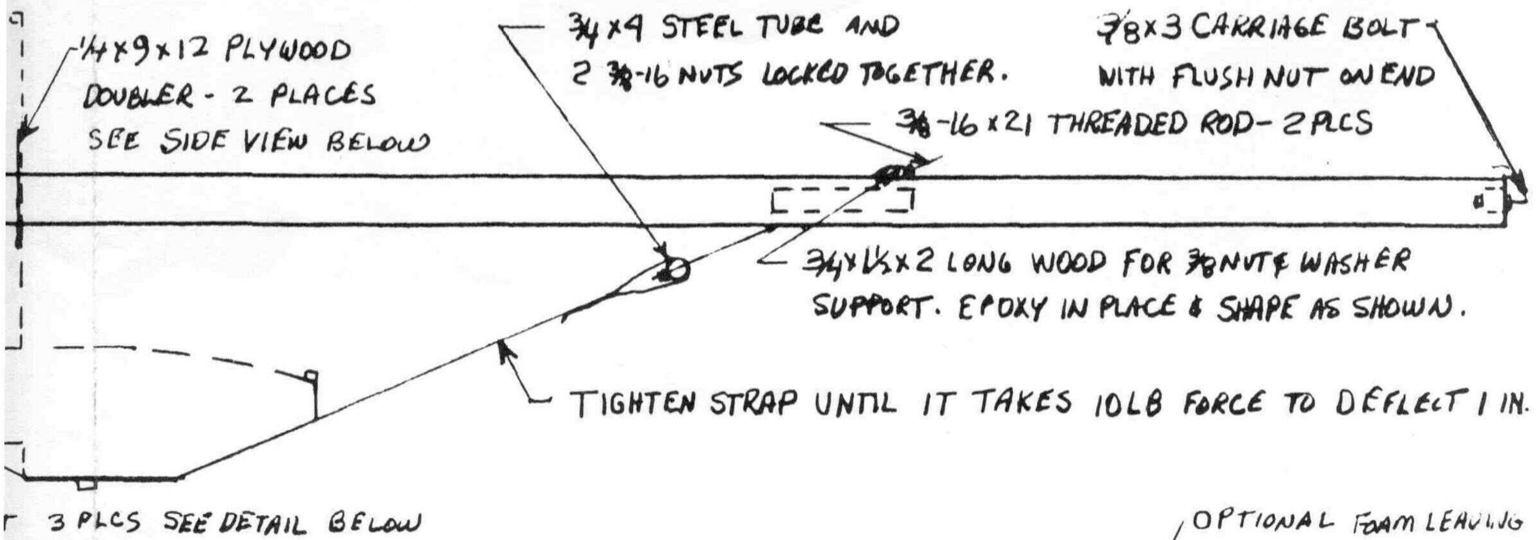
MAKE LT & RT. MAKE FROM 3 PCS 1/8 PLYWOOD OR 1 PC 1/4 AND 1 PC 1/8 PLYWOOD. CUT SLOT 2 INCHES ABOVE BOTTOM AND FIBERGLASS IN PLACE AS SHOWN ABOVE AND IN SIDE VIEW.



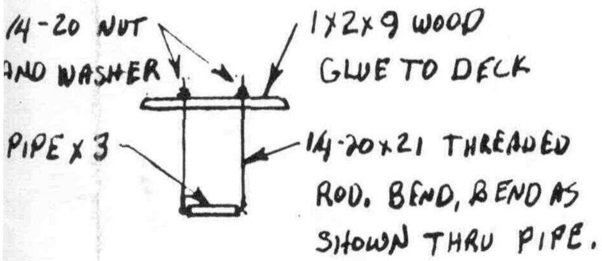
E FROM
1/8 PLYWOOD
C 1/4 & 1 PC 1/8 PLYWOOD



TRAILING EDGE
SHAPE FOR STATIONARY SURFA
MOVABLE TRAILING SURFACES CURVE
SHARP EDGE AS SHOWN IN SIDE VIEW.

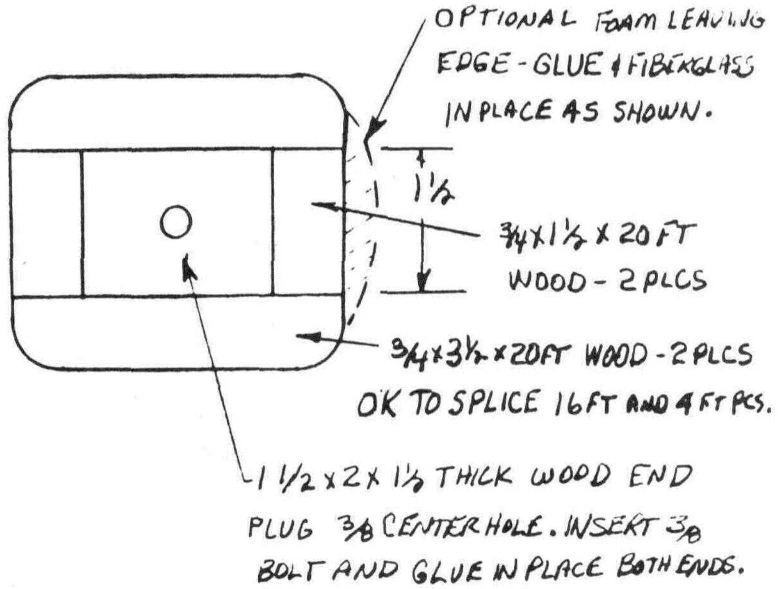


ING



STRAP SUPPORT MAKE 3

SIDE VIEW



WING SPAR END VIEW 1/2 SIZE

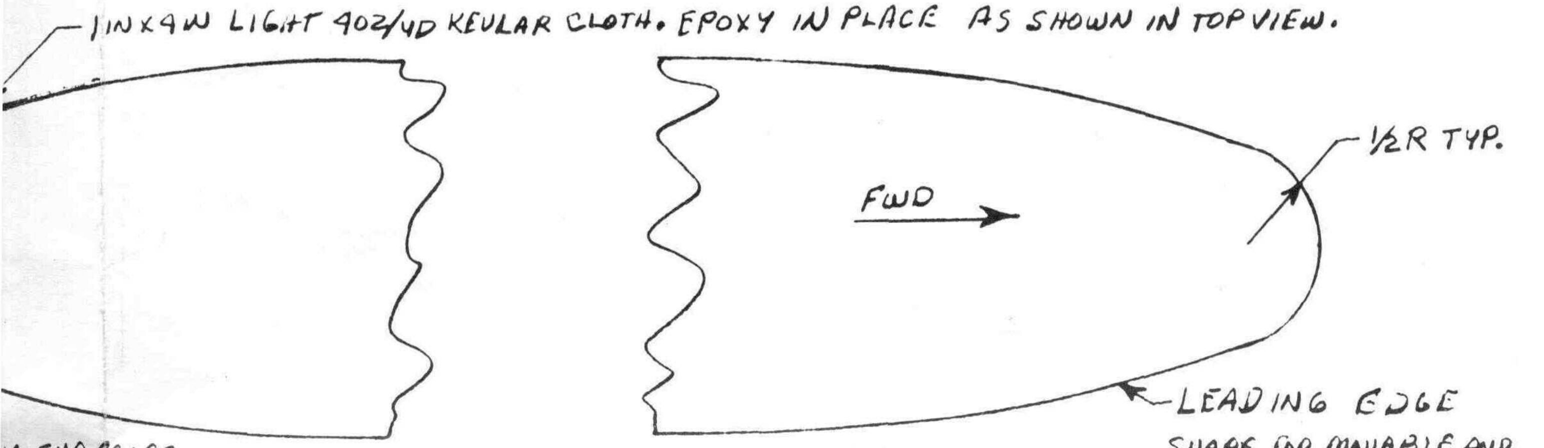
FIBERGLASS AROUND THE COMPLETE SPAR WITH ONE LAYER OF 6 OZ/YD CLOTH AND ALL BUT THE LAST 2 FT ON EACH SIDE WITH A SECOND LAYER OF 6 OZ/YD CLOTH.

MAKE 2 SEE SPLICE DETAIL BELOW.

SEE SH 3 FOR ALUM SPAR DETAILS.

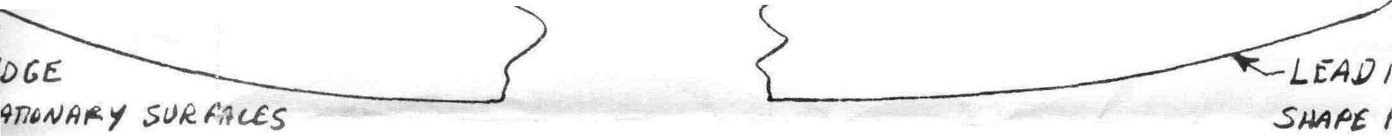
'E
)
NCHES
V

1 IN x 4 W LIGHT 4 OZ/YD KEVLAR CLOTH. EPOXY IN PLACE AS SHOWN IN TOP VIEW.

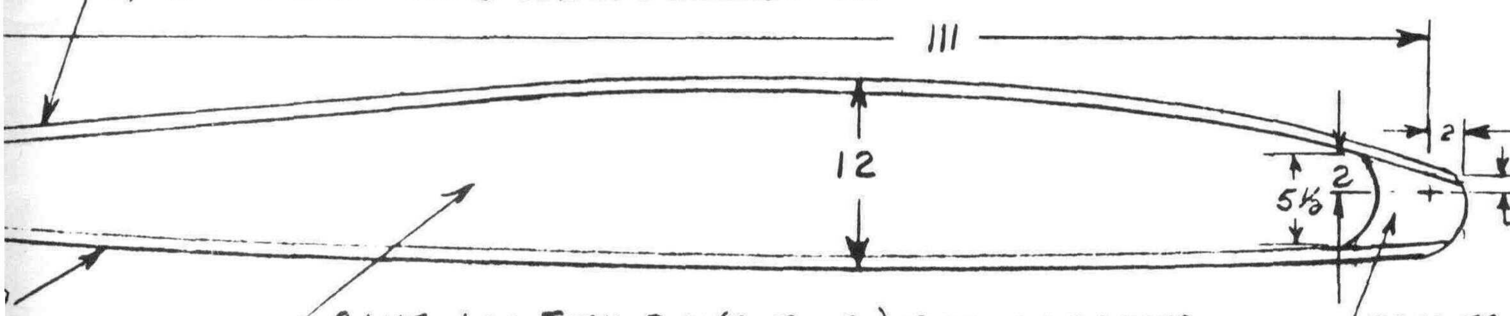


Y SURFACES
CURVE TO A
C VIEW.

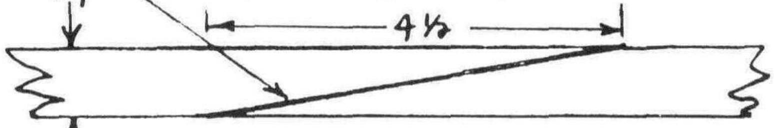
FULL SIZE CONTROL SURFACE SHAPES.



FULLSIZE CONTROL SURFACE SHAPES.

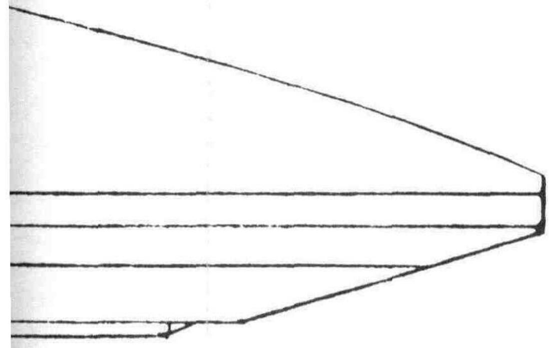


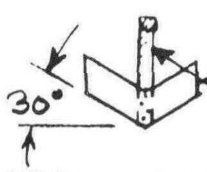
WING TIP DETAILS MAKE 2



SPLICE JOINT ON WING SPARS-½ SIZE

USE WOOD 16 FT AND 4 FT 4½ INCHES LONG TO MAKE 20 FT.
USE GOOD WORKMANSHIP & BE SURE JOINT IS COMPLETLY FILLED.

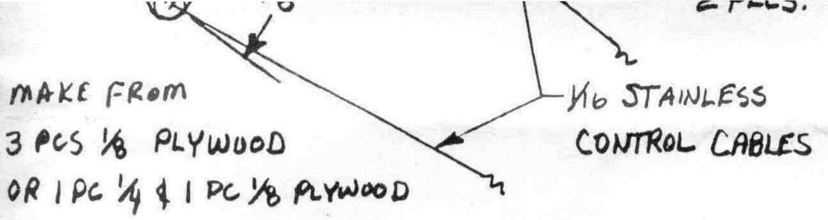


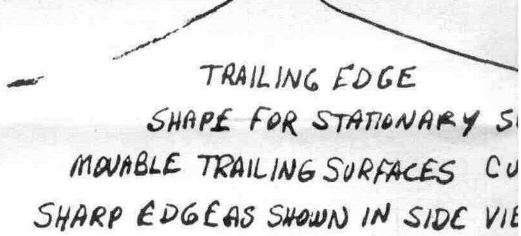


WINGTIP WATER SKI

LOOKING AFT

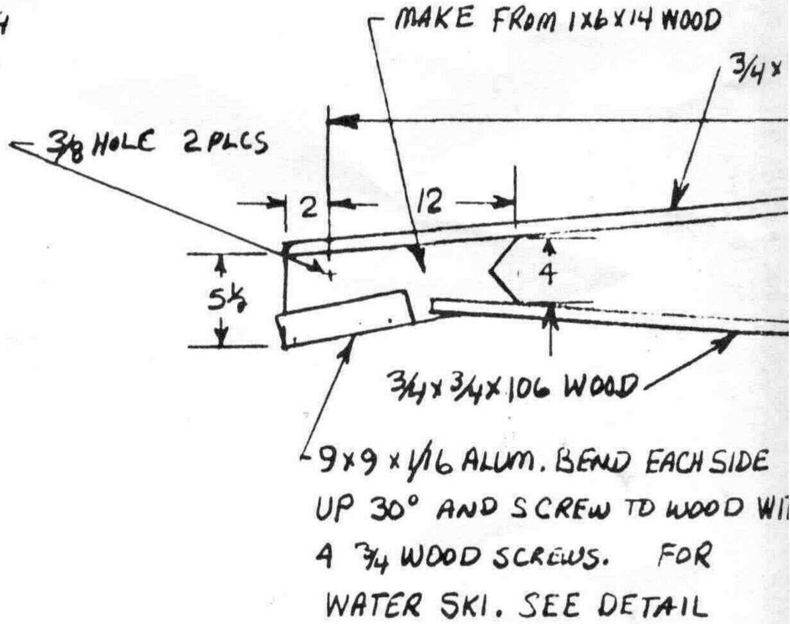
UH-18 SPW HOVERWING	SCALE 1/12 UNLESS NOTED
SHEET 4 SEPT 99	BY R.J. WINDT
UNIVERSAL HOVERCRAFT BOX 281 CORDOVA IL. 61242	

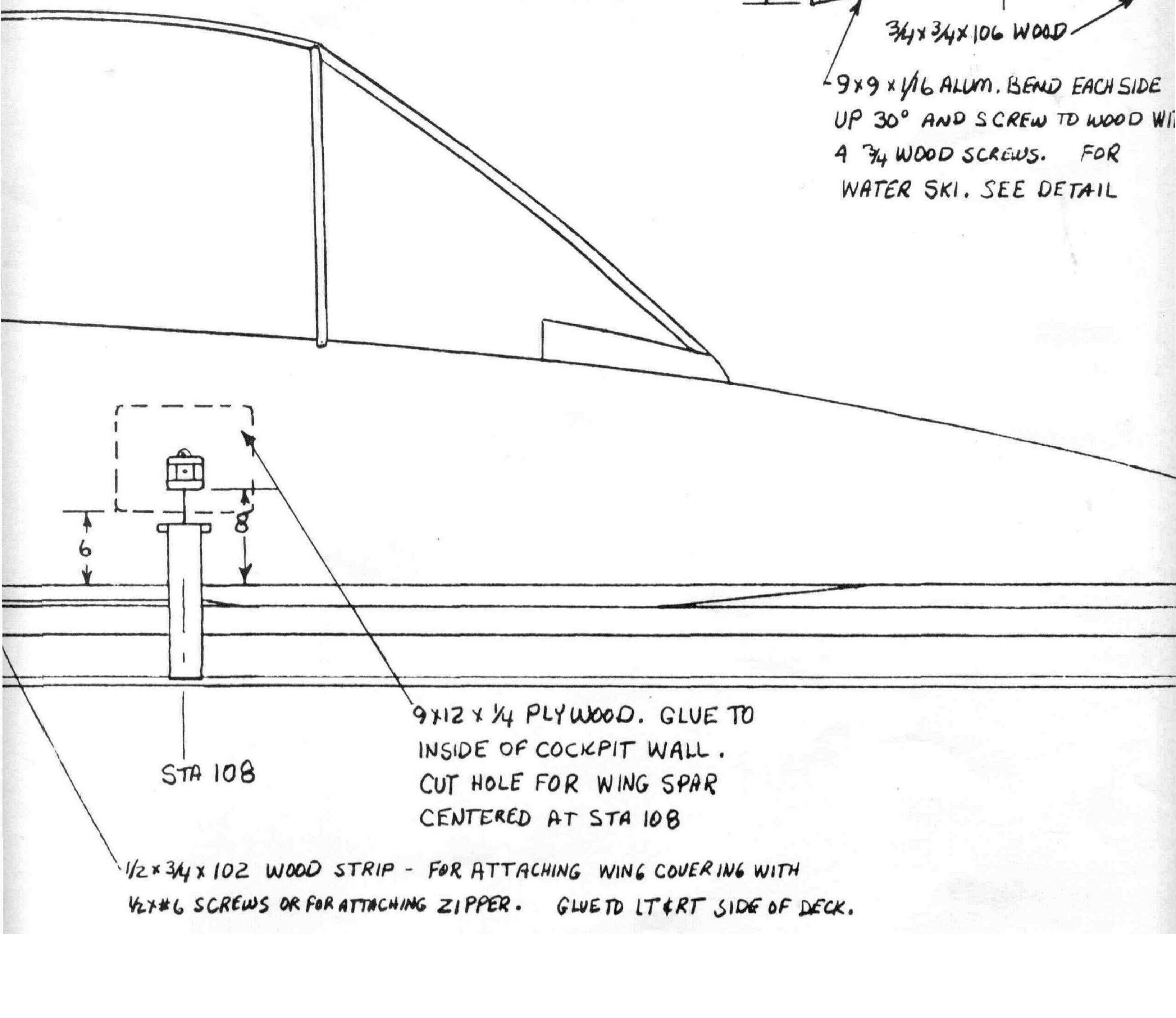


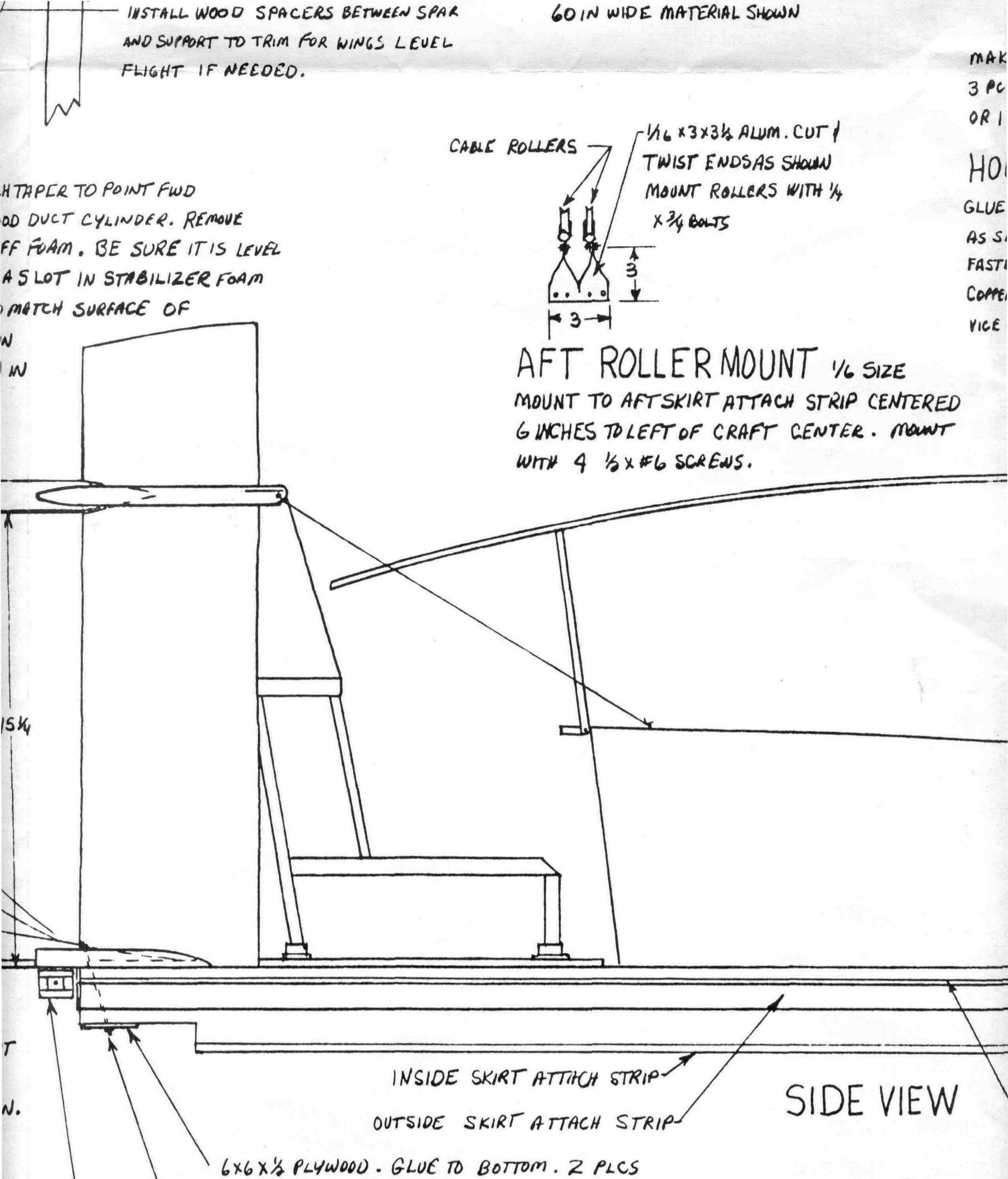


HORRIZONTAL STABILIZER CONTROL HORN

GLUE AND FIBERGLASS INTO THE MOVABLE PART OF THE STABILIZER AS SHOWN ABOVE AND CENTERED AS SHOWN ABOVE IN TOP VIEW. FASTEN CONTROL CABLE ENDS WITH 2 1 INCH LONG PCS OF 1/8 OR 1/4 COPPER TUBING. REMOVE SLACK AND SQUEEZE TUBING WITH VICE GRIPS MANY TIMES.





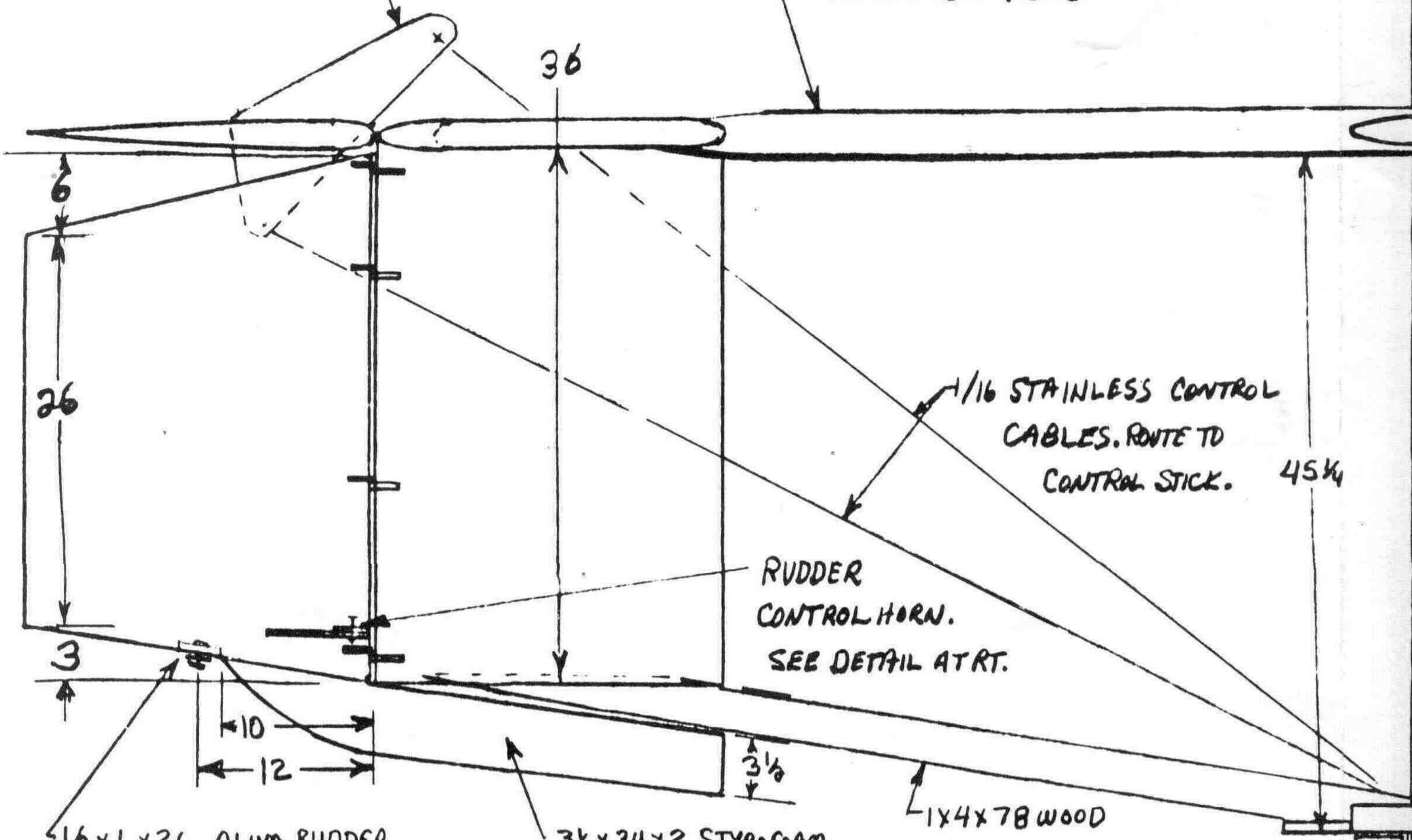


INSTALL WOOD SPACERS BETWEEN SPAR AND SUPPORT TO TRIM FOR WINGS LEVEL FLIGHT IF NEEDED.
60 IN WIDE MATERIAL SHOWN
MAK
3 PC
OR I
HO
GLUE
AS S
FASTI
COPPE
VICE
CABLE ROLLERS
1/16 x 3 x 3½ ALUM. CUT & TWIST ENDS AS SHOWN
MOUNT ROLLERS WITH ¼ x ¾ BOLTS
3
3
AFT ROLLER MOUNT 1/6 SIZE
MOUNT TO AFT SKIRT ATTACH STRIP CENTERED 6 INCHES TO LEFT OF CRAFT CENTER. MOUNT WITH 4 ½ x #6 SCREWS.
H TAPER TO POINT FWD
OD DUCT CYLINDER. REMOVE
FF FOAM. BE SURE IT IS LEVEL
A SLOT IN STABILIZER FOAM
MATCH SURFACE OF
N
IN
15¼
T
N.
2 PLCS.
INSIDE SKIRT ATTACH STRIP
OUTSIDE SKIRT ATTACH STRIP
SIDE VIEW
6x6x½ PLYWOOD. GLUE TO BOTTOM. 2 PLCS UNDER SPAR SUPPORT.
5/16-18 THREADED ROD x 10 LONG. THRU SPAR SUPPORT & PLYWOOD

1/2 TO 1 IN WIDE KEVLAR CLOTH OR STRANDS. EPOXY UNDER AND OVER AS SHOWN FOR HINGES. 20 PLCS ON STABILIZER AND 8 PLACES EACH RUDDER.

1X4X76 WOOD STABILIZER SUPPORT. 8 INCH TAPER T… AND GLUE AND STAPLE TO OUTSIDE OF 1/8 PLYWOOD DUCT … FOAM TO FIT AND FILL IN WITH GREAT STUFF FOAM. … SAME AS HULL DECK. LT & RT SIDES. CUT A SLOT I… TO MATCH 1X4 WOOD. TRIM 1X4 WOOD TO MATCH S… STABILIZER. GLUE AND FIBERGLASS IN PLACE - LT & RT SIDES AS SHOWN IN TOP AND SIDE VIEWS.

STABILIZER CONTROL HORN



1/16 STAINLESS CONTROL CABLES. ROUTE TO CONTROL STICK.

RUDDER CONTROL HORN. SEE DETAIL AT RT.

1/8 X 1 X 26 ALUM RUDDER ARM. FIBERGLASS A 2 INCH LONG WOOD BLOCK WITH A 1/4-20 T-NUT ON IT. MOUNT ARM WITH 1/4-20 X 1 1/2 BOLT AND THREAD LOCK (LOCTITE) ON EACH RUDDER.

3 1/2 X 34 X 2 STYROFOAM RUDDER BALANCE TAB. GLUE TO BOTTOM & FIBERGLASS ON MOVABLE PART OF RUDDER. ROUND LEADING EDGE AS SHOWN IN CONTROL SURFACE SHAPES ABOVE. 2 PLCS

1X4X78 WOOD RUDDER SUPPORT. TAPER AS SHOWN FWD & AFT. GLUE TO 1X4X63 WOOD ENGINE MOUNT 2 PLCS. FIBERGLASS INTO RUDDER BOTTOM AS SHOWN.

REAR SPAR. TIE UP TO SPAR SUPPORT WITH 1/8 NYLON LINE. 2 PLCS.