The enclosed copies of an original set of George Spratt's **Controlwing** drawing package are provided for reference information only and do not describe any detail changes that were made or may have been incorporated in the prototype aircraft after that date. Prototype aircraft were flown for eight to ten years, accumulating several hundred hours of accident free flight time. Anyone asking to fly a prototype **Controlwing** flying boat was graciously granted that opportunity to enjoy the delightful and impressive experience for themselves by George Spratt, a true gentleman, a remarkable experimenter and inventor and a great long time friend, who died in 1998 at the age 93.

Like many other plans offered, these plans will not provide 100 % of all the necessary detailed information required for the actual fabrication of a complete aircraft. General aircraft construction knowledge and techniques will be helpful to fill in the many gray areas. Other builders made their own undocumented design changes in the control system components, configuration, used different engines, substituted materials, redesigned attachment fittings, and numerous other details too extensive to even speculate. I know of only two other plans built **Controlwing** flying boats completed and flown in the US, both of wooden construction and VW powered. One was destroyed in an unfortunate water landing collision and the other was stored following early flight testing after seaplanes were banned from waterways near the builder's vicinity. Spratt's late 60's to late 70's prototype hulls were totally shaped in foam with fiberglass covering, local fiberglass stiffening and reinforcement with through hull tie rods for wing strut attachments. His wings were composite construction. My **Controlwing**, N107GW, of all wood construction with a very sturdy plywood covered and fiberglass encased hull, weighs 760 # empty vs. 500# for the early Spratt prototypes.

This information package consists of ; 2 Packages
32 Drawings - Incl Page 29
84 Pages of engineering data, construction, photos, operation and general information.
1 35 minute video.

Part of the video is a copy of 8mm movies taken during George G. Spratt's **Controlwing** flight demonstrations on Chesapeake Bay in 1969 to 1973. I am shown as the first to fly the 60 HP N910Z protype **Controlwing** flying boat after George completed several flight demonstrations. Note the very fast turns possible on the water immediately after touchdown and in particular, note the casual nonchalance of the audience, taking for granted that this aircraft flies quite easily and is really no big deal! The enclosed drawing package was based on the N2236, the lighter colored prototype, the slightly larger 85 HP Mercury powered flying boat pictured breifly. Mercury engines were modified according to instructions in his March 1978 Sport Aviation article. Note his personal aircraft carrier, a one of a kind, 1928 homebuilt 55' arc-welded steel utility boat that easily solved his storage and launching problems.

Also included is a bystander's 1998 unedited video of the pre launch preparations, launching and views of multiple low and high speed taxi runs taken during many of our trips to the lake to attempt liftoff to date. Before attempting real 'flight', many 'Howard Hughes' type liftoffs are required in order to establish, confirm or adjust the takeoff speed, engine rpm, control linkage ratios, control forces and response, in flight radiator cooling adequacy, pitch trim bungee need or adjustment and to insure the wing pivot is properly located with respect to the normal CG to obtain a desired 7 degree power-off hull touchdown angle.

Also included is video from 16 mm film of George's Florida flying boat operations and showing Coatesville, PA flight operations of the only Controlwing protype landplane including the liftoff of my last flight,

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Any questions? Call or e-mail me

Spratt 'Controlwing' Flying Boat Demonstrations

Pre launch preparation and taxi testing of N107GW
Prototype Controlwing Landplane operation

This video contains a copy of 8mm movies taken during George Spratt's **Controlwing** aircraft demonstrations on Chesapeake Bay in 1969 and 1973. I am shown as the first to fly the 60 HP Mercury powered N910Z protype **Controlwing** flying boat after George completes his prelimary demonstration flights. His 1973 construction plans were based on the lighter colored, slightly larger 85 HP Mercury outboard powered version also shown briefly. Note his unusual 1928 homebuilt 55' arc welded steel utility yacht or personal aircraft carrier. My 85 HP Mercury outboard engine modifications were made according to Spratt's instructions.

Shown on the same video are a bystander's 1998 unedited shots of some pre launch preparations, launching of my **Controlwing** flying boat N107GW and taxi runs for many of our trips to the lake to date. Also included is additional flying boat footage and the only video I know about showing the prototype **Controlwing** landplane operations. Before attempting regular 'flight', many more 'Howard Hughes' type liftoffs are required to establish, confirm and/or adjust the takeoff speed, engine rpm, control linkage to angular wing movement ratios, control forces, responses and interaction if any, in flight radiator cooling adequacy, and pitch trim bungee adjustment, if any, set a basic hands off airspeed and to insure the wing pivot location is set to obtain the desired hands-off water touchdown angle.

For more general Spratt and **Controlwing** flying boat information, see the listing of articles elsewhere in this package.

If you think ultralights are a very recent modern developement, see Spratt's 1936, 200 #, Evinrude powered, roadable aircraft in the September 1983 Sport Aviation magazine. This aircraft is the first aircraft shown in an EAA video of odd flying machines. George actually taxiis in street traffic, turns into an airport, stops, swings the wing into place, attaches a few cables and then takes off. He generally concentrated on using outboard engines due to their world wide acceptance, maintenance facilities and cost. This was well before the smaller, more modern two cycle aircraft engines became available.

I continue to develope different design ideas for possible incorporation into ultralight and two place **Controlwing** flying boats or amphibians and for future use if and when serious parties and / or funding becomes available to develope **Controlwing** kits.

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visit → http://groups.yahoo.com/group/SprattCtrlWng/
Internet group

The Spratt **Controlwing** Flying Boats Demonstrations & TESTS

Spratt **Controlwing** prototype flying boats were flown for at least eight to ten years and have accumulated several hundred hours of flight time in the period from the mid to late '60s through the late '70s. Over 100 pilots with any rating who simply requested permission to fly a prototype were graciously granted that opportunity to enjoy the very delightful and impressive experience for themselves by George Spratt, a fine gentleman and long time friend who recently died at the age 93. I was priveledged to witness two of the prototype **Controlwing** flying boats during his flight demonstrations on Chesapeake Bay.

The first part of this video shows 1969 -'73 8mm movies taken during flight demonstrations of the 60 HP Mercury outboard powered **Controlwing** flying boat prototype, N910Z. I had the opportunity to fly it and decided right then, this is the only airplane I would ever care to own. The larger and newer cream colored **Controlwing** shown here was powered by an 80 or 85 Mercury.
(Model 107 - plans included

Controlwing flight charactaristics are amazingly simple. Adequate flight instructions could be given over the phone. From a fast taxi on the water, just add power to fly. The aircraft will lift off and continue to climb, hands off. Reduce power to cruise and the hull will stabilize in a level attitude. Increasing power will cause the craft to climb again. Gentle turns are obtained solely by using the fixed steering wheel. When ready to land, just steer toward a clear area and cut the power. As the lifting tail looses lift, the hull assumes a nose high attitude and the **Controlwing** automatically enters a stable glide which may be continued all the way to a hands off water landing. The auxiliary pitch stick can be used to obtain a smoother flared landing, shorten a takeoff run or to move above and below an existing, hands off, flight path. In turbulent weather conditions, the wing will automatically spill gusts so the occupants will feel only one quarter of the normal G loads. On the water this aircraft handles like a boat, with fast turns possible without upset.

This same video also shows unedited 1998 pre launch preparations of my **Controlwing** flying boat and many low and high speed taxi runs aimed at obtaining liftoffs. They are necessary to establish takeoff speed and engine rpm, set control linkage ratios, get a feel for control forces, confirm in flight radiator adequacy, adjust pitch trim bungees, and become familiar with the control responses or feel and insure that the CG is correctly located for a proper landing attitude. All are required before actual 'flight' is even attempted. Details covering those taxi tests and liftoffs follow.

The first time out the engine, previously checked out OK at home, did not exceed 3000rpm. It just plowed along till getting drowned by an open water tank vent. Engine to prop ratio is 2.1/1. Beaver Lake, our large Corps.of Engrs. impoundment for water supply, flood control and good recreational use, was 8 feet above the normal pool for this attempt, later reaching ~~8~~ 16 feet below.!

At the second attempt to lift off the now closedand pressurized water cooling system worked well, but still not enough revs. The hull just plowed along again not even near getting on the step.

I added an electric fuel pump before the third trial. After home test runs reached 5000+rpm, I tweeked the Mukuni carbs wrong and did not retest before launching. Still plowing at 3000 rpm.

On our fourth trip to the lake I had to taxi 15 minutes to the test site. The safety boat took off without prior discusion regarding towing to save excess wear on the the first set of dual powerbands then in use. This time the engine got to 5000 rpm and then to 5500 rpm without doing anything but just plow a big wave along for a minute or so before smoke appeared. Then a big bang with the tach immediately reaching 6000rpm! After the quick shutdown the inspection revealed the tensioner had broken at a poor weld.

, slip, then

That failure caused the now unrestrained engine mounted lug of the tensioner to jamb between the engine mount and the engine mounted pulley, deforming and grinding off the edge in the few seconds before I could stop the engine. The second set of power bands were cooked. The prop shaft pulley had rubbed things after it dropped down a little bit, but fortunately held almost in place by the clearance notch in the aft cowling. That prevented any further serious damage. Vee belts tighten, not loosen, as they are highly loaded and tend to squeeze tighter into the pulley grooves and really heat things up while quickly leaving rubber dust on the pulleys and elsewhere as they cook themselves to death. After getting the **Controlwing** back home that day, we noticed water gurgling around inside the hull while parking the trailer in our garage. We bailed out about 200 pounds of water that had been slowly accumulating at each attempt, but unnoticed inside many presumed watertight compartments intended to be multiple floation spaces! No wonder it just plowed along displacement style.

The fifth attempt was made using another set of powerbands. Lightened up by removing all cowlings, anchor, paddle and muffler, I also moved the battery forward a bit to obtain a better ?? CG location. The engine pulley was built up by aluminum welding and remachined as best I could without any tooling available to make it like new and the prop shaft pulley was cleaned up cosmetically. A couple half minute taxi runs with engine rpm 5000 to 5500 reached only 45 mph before one powerband broke and the other was already cooked after only a few minutes.

The first run the sixth time out on the lake finally produced a very brief unrecorded liftoff at 5500-6000 rpm, using three separate vee belts in the hopefully undamaged pulley grooves. The second run at 5500-6000 rpm and 50 mph provided a longer and higher 5 to 6 foot liftoff for eight or ten seconds! Immediately after leaving the water a left bank tendency could not be overcome with the right roll input as it was apparently against a stop and unresponsive, so I cut the power and let it level out, tail low just like its 'sposed to, and land before running out of room since the accelleration distance was far longer than expected due to my heavy aircraft. The liftoff location was a long way past the shore based photographer and no photos were taken. Two video operators on the chase boat which I had just passed and left in the dust, fell down when the boat ~~bounced on a wave~~ just before my liftoff and recovered their wits only after as I was already touching down well over a hundred yards ahead of them. After all those many trial runs the very first actual measurable liftoff has no photographic evidence! I later determined that additional clearance is required between the wing fitting and strut to allow ~~the~~ maximun colletive pitch angular movement plus the additional angle due to roll or bank input. Suddenly speeded up

more

I assumed the seventh trial would be a piece of cake since the three belts still looked OK after being used only for two runs. I was usually towed back to the starting area. This time several still and video photographers were strategically located near the anticipated liftoff spot plus one of each on the safety boat. I warmed up and started the first run, but the engine ran very rough and would not turn over 3000 rpm. After some fiddling around with the throttle linkage and kicking the tires, we decided to try again. This time, running rough at only 5000rpm max, the highest speed attained was only 45 mph again, not quite enough to lift off. I kept it on step as long as possible till a sudden thump, immediately followed by the loud scream of the unloaded engine caused me to make a speedy shut down! One belt had broken and the other two were completely off the pulleys and partially cooked. That set of vee belts had survived only three or four minutes. The engine and prop have now accumulated 3.4 hours of static check outs and taxi testing time.

8th time out:
Engine rpm OK, but belts heated up due to slipping, got cooked and broke.

9th time out:
Engine would not reach maximum rpm and operation was canceled.

10th time out:
Original equipment Mercury carburetors and larger fuel lines were installed. The correct belt tension was used. 6000 rpm was attained, but takeoff was aborted due to large waves and coolant loss due to a loose filler cap.
(Continued on Page 58)

The Spratt *CONTROLWING* - Flying Boat Operation

The World's safest aircraft

In flight, the two hinged parasol wing panels of a Controlwing flying boat, unlike a conventional aircraft, automatically respond to aerodynamic forces to maintain a constant angle of attack with a variable angle of incidence. These panels are deflected differentially to obtain a very gentle banked turn. The fixed vee tail has no movable control surfaces. Flight controls consist of a throttle, steering wheel and a pitch stick. The pitch stick is provided only as an auxiliary device used to temporarily override the automatic feature only to shorten a takeoff, climb above or descend below an existing stable flight path or to flare for a smoother landing. Having no rudder or ailerons, the inherently stable and docile Controlwing aircraft does not require the usual pilot control coordination needed in other aircraft.

The primary vertical flight path control is the twist type throttle, convieniently mounted on a centrally located pitch stick which is installed low like a helicopter. By simply increasing power while at planing speed, the wing will seek the appropriate angle of incidence and the aircraft will take off, hands-off if desired, to enter a climb and continue climbing so long as that power setting is held. A reduction to cruise power will stop the climb and the aircraft will fly with a level hull attitude at the design cruise speed. Increasing the power will not increase the airspeed, it will only re-enter a climb. Less power will cause an altitude loss while still remaining at the design airspeed. The fixed design angle of attack prevents forcing the wing into a stall. Reducing power to idle reduces the lift from the tail and the aircraft will enter a stable nose high glide. Pitch trim adjustments may be added to obtain different airspeeds.

During steady flight, positive nose down aerodynamic pitching moments may be aided by bungees to balance the negative pitching moment from the weight of the wing. All of the aerodynamic forces produced by the wing pass through this selected design pivot location to automatically hold the wing at the appropriate angle of attack or incidence without pilot input. The steering wheel controls a water rudder and deflects the two wing panels differentially to initiate a limited roll or banked attitude Some altitude loss occurs in the resulting side slip which produces a side force on the tail causing the aircraft to turn. No air rudder is required because the differential angle between wing panels is so small there is no adverse yaw.

A small retractable water rudder provides positive maneuvering capability on the water with high speed turns possible without upset due to a wide hull, low center of gravity and lack of outboard wing tip floats. At low speed the aircraft may be pivoted about a wing tip.

The Controlwing can not be forced into a stall, spin or dive. When the pitch stick remains unrestrained during flight in turbulence, the wing will automatically spill gusts. Occupants will sense only about one quarter of the normal gust loading resulting in a more comfortable ride.

The all wood Controlwing, N107GW, is powered by a highly modified 85 HP Mercury outboard powerhead turning a pusher propeller mounted on a belt driven extension shaft. The Ivoprop is mounted close to the surrounding vee shaped tail surfaces to act as a venturi to provide lift at higher power settings. The closed liquid cooling system incorporates an automotive water pump, a small accumulator tank and several heater cores installed flush with the hull bottom aft of the step. Ram air from the twin nose inlets is aided by step suction to provide in flight cooling with direct contact cooling while on the water.

Controlwing aircraft should become very popular with beginning students and many others who will appreciate the obvious safety features, simplicity of construction, ease of control and the softer ride. Only a minimum of flight training is needed and no additional seaplane pilot rating is required to safely operate this flying boat. Experimental and ultralight Controlwing amphibians or flying boat kits have been considered when funding is available.

George Spratt often asked, "Did you ever see a fixed wing bird ?"
To this I ask, "Did you ever see a low winged bird or one with a rudder ?"

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6

1973

TO ALL BUILDERS OF MODEL 107 CONTROLWING
FLYING BOAT USING MERCURY 800 OR 850 ENGINES

In our original design power was taken from the splined end of the crankshaft as the designer intended for the outboard.

This arrangement was good mechanically and gave no trouble during the several hundred hours of flight in N-910Z and N-2236.

However it did require a splined quill and a machined cast bearing support in place of the outboard lower housing. Used this for pump pulley on N107GW

Many builders found this difficult and expensive to build and asked if we could provide a simpler design.

Last winter we did this by bolting the pulley directly to the flywheel using existing bolts. A simple belt tightener contained all belt loads between a bearing in the center of this pulley and the propeller shaft bearing. Changed This is simple and economical to build and ourflying experience last summer showed it to be trouble free. This drive did so well that we are sending the data to all builders using Mercury power.

The enclosed eight drawings and two photos should be clear but a few tips on how we built this drive may be helpful:

DRIVE SHAFT See notes on drawings.

Before assembling the drive shaft (drg.400-001/006) the ends of the aluminum tube should be finished in a lathe to be sure the pulley stub and propeller hub will be properly alligned when pressed into the ends of the tube.

A turned washer should be bolted, using the pulley cap screws, firmlyto the face of the pulley hub to act as a stop when the stub is pressed into the tube.

When machining this stub and propeller hub be sure to leave at least 1/32 on all external surfaces for finish after assembly.

After the stub and hub are pressed in place and secured with the twelve 10-32 cap screws, center the propeller hub in the lathe and put a steady rest between the rows of cap screws on the pulley end. First finish the face that mates with the pulley, then finish the shaft to a push fit with the pulley bore and then fit the bearing. We do not finish the pump shaft after assembly as it is properly aligned by the bearing. Finally put the pulley shaft in the chuck and completely finish the propeller hub. The shaft should now run perfectly on its bearings.

ENGINE PULLEY

In machining this pulley there are three surfaces that must be concentric: The face that mates with the flywheel, the belt grooves and the belt tightener bearing.
Remove the rope starter ring from the flywheel and press the pulley in place. Reolace and securely tighten the eight $\frac{1}{4}$inch flywheel cap screws. There is plenty of stock in our pulley blanks to use any type belt you choose: Standard 3V, Gates 11M or timing belts.

ENGINE MOUNT

The engine is supported in a cradle with widely spaced rubber mounts in line with the crankshaft. This resists the rocking couple yet allows freedom in torsion. Torsional vibrations are absorbed by a rubber damper located about 15 inches from the crankshaft. It should compress at least $\frac{1}{4}$inch with 100lbs. load. We made ours by grinding a Volvo engine mount down to just under one inch in diameter.
The three parallel tubes of the cradle are attached to existing holes in the block. They should be easily identified from the photograph. We found that by using many attachment pionts vibration in the cradle was reduced.
In making this cradle we bolted the three parallel tubes in place, after welding all the fittings. The washers were welded to the three inch stubs and these assemblies held in exact alignment with the crankshaft by inserting a 15/16 round in the splined end and screwing a threaded round on the trheadedcrankshaft end. These stube must, of course, be held concentric on the rounds with bushings.
Tubes were then fitted and tacked between the ends of the parallel tubes and the stubs.
We used the original cradle built for the pulley on the splined en but found that there was not enough belt clearance when the pulley was put on the flywheel.
This accounts for the notches that show on the picture.
Make sure there is enough belt space when fitting the tubes.

If rope start pulley used L.H. Prop needed

ENGINE CRADLE SUPPORT

The front of the cradle extends through the fire wall and is supported by a rugged weldment that also supports the mast and collective pitch lever. This is tied down by four $\frac{1}{4}$inch stainless steel rounds extending through the hull bottom. These are threaded and silver soldered in a steel plate under the bottom ahead of the step.
Don't forget compression dowels at each tie rod for this assembly must be tightened far beyond what the foam under the floor will stand.

The aft support is similar but is held down by only two tie rods. The top of this weldment is restrained laterally by adjustable tubes to the brackets that also support the lower end of the fire wall braces.
This aft support must be adjustable both laterally and vertically for belt alignment. Allow room for spacers at each tie bolt for adjustment.

WING CONSTRUCTION 1973

Because the wing and attachments are the most important and critical part of the entire controlwing flying boat our method of construction will be described in great detail.

Machine tools used :

1) Band saw.
2) Bench saw with wobble blade.
3) Drill press with circle cutter, sanding drum $1\frac{1}{2}$ inches in diameter by 1 inch wide and a 5/16 inch router bit.

Jigs required are four: Two for the nose ribs and two for the aft ribs.

1) The nose and aft shaping jigs are made from 3/4 inch mahogany, band sawed and carefully sanded to the exact contour of the master template.
2) The nose rib gluing jig is female duplicate of the nose rib shaping jig glued to a 10 x16 base of 3/4 inch plywood.
3) The aft gluing jig is made by placing the aft shaping jig on a 9 x 40 piece of 3/4 inch plywood and nailing 3/4 inch blocks on both sides. A thin piece of cardboard between the block and jig allows for finish sanding. Put the cap strips in place and glue a thin block opposite each outer block to hold the cap strip in place. No cardboard this time.

Preparation of drill press:

1) Drill and tap a 10-32 hole in the bed.
2) Tighten a 10-32 bolt, with head removed, in place.
3) Make two bushings that fit snugly over this bolt: One the same diameter as the router bit (5/16). The other exactly the same as the sanding drum with the sand paper sleeve in place. If it is preferred not to drill the drill press bed a sheet of aluminum or plywood may be bolted to the bed and prepared in the same way.

Note:
If you are inexperienced in aircraft construction - seek help at your local airport; Experimental Aircraft Association local Chapter and EAA Technical counselors. EAA web-site is www. EAA.org

MAKING THE COMPONENTS

Nose ribs:

1) Band saw all webs from the 1/8 inch plywood.
2) Place one of these webs on shaping jig and drill the two locating holes with #14 drill.
3) Press 3/16 diameter locating pins in holes in jig.
4) Using the drilled web as a template, drill all webs with #11 drill.
5) Route each web seperately to 1/16 undersize using pin only as a guide.
6) Rip cap strips and groove them 1/16 deep with saw set for a press fit over the web.
7) Steam cap strips, at least part having extreme bend over the nose.
8) Cut lightening holes in web.
9) Glue cap strips to web in gluing jig.
10) Sand to exact size on shaping jig using the large spacer over the pin.

Aft ribs:

1) Band saw aft rib webs slightly large.
2) Drill and prepare locating pins in the shaping jig exactly as was done with the nose rib.
3) Route on jig to exact size, using 5/16 guide.
4) Glue cap strips to web in gluing jig.
5) Sand to exact size on shaping jig using large guide.

Spar; For this operation a flat bench at least 12 feet long is essential. This can be made from a 2 x 12 plank if rigidly supported and finished absolutely flat and smooth.

1) Glue and clamp filler blocks between spar caps at root, strut attachment and wing tips. Make sure spar caps are flat on bench and block edges are flush with caps.
2) Place each web on the bench and with the cap assembly mark for glue and varnish lines.
3) Varnishall areas that will be inaccessible when the webs are glued in place.
4) Apply glue to all surfaces to be glued.
5) Clamp webs in place with one web flat on the bench, using a pressure plate on top to assure even glue pressure. Nails may be used but we have found it difficult to get even pressure and there is danger of some glue setting before the hundred of nails can be properly driven.
6) At this time the holes for the strut and center section fittings should be drilled. Much care must be used to be sure the holes are square with the spar and match those in the steel fittings.

WING ASSEMBLY

1) Glue and nail nose ribs to front of spar.
2) Carefully contour spar caps to airfoil shape so as to contour into the aft ribs smoothly.
3) Prepare leading edge 1/16 inch plywood 12½ feet long and 22½ inches wide. Scarf and glue if made from standard 8ft. stack.
4) place leading edge plywood on a flat surface. Position top of spar correctly on edge and mark the glue-varnish line as the spar is rolled over with the nose ribs contacting the plywood as it is marked.
5) Varnish the front of spar and nose ribs, being careful not to get varnish on the surface to be glued.
6) Place the spar, leading edge up, on the bench. Mark and drill a hole through the bench directly under each rib at the top and bottom of the spar. These are for the glue clamping straps to pass through.
7) Glue top of spar and corresponding area on leading edge plywood cover.
8) Locate plywood cover and nail along this edge.
9) Place spar on bench with nose ribs and plywood cover up.
10) Apply glue to remaining surfaces.
11) Thread gluing straps through the holes and over the spar assembly.
12) Tighten the straps gradually pulling the leading edge plywood into place. Apply considerable pressure over each rib with wedges under the bench.
13) Nails or clamps may be used to apply pressure along the spar. Some times additional wedges are necessary to bring the leading edge plywood into contact with the straight portion of the nose rib just below the nose.

Note: If the leading edge plywood is very dry it may crack in bending over the small radius of the nose. To avoid this it is sometimes necessary to soak the outside of the plywood before bending. We sometimes place a
8 wet cloth along this line while the plywood is on a flat surface. Some times heat from a torch can be carefully used as the bending is being done, in effect steaming the wood.

14) The aft ribs may now be nailed in place with glue, using the triangular fillets and 1/16 plywood gussets.
15) The control link rod end fittings may now be fitted and glued in place.
16) The trailing edge and polyurethane 2# foam wing tip can now be attached, making the wing ready for covering.

I used beveled 5/8" X 2" Spruce T.E., not metal T.E., or
Suggest using a fiberglass vee 2-3" long a foam fill

3 of 3

SPRATT CONTROLWING MODEL 107
HULL CONSTRUCTION

107

1973 INFO

The hull of model 107 is made by bonding blocks of rigid foam to form the general outline desired, and sanding to the final exact contour.

There are no limitations as to smoothness of lines and a double curvature is formed as easily as a flat surface.

Only after the lines meet the complete satisfaction of the builder is the skin formed. This is done by smoothing on woven fabric with epoxy resin. Strength and rigidity may be varied to match the requirements of a particular area by varing the number of layers or the type of fabric used.

The question has often been asked: How much does this foam add to the weight of the aircraft? Actually very little as the foam backing permits the use of thinner skin in many places. The advantages far outweigh any slight weight penalty. The hull is actually unsinkable, there is no bailing from leakage for the inside floor is above water level, the foam gives noticeable sound and vibration reduction and in case of possible collision, work to destruction is higher than almost any other structure.

MATERIALS

use closed cell foam so it won't absorb water

There are several newer plastics that might be explored to advantage by someone willing to do some pioneering. An example could be crosslinked vinyl foam. N-910Z was built ~~ten years ago~~ with epoxy and styrofoam.
IN 1962-66

in 1969-1970

It is still in good condition having required almost no maintenance except some repairs from striking stumps and piers. N-2236 was built ~~five years~~ ago using polyester resin and urethane foam and has already needed some maintenance.

N/G

Polyester is less expensive than epoxy but we have found that it is not good economy to use it in the primary structure. Our experience with epoxy and polysrene foam has been so good that unless someone wants to experiment, we recommend this material. There are several good epoxies. We use Ciba 502 with 951 hardener and Cab-O-Sil (made by the Cabot Corp.) for thickening where needed. No other adhesive is used in the hull, all bonding and laminating is done with these materials.

TRY WEST SYSTEM 5 to 1 Ratio

The glass cloth used is ten ounce coarse weave boat fabric. The coarsness of this material makes application easy as there is less problem with bubbles. Some builders have used a finer weave obtaining a smoother, lighter surface but with some additional work.

Glass cloth has a high modulus of elasticity but is heavy and does not stand abrasion well so should be used only where a thin stiff section is required. Dynell is much lighter than glass and has much better wearing properties. We use the standard four ounce weave that is available from marine supply stores. Polypropolene is still lighter and wears well. It is available under the trade name of Vectron.

KEVLAR BEST FIBRE

The builder should work with each of these materials to see which he likes best before starting the hull. The foam weights just under two pounds per cubic foot and can be bought economically in a "bun". This is a 4 X 4 X 8 feet. It can be cut with a hand saw or even better with a stretched hot wire, electrically heated. There are several people who make a business of buying these buns and cutting them to meet customers requirements. If such a source is handy it may be used to an advantage.

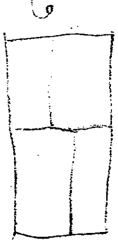
PROCEDURE

Unless the builder has had experience working plastics he should start by reading the many good articles published on the subject. April 1973 SPORT AVIATION has an article by Tony Bengilis that is a good example. EAA DESIGNEE REVIEW "Plastics In Aircraft Construction" should also be helpful.

Before starting construction of the hull the builder should make up samples and test them to destruction, much as an inexperienced welder would do before starting to weld a tubular fucilage.

One word of warning: Epoxy, unlike polyester requires precise hardner to resin ratio and thorough mixing. We use postal scales to carefully weigh each mix. The household scales we tried were not accurate enough.

TABLE 6 x 16 ok



We build our hulls on a flat level table 8 ft. by 16 ft. 6 ft is ok This is made by nailing four sheets of 3/4 inch plywood to two 2 X 8s, 16 feet long with 2 X 4 stiffners where needed. This way the 2 X 8s may rest on the floor and be easily leveled with spacers. 4

Our ~~tools~~ are: An electric disc sander for fast rough sanding, several sanding boards made by glueing 3 1/2 grit Type 7 paper made by the 3 M Co. to boards for easy sandings. This material is used on floor sanding drums and may be purchased from many hardware stores. A few sanding blocks with finer paper for finishing. Several cheap paint brushes for applying the resin and several squeegees for spreading and working the epoxy. We make these from pieces of 1/8 inch plywood.

NOTE: FILL UNDER SEATS TO BOTTOM WITH STYRAFOAM FOR ADDITIONAL CUSHIONING FOR HARD LANDINGS.

When ready, start construction of the hull as follows:

1) Staple a sheet of thin (4 to 10 mil) plastic over the table to prevent epoxy from sticking. Then build a platform of the hull bottom from 4 inch thick foam, using as large blocks as practical to reduce bonded seams, allowing ample material for sanding aft of the step. Nail blocks to the table on either side of the foam using wedges and slip blocks to secure bonding pressure. Disassemble, painting all mating surfaces with epoxy, reassemble and apply pressure with wedges. Weights may be necessary on top to keep the foam in contact with the table until the resin sets. Sketch 107-200SK-010A.

2) Bond a sheet of fabric (dynell) from the radiator cut out forward, full length and width.

3) Build area aft of the engine compartment.

4) Bond wedge shaped blocks under the air duct and fill in bow area between them. Photo ~~#~~ on Page 28.

5) Bond fire wall in place and inner duct wall to it.

6) Fit and bond fins in place using wooden supports from the table to hold them flat and at the correct angle. These fins are too large to be cut from one piece so the upper edge must be edge bonded. We make these from sheets 1 1/2 inches thick sanded to streamline shape to reduce drag, using care not to make the trailing edge so sharp that it is fragile.

7) Contour side of hull fitting and bond side from bow to aft of the engine compartment.

8) The entire top of hull can now be contoured by sanding. Filler blocks can be fitted and bonded where necessary. Large blocks must be bonded between the fins and aft deck to permit sanding to smooth flow lines.

9, When the entire forward deck and air ducts have been shaped from the bow to the engine compartment, skin may be applied to the bottom and sides of the ducts. The steering wheel, control cable and pulley brackets may be alligned and secured. Spacers for each bolt must be bonded through the foam between skins to prevent crushing the foam when bolts are tightened. These can easily be made by drilling a piece of maple dowel. a bed for the pulley brackets by filling a piece of fabric with epoxy thickened with Cab-O-Sil, drawing the bolts down firmly before the epoxy starts to set. The same should be done under the washers on the other side of the wall.

10) Air duct covers may now be prepared, the underside skin applied and the covers bonded in place.

11) Landing in rough water gives the portion of hull just ahead of the rudder a severe pounding. To prevent possible cracking, we have found it necessary to strengthen this area of the hull. To do this, cut out section 28 inches wide at the transom extending at least 24 inches forward. This piece is sliced longitudinally into 4 inch strips and put back with fabric and epoxy between each strip and folded over top and bottom to bond to the next piece. This gives the shear strength and resillancy necessary to absorb the shock. Use blocks and wedges on either side of the hull to provide pressure for a good bond. If the material removed in cutting these strips is greater than the material going back in it may be necessary to replace one strip with a wider piece to get the side pressure desired.

12) Water rudder fair leads may now be put in place. The aft portion of the run is in open grooves and the forward part through a hole. We drill this hole with a piece of tubing having cutting teeth filed in the cutting edge. Try to keep as few bends in the run as possible, they add friction. Teflon tubing would have the least friction but it is expensive so we use 3/16 X 1/4 vinyl which is cheap, available and, we have found, entirely satisfactory.

KEVLAR OR CARBON integral

13) Skin may now be put on the entire upper surface of the hull. One layer is enough for the fins except for a strip, preferably of ~~glass~~, 18 inches wide running from the top of one fin to the top of the other near the leading edge. This acts as a spar or stiffner and can be seen in Photo, P28. There has been some problem with the skin loosening on the concave portion of the aft deck. This has been cured by making 4 equally spaced 3/4 inch saw cuts running fore and aft. The cloth is then put on in sections running from one saw cut to the next. Balsa strips 3/4 X 1/8 are cut and with ample epoxy pressed with the cloth into the slots. This prevents peel in this concave area by giving ample sheer. The cabin floor should have a second layer well bonded to the sides for a couple of inches before being walked on.

14) The hull can now be turned over, being careful not to put weight on the fire wall or fins.

15) Strips of foam to form the step are now bonded in place. Use plenty of weights to assure good contact. There is usually much foam to be removed here so the electric sander is a big help. 15-18 FT RADIUS +/-
To assure the proper bottom curvature, a template should be made. This curvature should be cut in the edge of a board long enough to reach from chine to chine.
As the fore and aft section of the bottom is straight for some distance ahead of the step we use a long sanding board, making it easier to avoid the small irregularities. 14
Photos P28

16) After the contouring is finished the skin may be applied, making sure it is well bonded over the chines and onto the sided as well as over the step. Try to keep sharp 90 degree angles to reduce suction. One layer of fabric is enough at the bow but should increase to at least three layers for the three feet immediately ahead of the step.

ENGINE COWLING

The best time to build the cowling is after the engine and shaft have been installed.

* We cover the entire engine with plenty of paper so no plaster will get on any of the parts. Then clamp a rough wooden framework in place, expanded metal lath that plasterers use is stapled over this frame. Using pointed nose pliers in the openings of this material it may be shrunk to the proper curves. When the general outline of the cowl has been formed, the lath is plastered over with gauging plaster to the exact form. Remember the finished surface is no smoother than the plaster form so care here can save much sanding later.

When through with the final scraping and finishing rub on at least two coats of wax, extending several inches over the adjoining deck area. Floor wax or simonize are fine.

First lay up the fixed portion of the cowling with two layers of cloth. Extend the fabric some two inches over the deck for later bonding. After this has hardened wax the area of overlap of the removable part and lay this up. Allow an extra layer at all edges to prevent breakage while handeling. If this removable cowl is to be fastened down with screws through the deck allow still another layer on the flange over the deck to reduce abrasion from vibration and taking it off and on.

As soon as this is well set peel the cowling off, break up and remove the plaster and paper. Plaster has a corrosive effect so should be removed from metal parts promptly.

* N107GW used 1/8 plywood cowlings + stringers
No mold req'd.

SPRATT CONTROLWING MODEL 108
POWER UNIT

The very roomy engine compartment with the engine belted to the propeller shaft allows maximum freedom in engine selection. A turbine would be ideal since it is light, trouble free and has simple cooling requirements. A close second to the turbine is a good two stroke engine. It is almost as light and has few moving parts. It does require cooling, though, and at the present stage of development requires liquid cooling.

If it is planned to use the aircraft for longer range work a four stroke engine should be considered as it uses 10-15% less fuel than the two stroke or turbine. This lower fuel rate is purchased at the cost of greater weight and complexity. Additional cooling capacity is also needed for more heat is rejected to the water jacket than with the two stroke.

Our experience with the Mercury ~~800~~ 850 outboards has been so satisfactory that we will give a description of our conversion:

For N107GW

MOUNTING

very noisy

Now with 2 exhaust collectors + one tailpipe.

We install this engine with the cylinders horizontal and the exhaust ports down with short stacks extending through the hull bottom. A cradle shown in Photo 1 is rigidly attached to the block at many points. This cradle is rubber mounted to the hull at two points on the center line of the crankshaft. Torque reaction is then taken through a rubber damper on an arm to ~~the~~ left side, this allows tortional impulses to be smoothed, reducing peak loads in the belt and shaft. Removal of the engine is easy as there are only two supports.

stops req'd on right side to hold engine steady + level

Used new ~~Mercury~~ original equipment carbs with 2" standoffs. ?

CARBURETORS

??

Float type carburetors must be replaced with diaphram type. This is because each carburetor supplies two cylinders and the manifolding is such that unless the throttle shaft is parallel with the crankshaft fuel distribution will not be even to the cylinders. The carburetors are properly positioned with aluminum filler blocks to the engine. Carburetors having integral fuel pumps should be used. Water jacket [illegible]ture is higher than in an outboard using sea [illegible] cooling so engine mounted pumps tend to [illegible] hot side. The crankcase is drilled and [illegible]/8 inch pipe for the fittings and rubber tubes [illegible] the fuel pump actuating pressure. These [illegible] in Photo #2.

16

17

1993

EXHAUST OLDER MERC 800 MODS. INCLUDED HEREIN

In the outboard, exhaust is collected in a liquid cooled chamber and fed down the lower housing and out through the propeller. It would be mechanically simple to connect the exhaust line directly to this outlet but would put unnecessary burden on the cooling system. By conducting the exhaust directly away from the ports without allowing heat to flow back into the block, heat rejection to the coolant can be reduced some 30%. This reduces the weight and size of the radiator as well as the weight of coolant required.

COOLING

SEE MAR '78 SPORT AVIATION FOR MERCURY 850 MOD

Photo #28 looks directly up at the exhaust port area with the stacks and water passage covers removed. The inlet hole marked "A" is enlarged from the original #32 drill size to #22 drill. A dam is built at "B" using filled epoxy. Be sure to clean the aluminum with sand paper to get a good bond. After hardening, smooth the surface to make a water tight seal with the cover gasket. Drill diagonally through the 3 webs at "C" and press in three 1/4 inch aluminum tubes. These are the outlets for the exhaust port coolant and must reach well to the top of the cavity to remove trapped air. Cut an angle on the bottom of these tubes so that the flow will not be restricted should they work down against the gasket. Drill and tap the six water passage holes "D" using 1/8 inch pipe tap. Plug the five shown and in the other put a fitting (1/8 pipe to 1/4 inch rubber tube) to return to the coolant pump. Tap "E" with 3/8 pipe tap and plug. Make an aluminum cover and gasket to seal the rectangular opening at "F". Cut 1/4" inch aluminum plate to cover the coolant passages on either side of the exhaust ports. Drill to match tapped holes in block. Tighten in place using cap screws and gaskets. These are shown in the center of Photo 32. Each end of the cylinder block is drilled and tapped 1/2 inch pipe for water inlet at the flywheel end and outlet at the opposite end, marked "H" and "I" in the photo. SEE ENGINE MOD INFO.

Filled epoxy OK here

As the top of the cylinder jacket is higher than the outlet air traps over the aft cylinder. We run a bleed tube from this highest point to a fitting screwed in the existing tapped hole in the head, a rubber tube then returns to the external coolant system. Photo #3 the temperature bulb may be inserted by drilling and tapping a hole in this head Photo #3. We have found the Jabsco plastic pump model 3010-01 to be light and reliable if not turned faster than 2500 RPM. As shown in the drawing we let it float on a stainless steel shaft combined with the propeller thrust bearing retainer.

WILL USE ANOTHER PUMP SUBARU?

17

Tilt FLYWHEEL END up

about 10-12° tilt in operation as installed.

IGNITION

1973

With the engine on its side the distributor must be moved to a more suitable location. In this aircraft application variable timing is not needed, even though the idle is a little faster and rougher than when retarded. We put the distributor on top as shown in the drawing, driving it with a standard timing belt and pulleys. If it is desired to avoid the 30 lbs. weight and complications of an electrical system the Mercury magneto works well on the same mounting using an aluminum adapter. The disadvantages are hand cranking (not so difficult with a good pull starter) and a step back to standard plugs having much shorter life than surface gap type and a greater tendency for preignition. With either system the timing should be set and locked 0.172 inches before top dead center (we use a 11/64 drill for a gauge).

POWER TAKE OFF

The drive pulley assembly that bolts on the engine in place of the lower housing has proven entirely practical and trouble free. It would be good on a production basis but we have found the home builder having trouble because of the large lathe and milling machine needed to finish the castings. Also the cost of the quill is high in small quantities. For these reasons we are changing N-2236 to take the power from the flywheel end. This way the drive pulley can be bolted directly to the existing holes in the flywheel. The belt tightener is extended to a bearing in the center of the drive pulley because the crankshaft is not capable of taking the side load imposed by the belts. This makes a very simple installation to build and the propeller turns in the standard direction, clockwise looking forward. Drawings for this new power take off will be available as soon as we have had ample flight time to be sure there are no more bugs.

2/2

NOTE:

IF RH PROP (LOOKING FWD) IS USED, LOCATE PILOT FWD AND ON RH SIDE TO REDUCE TORQUE EFFECT IF DESIRED. THERE WAS NO NOTICEABLE TORQUE WITH LH PROP ON PROTOTYPE N9107.

ADD - PROVISION NEAR R.H. WING TIP TO ADD BALANCING WEIGHTS ON N107GW. WHEN PILOT ALONE ON LEFT

ENGINE WEIGHTS

Block, 2 carburetors, fuel pumps & adapters	67.0
Cylinder head	1.3
Alternator	1.7
Flywheel	9.75
Starter and bolts	8.75
Distributor, ignition wires & pulley	4.0
Basic engine weight	92.5
CONVERSION PARTS	
End casting	4.4
Pulley	1.5
Bearing	.6
Quill	1.00
Exhaust stacks and supports	2.25
	9.75
Engine mount	6.25
Propeller, shaft, pulley, bearings & pump	22.00
Radiator	8.00
Water	7.00
COMPLETE PROPULSION UNIT	145.6 lbs.

ENGINE CHARACTISTICS

Displacement	66.6 Cubic inches
Take off horsepower	80 85
Take off R.P.M.	5200 to 6000
Cruise R.P.M.	4200
Coolant outlet temperature	180 F.

Note:
For wing spar + leading edge plywood + spar facing.
Splice only inboard of lift strut fittings;
not outboard.

20

The Controlwing Aircraft

Society of Automotive Engineers

Business Aircraft Meeting
Century II, Wichita
March 29 - April 1, 1977

770474

~~George G. Spratt~~ Deceased 1998

THE PURPOSE OF THIS PAPER is to attempt to explain the basic aerodynamics and mechanics of this system and to briefly describe a flying boat used in development. The small size of this boat was dictated by ease of construction and handling as well as economy, and not by any foreseeable structural or aerodynamic limitations. As in the conventional aircraft there are two wing panels, right and left, but unlike the conventional, these panels are allowed to rotate about a spanwise axis. This axis is below the chord and some 23% aft of the leading edge.

Collectively these panels are not mechanically restrained but are entirely free to float in response to aerodynamic forces. They are, however, connected to the pilots control wheel so they can be tilted differentially without affecting their collective freedom. Fig. 1 shows the general configuration of one of the boats used for testing. The wings are high to give clearance for steeply banked turns on the water. Fins on either side of the propeller are principally to keep spray out but also assist the slight weather cocking needed in the hull. The bottom is designed for optimum water performance as it is not necessary to rock about the step for take off.

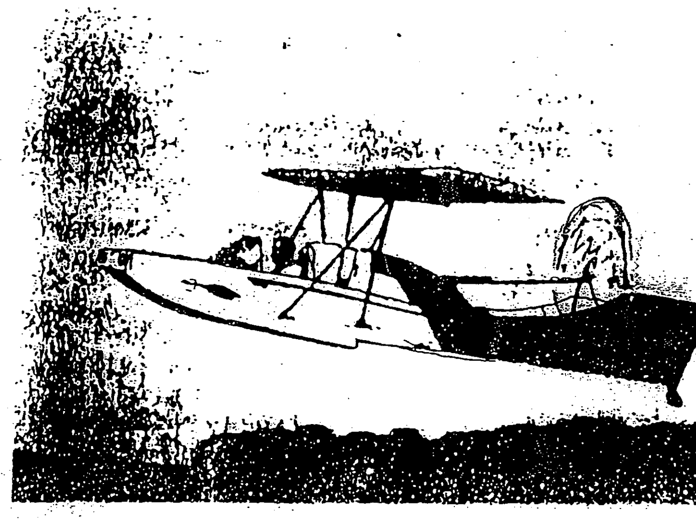


Fig. 1 - Showing general configuration of test vehicle

Fig. 2 is an aft inboard profile showing the ~~forward~~ location of the passengers and the low position of the Mercury 85 horsepower outboard driving the rear propeller through a belt and shaft. The center of gravity is so low that no wing tip floats are needed.

A schematic of the entire control system is shown in Fig. 3. The collec-

ABSTRACT

A new concept in aircraft control and stability has been developed having greater control effectiveness than the Aileron, rudder, elevator system. It is structurally simple, having no movable vanes subject to flutter.

There are no dive, stall, or spin characteristics. This system has natural gust-alleviation properties and as there are but two primary controls. No coordination is needed in piloting.

20

1/6

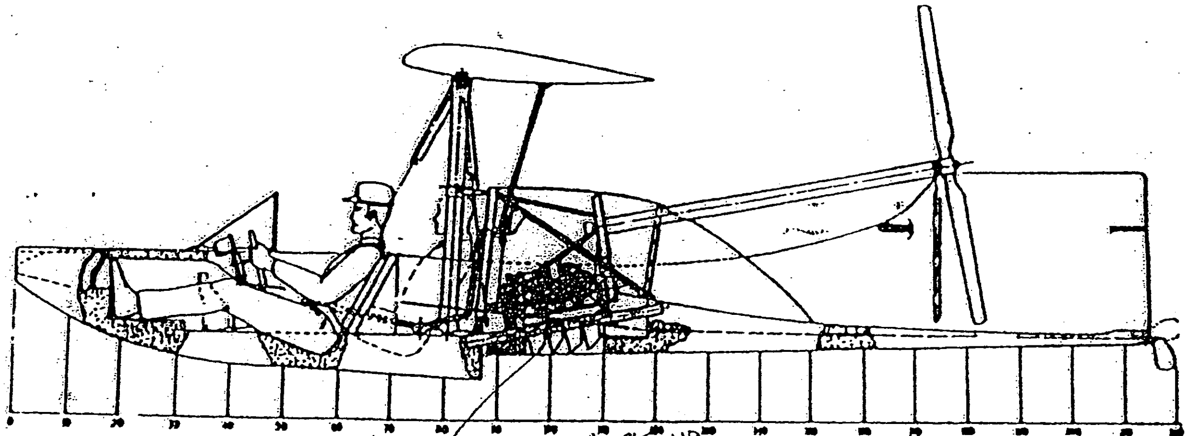


Fig. 2 - Inboard profile

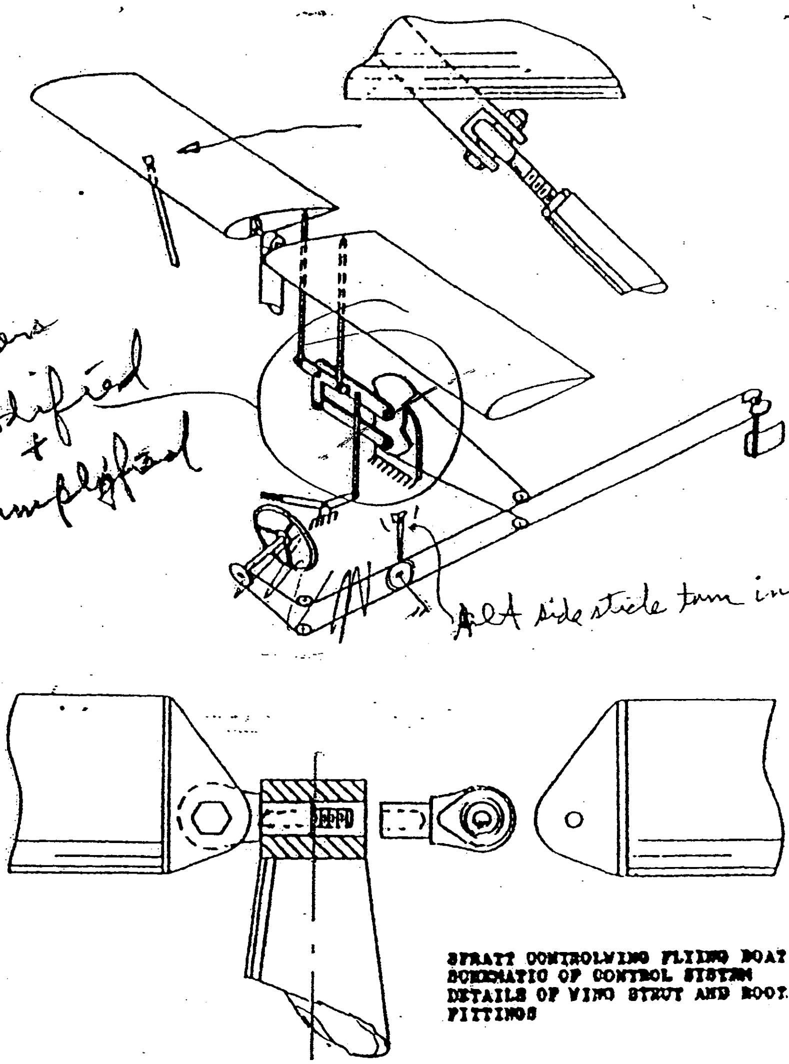


Fig. 3 - Control schematic

tive pitch lever is not a primary control as it is not normally used in flight. It has only enough authority to flare in case of a power off landing. If desired it can be used as a speed adjustment during landing or take off, but at no time can it increase the angle of attack beyond the peak of the lift curve.

The steering wheel moves the wings differentially through a parallel bar system so as not to feed back into the wings collectively. The small interconnected water rudder is for water handling.

or side stick & rudder

Fig. 4 shows this aircraft in land configuration. The main landing gear is located far aft of the center of gravity so that some 70% of the weight is carried on the steerable front wheel, thus greatly reducing cross wind landing problems. Touch down on the main landing gear with side drift does not cause roll but yaws the aircraft in the direction of the landing roll.

Longitudinal or up and down control in any aircraft is basically by power. In the fixed wing aircraft this is an insensitive means of control because of lag due to the inertia of the entire aircraft and possible oscillation or overshooting. In this aircraft much of the wing weight is concentrated at the spar at the hinge; thus polar moments are negligible, allowing the wing to follow the air currents so accurately that the throttle can be the primary longitudinal control. There is no oscillation or phugoid in flight.

A look at the vector diagram of the 23112 airfoil used, Fig. 5, shows how this works. In stable flight the vector must pass through the hinge and center of gravity of the aircraft. For example, suppose the hinge is located on the vector corresponding to 84 MPH. For the aircraft to fly straight and level the propeller thrust must exactly equal the total aircraft drag. An increase in thrust tends to increase the speed and move the vector forward. This increases incidence until all excess thrust is going into climb. All conditions are again stable at essentially the original trim speed and the vector again passes through the hinge.

Conversely, if there is less thrust than needed for level flight, the aircraft tends to slow down and the vector moves aft, decreasing the incidence. The aircraft now descends at a rate just fast enough to maintain trim speed, and is still in equilibrium.

Refering again to the vector diagram, it is seen that moving the hinge forward in relation to the wing increases the trim speed and moving it aft decreases the trim speed. Moving it up decreases the restoring moment and lowering it makes the corrective force greater. These moments must be high enough to easily overcome friction in the system and allow the wing to maintain constant C_l in turbulence. Fig. 6 is a typical moment curve plotted against speed.

Three methods of speed trim have been investigated:

(1) The simplest is to locate the hinge at the maximum desired speed, then with a bungee apply a torque about the hinge tending to increase the incidence. This, as Fig. 6 shows,

I never saw any bungee on proto.

NOW IN MUSEUM AT READING, PA.

only 1 built.

Never fully developed

In crosswind, fixed outbd gear touches down first & A/C will rotate in the direction of ground travel just before nose wheel touches.

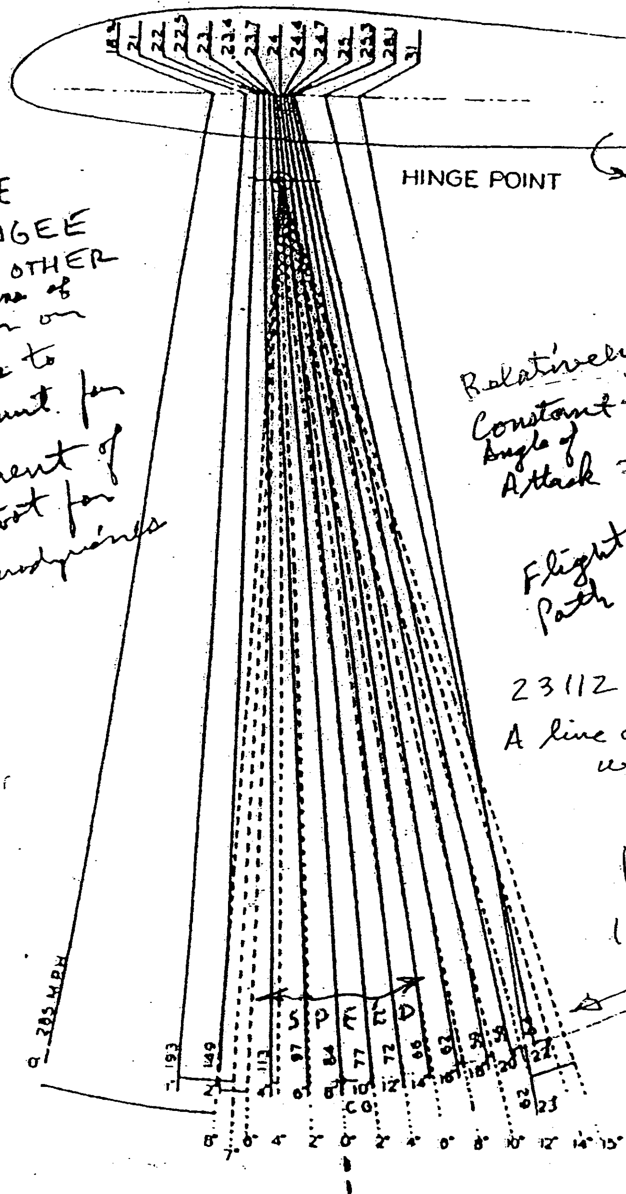
Now in Air Museum Reading, PA Airport

Steerable single main gear

Fig. 4 - Land version.

Hinge loc. spot used — 22.83% / 10.96" from L.E. of 48" wing

Per plans ↑



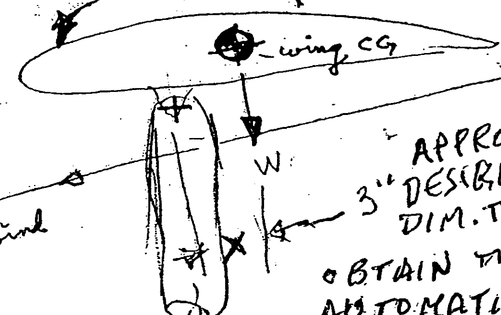
23112 AIRFOIL

NOT 23012

USE BUNGEE OR OTHER means of trim on stick to account for movement of wing pivot for best aerodynamics

nose down Aerodynamic Mp vs GRAVITY MOMENT = XW

WING X X



Relatively Constant Angle of Attack = α

Flight Path

Relative wind

APPROX 3" DESIRED DIM. TO OBTAIN THE AUTOMATIC PITCH CHANGE WHEN POWER REDUCED.

23112 is a reflex airfoil
A line along ½ the thickness will be like this

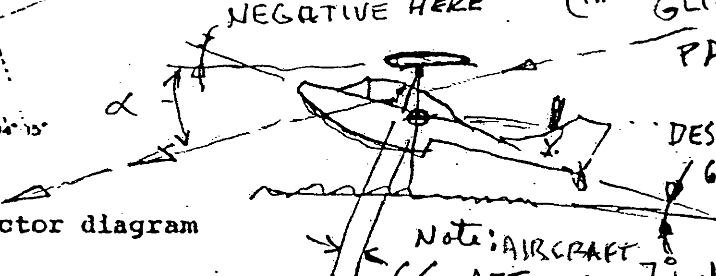
- TITLE -
VECTOR DIAGRAM

-IMPORTANT-
C.G. LOC CAN BE CHANGED BY ADDING WGT FWD OR AFT IF NEEDED

Ref for 1000# G. Weight

NOTE: INCIDENCE ANGLE IS NEGATIVE HERE

CONSTANT (HANDS OFF) GLIDE PATH



DESIRED 6-8°

Note: AIRCRAFT C.G AFT OF WING PIVOT

7° preferred

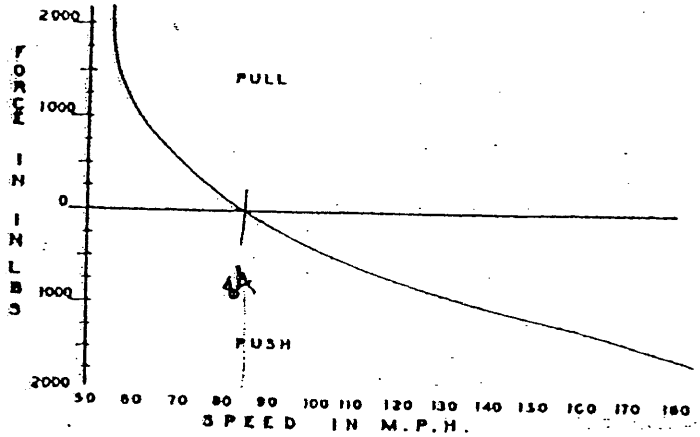
Fig. 5 - Airfoil vector diagram

EACH HOME BUILT INDIVIDUAL COMPLETED COVERED & PAINTED WING WILL HAVE DIFFERENT WGT & C.G. LOC

-IMPORTANT-
FLIGHT TESTING MAY BE REQD TO DETERMINE IF YOUR WING C.G. IS LOCATED PROPERLY TO INSURE POWER-OFF PITCH DOWN FEATURE

High Power tail: lifts
IDLE = tail low

NOTE: your Completed & Covered wing CG LOC. May not be 3" from Pivot.



TITLE
STICK FORCES

Fig. 6 - Typical collective pitch stick force curve for a trim speed of 84 miles per hour

provides a good aerodynamic stop at the low speed end and also adds a constant lift component to the constant C_1.

(2) Moving the hinge fore or aft in relation to the wing. This method has certain aerodynamic advantages but is mechanically complicated.

(3) A trim tab at or aft of the trailing edge. Our tests have shown this to be simple mechanically but the least desirable aerodynamically.

In practice we have found using method #1 with a two position lever adequate. One position is for cruise and the other for take off or landing.

I never saw any Detail for this was undefined

At the start of this development we were concerned about what might happen if, in extreme turbulence, the wing was unable to follow the air currents. Would there be an instant of instability when the lift went from positive to negative? To answer this, Detroit University ran a test on this airfoil through the entire range of both positive and negative incidence. The result shown on Fig. 7 indicates that if the hinge is ahead of 23% chord no instability will occur. As this is close to the optimum location there is no problem.

MAX 25% OK

DIRECTIONAL CONTROL - Ideally if an aircraft was built having no resistance to roll, then causing roll by differential incidence of the wings would produce no yaw. Obviously it is not possible to build an aircraft having no roll resistance. The aircraft must have mass and structure so there will be inertia and aerodynamic resistance. In the conventional fixed wing aircraft nearly all the aerodynamic resistance to roll is in the wings, with a minor portion contributed by the empanage and other parts. This aircraft has no empenage and there is no resistance or damping with differential tilt of the wings. As for inertia the wings are again the major offenders. It is true that this aircraft has wings, but they are far lighter than fixed wings because no structure is required to withstand aileron loads or peak gust loads. We have found that in this aircraft adverse yaw is so small that no movable vertical fin is required. When flying at low speed with aileron control it is possible to induce a stall. The same would be possible with this system if, while flying at minimum speed, moving the directional control would increase the angle of attack of one wing. Refering to the moment curve, Fig. 6, it is apparent that while flying at low speed any attempt to increase the angle of attack is met with increasing resistance. At or near the peak of the lift curve a differential wing displacement will result in practically no angle increase of either wing but nearly all rotation will be in the wing having decreasing angle. Throughout the center of the flight range the curve is more linear and motion is more evenly divided between the wings.

Should an up gust strike only one wing, this wing tends to maintain its angle of attack and lift but reduce the incidence. If it is allowed to do this there will be no roll. Two factors limit this ideal condition: One is fric-

25

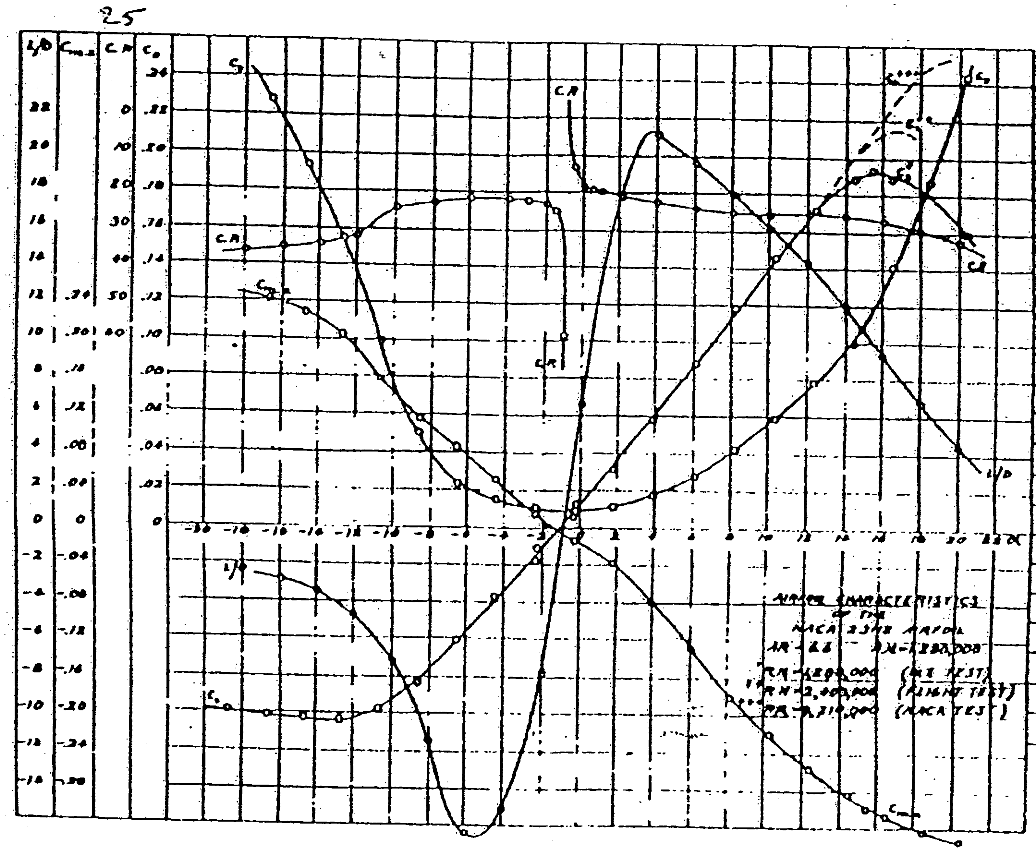


Fig. 7 - Airfoil characteristics in both positive and negative range

tion in the control system, the other pilot resistance. We have found in practice that it is possible by good design to have very low mechanical resistance. The pilot, with experience, tends to move the control the way it wants to go rather than fight it.

The controlwing is easier to fly but is more critical in design than the conventional aircraft. The pilot has no movable vanes to correct the designers errors.

Later on, ~~At the present time~~ some twenty 100+ pilots have flown the controlwing. In most instances the less experienced have been quicker to get the new feel of this aircraft than the more experienced. The highly trained pilot feels something should be done but apparently has nothing to do it with. Many have also said that they were distrubed by seeing the rapid motion of the wings while flying through turbulence yet feeling little or nothing in the aircraft.

So far, with the exception of those interested only in aerobatics, all who have flown this aircraft long enough to get the new feel and understand what is happening have become converts.

Potential gain in using this control and stability system appears to be:

(1) Gust-alleviation, both vertical and roll. According to 1970 NASA Report CR-1523 about 75% reduction should be expected.

(2) No stall, dive or spin characteristics.

(3) No flutter problems as there are no hinged vanes or elastically supported airfoils.

(4) Ease of flight. No control coordination is required.

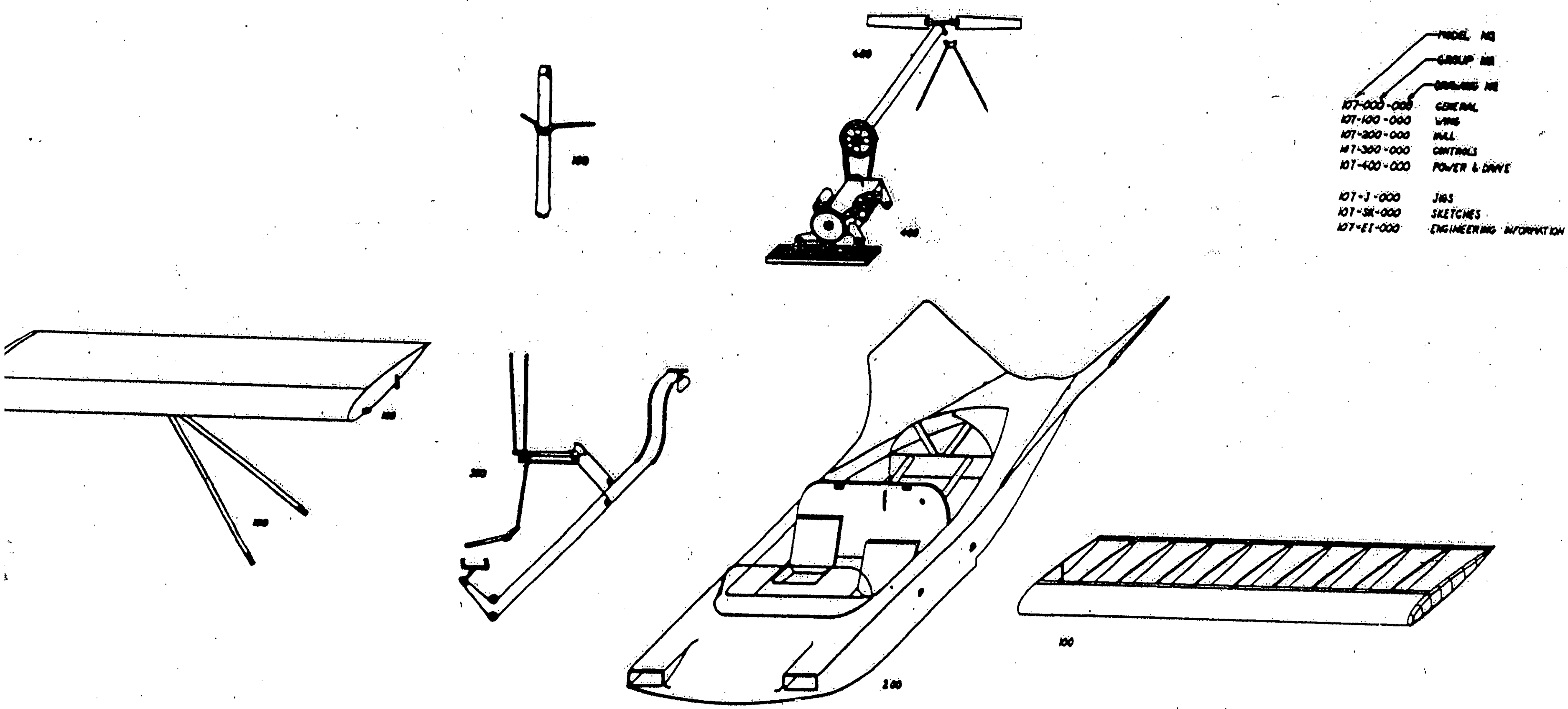
(5) Greater control effectiveness.

(6) Lower cost.

(7) Safest A/C known!

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE WARRENDALE PA 15096

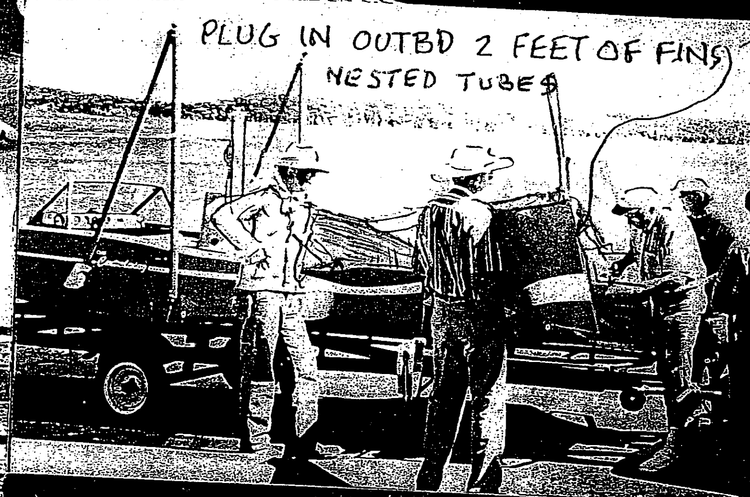
Printed in U.S.A.

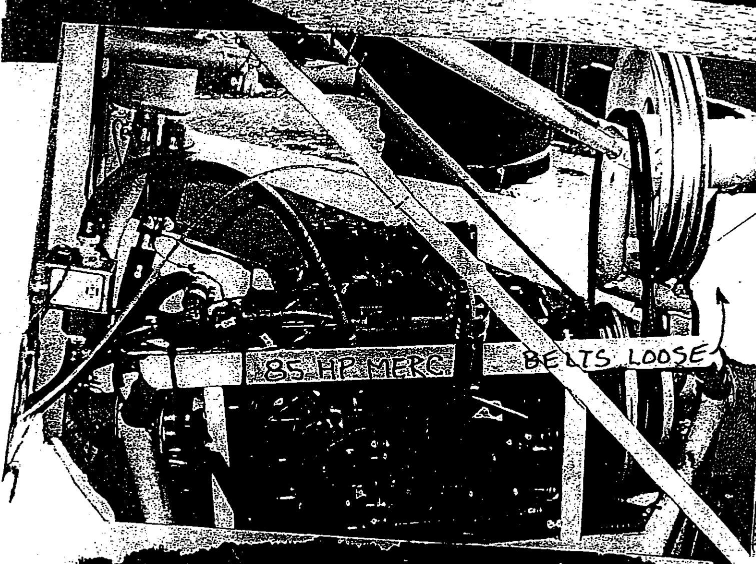


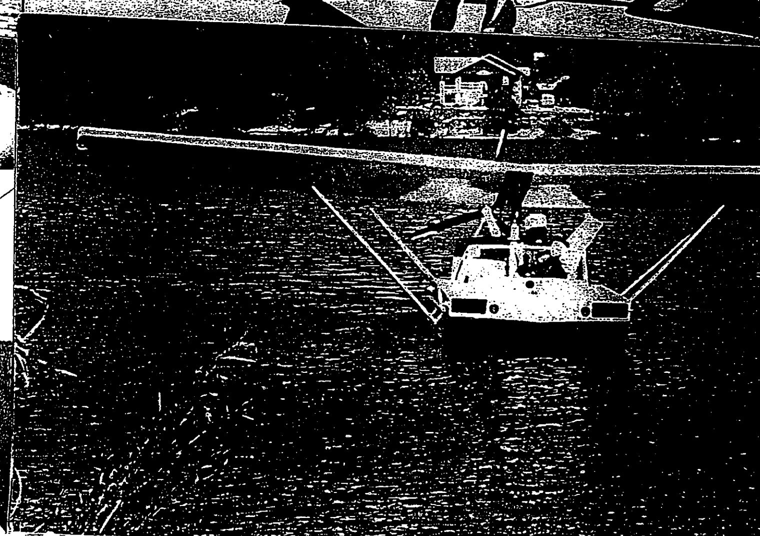
SPRATT "CONTROLWING" FLYING BOAT
PARTS BREAKDOWN VIEW
DWG NO 107-000-001 4-25-72


27
N107GW


N107GW
"CONTROLWING"


PLUG IN OUTBD 2 FEET OF FINS
NESTED TUBES

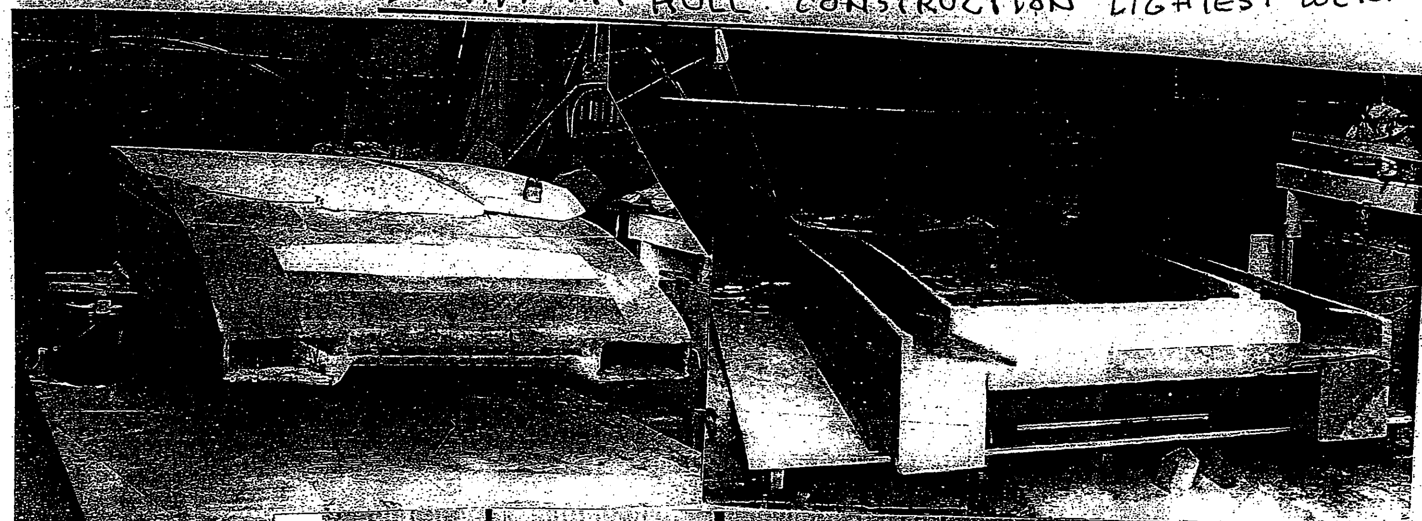

85 HP MERC
BELTS LOOSE

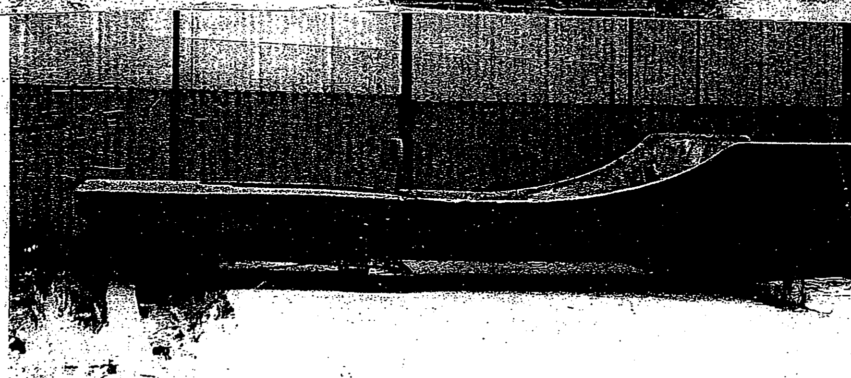


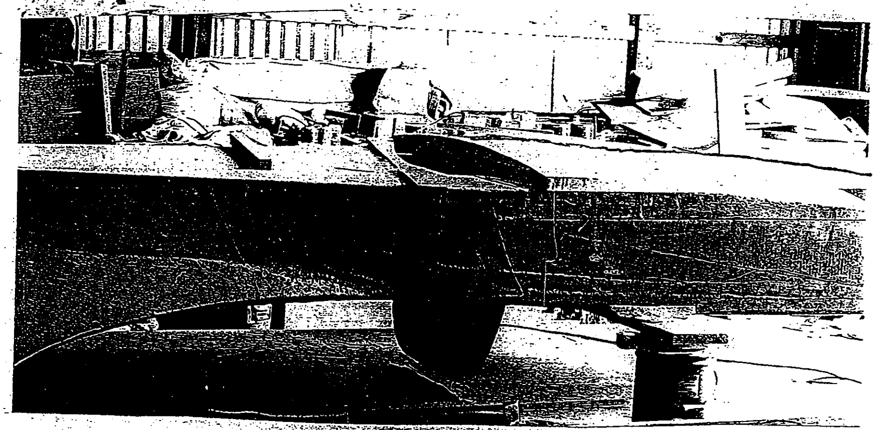

40-45 M.P.H. TAXI


IGN +
SWITCHES, HOBBS & TACH NOT SHOWN.
KILL BALL
COMPASS
MIRROR
27

SPRATT FOAM HULL CONSTRUCTION LIGHTEST WEIGT

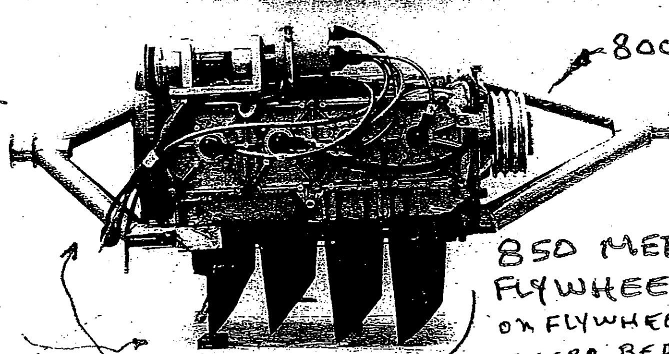






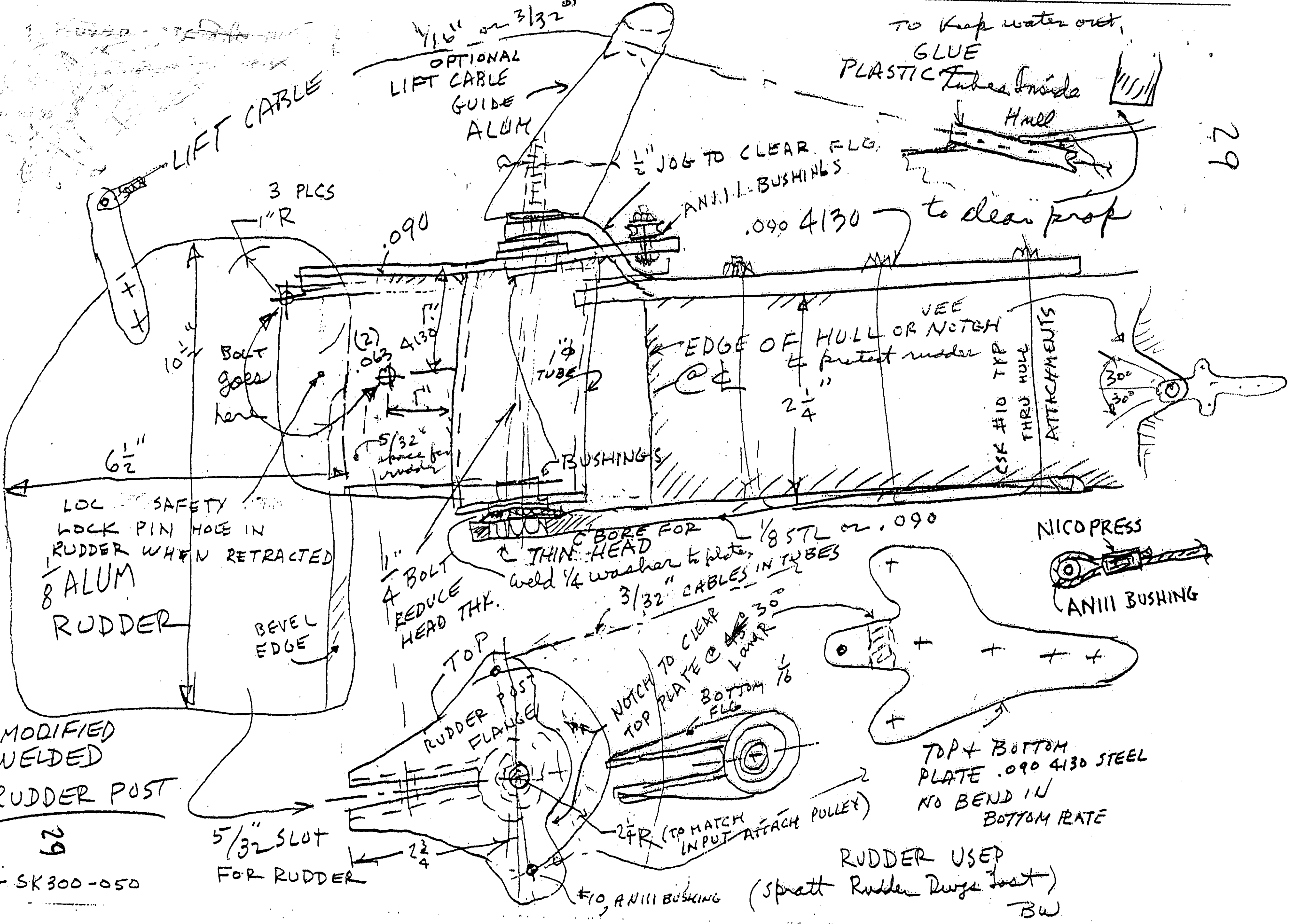
800 MERC USED L.H. PROP

FWD ←
800
Shown



Very loud exhaust

850 MERC USED R.H. PROP W/
FLYWHEEL AFT + PROP PULLEY
ON FLYWHEEL + EXHAUST COLLECTORS
EXTRA BEARING SEAT + STUB SHAFT
ADDED FOR WATER PUMP PULLEY



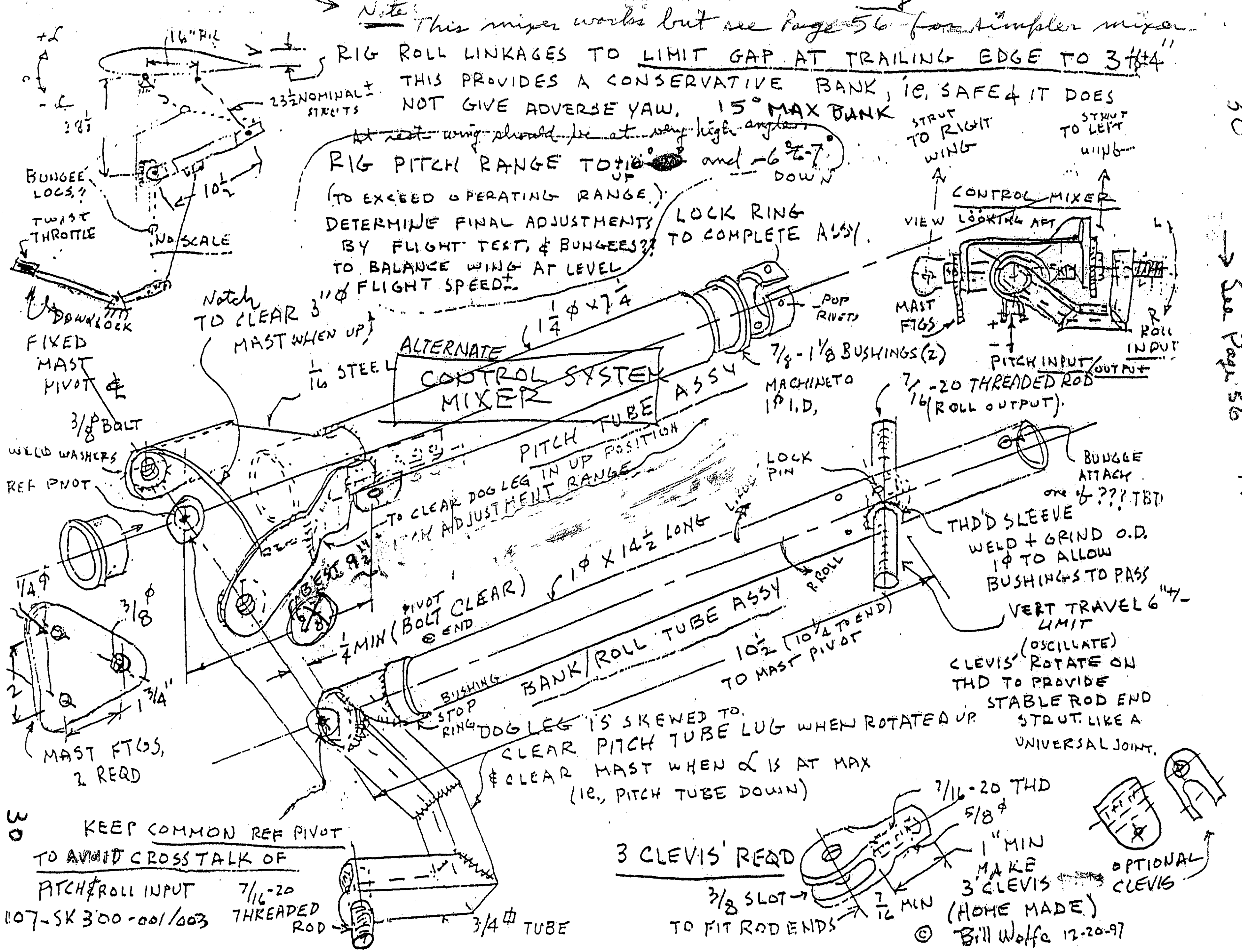
MODIFIED WELDED RUDDER POST

107-SK300-050

→ See Page 56

Used only on N107GW.

this was used on N107GW only.



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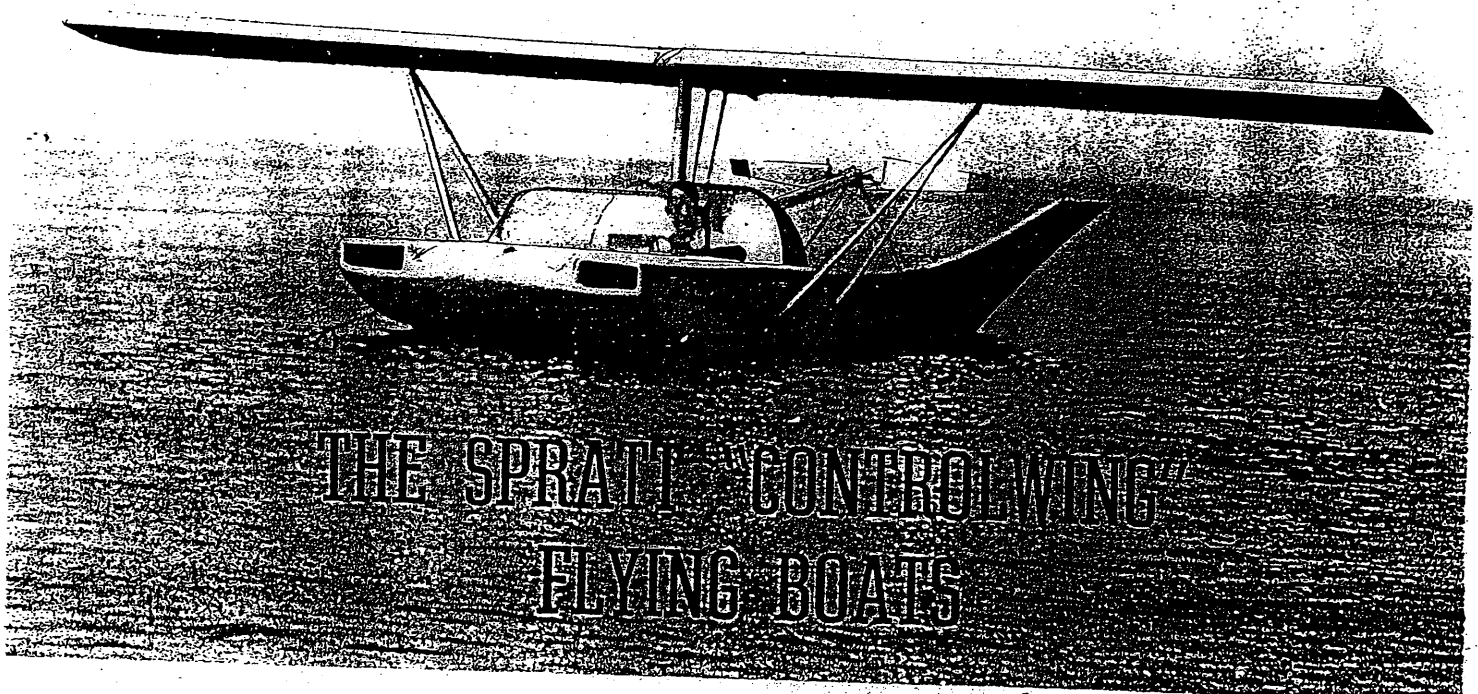


THE SPRATT "CONTROLWING" FLYING BOATS

Built Landplane Controlwing proto. + flight tested

Bob Quaintance, able mechanic, plastic fabricator, and test pilot in the cockpit of the latest prototype "Controlwing", N-2236.

NO LONGER

Model 107 - plans available

1520 W. ASH, ROGERS, AR 72758
479(~~501~~) 621-5822

Bill

By G. W. Wolfe (EAA 5716)

~~3190 Santiago Drive, Apt. P~~
~~Florissant, Missouri~~

AT THE SUGGESTION of Octave Chanute, the Wright Brothers were aided at Kitty Hawk by a frequently overlooked aeronautical pioneer, Dr. George A. Spratt, medical doctor turned engineer. His early studies in the theory of flight introduced the first wind tunnel in which the unknown surface was evaluated by balancing it against a known airfoil, a method later used by the Wright Brothers for their measurements. Close observation of birds and insects convinced him that simpler flying machines were feasible. He and Chanute concluded that an airplane does not really need warping wings, ailerons, elevators and rudders, along with their complications. Analysis and observations disclosed that a single wing was adequate without movable tail surfaces. Even though the Wrights rejected many of his ideas, they accepted some and had a large measure of success still followed in traditional aircraft design.

The late Dr. Spratt quietly studied and continued testing his theories over the intervening years and, with his son, George G. Spratt, built several unusual flying machines to test and evaluate the theories leading to ~~this advanced~~ control and stability system.

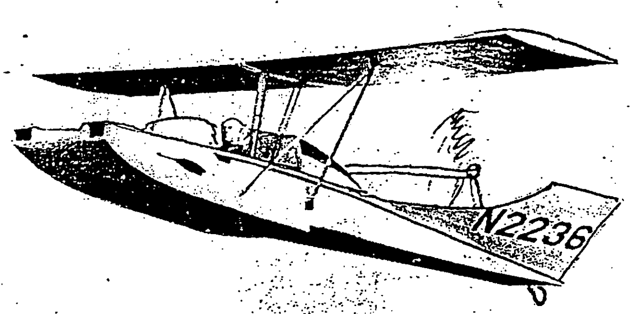
After retirement, George continued to pursue his father's aircraft theories and believed the well-developed and serviceable outboard engine would be practical to power a light flying boat for typical short-range operations. Several years ago he decided to use his 55-ft. arc-welded homebuilt yacht as a mobile operations base for leisurely full-scale experiments with the "Controlwing" prototypes on Chesapeake Bay, far away from crowded airports. N-910Z started flying in 1963 and has now been flown well over 3 hundred hours by over 2 different pilots. The newer, more elaborate, and larger N-2236 has now accumulated about 50 hours. & 100 later

85HP

The early prototype first had a welded-steel fuselage and tail framework, but corrosion considerations ruled out that material for an aircraft meant to be in or near water all its life. Later use of reinforced plastic skin over rigid foam proved to be a simple, inexpensive and attractive solution to the hull problem.

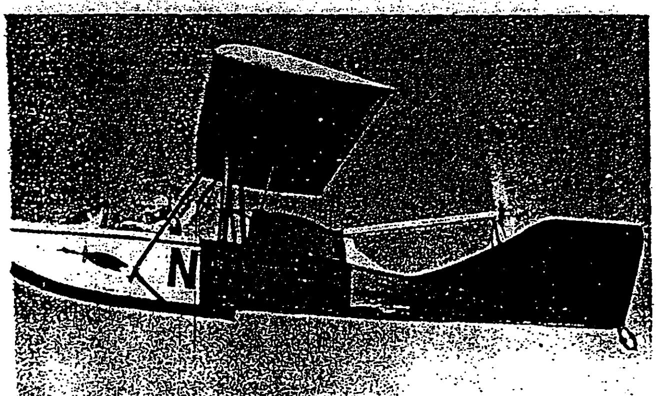
The hinged wing panels followed suit. An epoxy laminated D spar, fiberglas-covered rigid foam ribs, and laminated trailing edge comprise the Dacron-covered structure. The only metal parts in the airframe are the visible attachment fittings, struts, and tie rods across the hull bottom. 31

A standard Mercury outboard block with off-the-shelf accessories is clamped to a pair of tubes anchored between the firewall and bulkhead. A multiple-belt reduction drives the reinforced plastic pusher propeller



Model 107 - plans available

Note the negative angle of incidence and typical nose-high landing attitude which may be obtained automatically by power reduction alone. 85 HP.



SLIGHTLY SMALLER VERSION

George G. Spratt flying the 60-hp model of his "Controlwing", N-910Z.

located within the fixed bat-like tail surfaces, offering both protection from water spray and from personal injury.

Dual-purpose radiators in the hull step serve the closed cooling system both in the water and in flight.

By now it becomes apparent that the flight controls of this aircraft must be unique. They are simple; pilot training for this machine is minimal.

In every aircraft there must be provision for power control plus vertical and lateral maneuvering capability. In this craft add power to climb; that is all you need to do. Without any elevator as such, the "Controlwing" itself is free to pitch about its own hinge to maintain a constant angle of attack, independent of fuselage attitude. The twist-grip throttle is attached to the horizontal stick, similar to the collective pitch control of a helicopter. This stick moves in conjunction with the wing, which continuously maintains the appropriate angle of attack due to aerodynamic forces, independent of pilot effort. This free-floating stick may be ignored if one chooses to accept the longer take-off run, altitude loss in turns, or the flareless glide resulting from the built-in geometry, trim, and balance of the craft. This machine becomes essentially a one-G aircraft under these conditions and flies in a straight path if power remains constant. Wheel movement only changes the angle between the wing halves and turns a water rudder. Very smooth and gentle turns result from this roll or banked attitude. There are no foot controls, movable tail surfaces, flaps,

DECEASED

area on Chesapeake Bay.

trim surfaces, or other gadgets on these prototypes.

I had the privilege to fly N-910Z when it was demonstrated in Philadelphia. A single pull on the rope starter in the cockpit was adequate to start the 60-hp outboard engine. In the water it handled like a runabout. It is capable of pulling alongside a dock or making safe, sharp turns with a wing tip dragging the water.

After accelerating a bit, I pulled up on the stick to ease the craft off the choppy water, intending to skim the surface first to get the feel of the machine, but started climbing at a surprising rate. I reduced power and immediately observed the most unusual operational feature of the "Controlwing" aircraft.

The hull surprisingly assumed a nose-up attitude while the craft settled steadily until making gentle contact with the water. The butterfly tail loses lift as power is reduced, unlike the normal airplane which does not have a lifting tail. The nose-high landing attitude is inherent with the design and cannot be changed by pilot effort. (EXCEPT RE-APPLY POWER.)

This feature is a major safety contribution. In addition, the "Controlwing" aircraft is incapable of getting into a spin or stall. When the collective is pulled up at low power settings, the craft only settles faster, while remaining in a stable nose-high attitude.

In cruising flight the hull remains level. When flown hands off, the "Controlwing" is free to alleviate gusts simply by momentary correction in angle of attack due to the low inertia and unrestrained pivot of the wing panels. This feature provides a softer ride and substantially lowers structural design load factors, further simplifying the already uncomplicated airframe. I suggest a review of a 1970 NASA report, CR-1523, for further explanations. (ONLY 1/4 GUST LOAD IS FELT!)

George has taken his time in the investigation of numerous aerodynamic, material, and structural design possibilities, has thoroughly experimented, and is only now ready to consider offering detailed design plans and specs or perhaps initiate commerical production, estimated at less than $4000.00 for the basic two-place flying boat. ← 69-70

The simple control system and the plastic construction seem "ideal" for the homebuilder; however, plastic forming is a step beyond the novice. The deceptively simple control system, if not accurately followed, can be a serious problem. Some homebuilders are notorious for using untested design changes and material substitutions, thus George has so far been reluctant to offer design plans. 1973 → Eventually 150 sets were released.

If you are looking for an extremely simple, safe, inexpensive, and easily maintained flying boat, this may be it. An aerobatic hot rod it is not. The 80-hp model has take-off and landing speeds of 50-60 mph., cruise of 70-90 mph., and a maximum speed of 100 mph. While not spectacular, they are adequate for flying a friend around the pea patch or lake, for fishing, or for cross-country, and the stowable wings permit trailering. The unsurpassed view from the open cockpit is suggestive of a fast convertible. It's a fun machine, easy to handle and maintain.

Polypropylene fibers were used where maximum strength-to-weight was required, acrylic fibers for abrasion, and glass fiber for high modulus use. Newer fibers are now available and their higher properties will permit further design improvement.

~~George bases a "Controlwing" flying boat on his yacht at the Sea Mark Marina at Chestertown, Maryland, where on most weekends you will find him leisurely flying around the upper Chesapeake. He enjoys the "Blue Stoose", the stout goose, the end result of doing his "thing" for over 40 years.~~

~~George can be reached at P. O. Box 351 in Media, Pennsylvania 19063, but don't expect any early response — he is swamped with mail.~~

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the  stroke engine today

~~By George G. Spratt (EAA 17426)~~ → Deceased 1998

(Photos Courtesy of the Author)

Editor's Note: Virtually since the dawn of aviation, arguments have raged over the suitability of the two-cycle engine for aircraft use. Unfortunately, the talk has far outstripped experimentation and actual flight experience . . . with a couple of notable exceptions. Perhaps the best known example of the aeronautical use of the two-cycle engine has been the case of the converted McCullough drone units in the Bensen Gyrocopter . . . but it is not the only one. George Spratt of Controlwing fame has been unobtrusively flying modified outboard engines for the past 18 years . . . and with great success. He believes that for local fun flying a properly modified, liquid cooled two-cycle engine has a lot to offer EAAers . . . but let's listen to the expert . . .

Many of you old timers may remember an article written by Bill Stout about the time of World War II. The title was: **One Hundred Horsepower, One Hundred Pounds, One Hundred Dollars.**

This article was based on an engine that Julius Dusevoir built and brought to Bill's research activity on Telegraph Avenue in Dearborn. Although much time and money was spent on the project, the development was never completed, so unfortunately the engine never reached production. Bill told me later, jokingly, that he wished he had included "in one hundred years".

1978 ← Now, 35 years later, the engine in my Controlwing flying boat comes surprisingly close to his prediction. It weighs 99.85 pounds bare, puts out 85 real horsepower and costs $660.00 (the list price of the Mercury replacement engine). Considering inflation since the late 30s, the price is very close to Bill's $100.00 goal.

About here you will hear someone say, "Oh, two cycle." This will be someone who, in his younger days, owned one of the older breed of outboard or lawn mower — the old two-cycle or more properly two-stroke engine. Your car or aircraft engine makes four strokes per cycle, a stroke being the motion of the piston from standstill at one end of the cylinder to standstill at the other end of the cylinder. A cycle is the complete series of events that takes place in an engine before repeating. For instance, from ignition to ignition or exhaust to exhaust. In your car engine the first stroke after ignition is the power stroke where energy is transferred from the burning gas to the piston. During the second stroke, burned gas is displaced from the cylinder through the exhaust valve. The third stroke allows fuel-air mixture to enter the cylinder through the intake valve. The fourth stroke compresses this mixture ready for the next ignition.

In the two-stroke cycle the first stroke after ignition is the same except that at about 80% of the way down, the piston uncovers an exhaust port in the cylinder wall. A few degrees later a transfer port in the opposite wall of the cylinder is uncovered allowing the fuel-air mixture, which has been compressed in the crankcase by the down stroke of the piston, to enter the cylinder and assist the burned gas out the exhaust.

The second stroke covers the transfer and exhaust ports then compresses the gas ready for ignition. This engine has completed its cycle in two strokes compared to four in the automobile engine. One is therefore a two-stroke cycle engine and the other a four-stroke cycle. This is an awkward expression and it makes good sense to leave out one of the terms, but since cycle is assumed it makes far more sense to say two-stroke or four-stroke.

So much for terminology . . . let's return to your friend who remembers the old cantankerous lawn mower.

In addition to the many mechanical and metalurgical improvements made since then, there have been two outstanding developments that have made the two-stroke engine a different creature:

1) **Metallic ash-free oil** — Fuel-air mixture must, in most small two-stroke engines, be compressed and flow through the crankcase. For this reason oil cannot be retained as in the four-stroke engine, therefore, lubricant is mixed with the fuel. With the old automotive type oil a ratio of 20-1 was needed (20 parts gasoline to 1 part oil). This not only resulted in a smokey exhaust but built up hard deposits, particularly in the exhaust ports, tending to close them up and reduce power. Rings were often found locked solidly in their grooves after a relatively short operating time. To the ordinary user the most common trouble was hard starting due to spark plug fouling.

Now with the new clean burning organic dispersant oils such as Mercury Quicksilver we use a 50-1 ratio. After several hundred hours the exhaust ports are still clean and the rings free. There is no smoke except perhaps on starting.

2) **The surface gap plug made possible by capacitive discharge ignition.** Before this development we used a magneto and conventional plugs. Under some conditions there was detonation and usually after about twenty hours flying, some starting difficulty could be expected. With the present ignition system plugs are still serviceable after one hundred hours with no apparent deterioration in ease of starting. 33

The question often asked — "Which is the best, two-stroke or four-stroke?" — cannot be answered. The questioner should ask, "Which engine is best suited to my

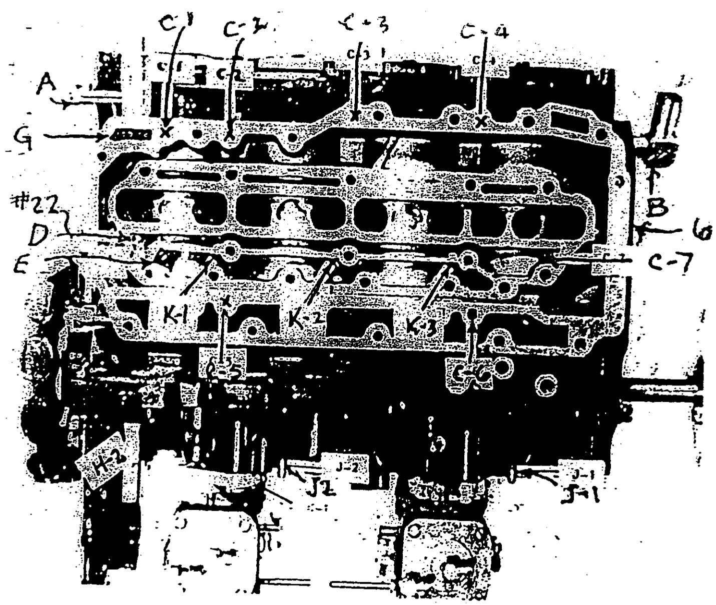

PHOTO 1 — Underside of Mercury 850 showing modifications made in coolant passages and carburetors w/ built in fuel pump.

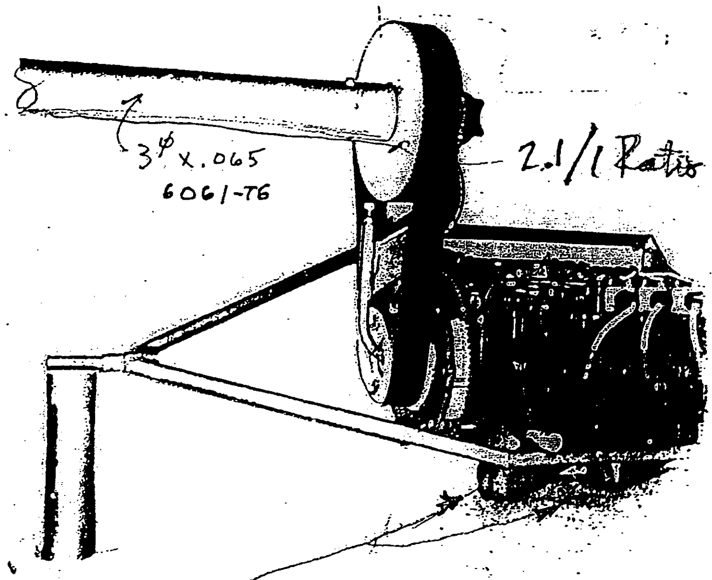

PHOTO 2 — Mercury 850 in mounting cradle with relocated ignition coils and exhaust collector in place.

specific need?" As we are talking about a light, simple aircraft for the homebuilder, we will compare the engines only for this use.

SIMPLICITY

Here all is in favor of the two stroke. There are no cam, valves or valve train. The only thing called a valve is a set of reed valves between the manifold and crankcase. They are simple spring type reeds that work automatically in the cool fuel-air-lubricant mixture and are never exposed to high temperature or pressure.

There is no oil pump, sump or passage. As long as you have fuel there can be no lubrication failure. If the pump at your marina does not have premixed gas the chore of adding a can of oil to each five gallons of gas is a simple one.

FUEL CONSUMPTION

For the same power at cruise the two stroke burns some 15% more fuel than the four stroke air cooled engine common in the homebuilt. For long range work where fuel weight is important the advantage is with the four stroke. For short range flying, usual for the homebuilt, the lighter weight of the two stroke may result in an aircraft so much lighter that fuel burned per mile may actually be less.

As a practical example there have been many attempts to build four stroke outboards. Till 1994. Cost and weight doomed their success. Fuel economy was no advantage because added four stroke weight offsets the basic brake specific fuel consumption advantage. This in a boat not nearly so weight sensitive as an aircraft.

COOLING

Less heat is rejected to the cylinder per unit of output than in the four stroke because the hot gas is replaced by cool fuel mixture at the bottom of the stroke. Burned gas does not remain in the cylinder during the exhaust stroke or heat the head by flowing through the valve or passage. However, actual heat rejected to the cylinder is much greater because of the high output per unit of displacement. For example the popular Continental A-65 is rated 0.38 hp/cubic inch displacement and the Mercury 1.27 hp/cubic inch. This is why, at the

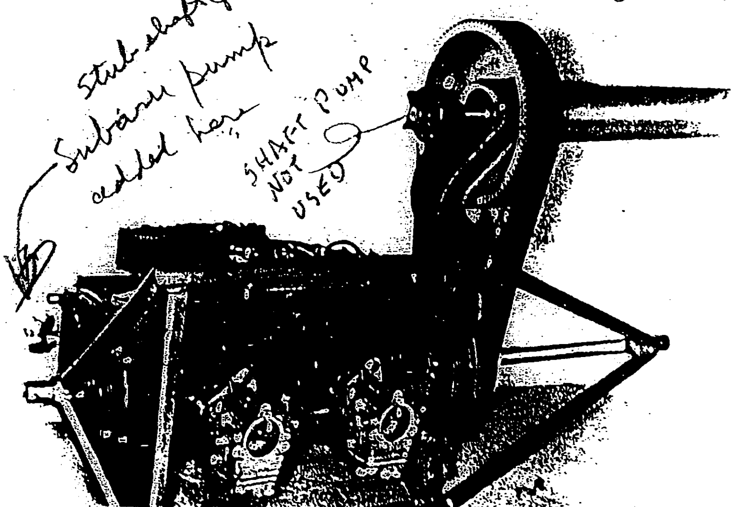

PHOTO 3 — Carburetor side of Mercury conversion. Coolant pump is on the propeller shaft.

(Carbs + adapters by owner, water pump + bearing fittings

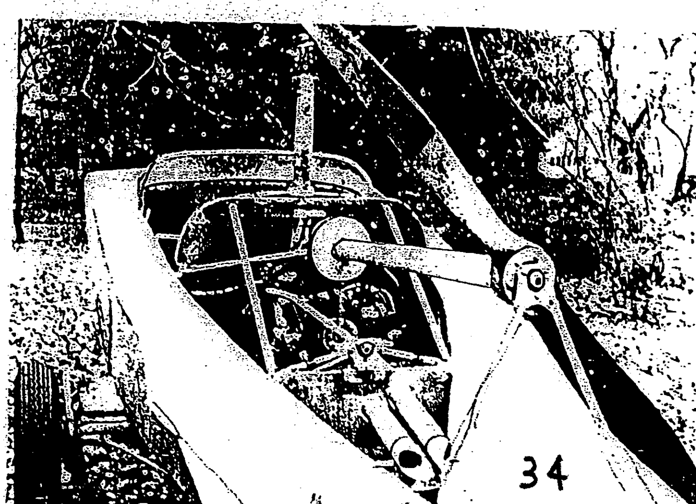

PHOTO 4 — Mercury package being fitted into nearly completed experimental hull for new N-910Z. Hull material is PVC 1/4" foam with Kevlar skin.

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present state of the art, air cooling is not practical in a high performance two stroke engine. Unless you want to fly only in freezing weather as with the snowmobiles. Aside from cylinder temperature there are two other reasons for not using air cooling:

1. Heat from the cylinder creeps down to the crankcase, heating and expanding the incoming charge. This accounts for the drop off in power often noticed in the air cooled two-stroke engine as it gets hotter.

2. Exhaust port bridge temperature. If the exhaust ports are large enough to be adequate, piston rings will bulge into these openings as they go by, resulting in wear or possible breakage. To avoid this, bridges must be placed across these ports. During exhaust these bridges are washed on all sides by hot exhaust gas. All heat from these bridges must be conducted out the ends. The most effective way to do this is by water passages as close as possible to the ends. Bridge temperature is really one of the major limits to the output of a two-stroke engine. Excessive heat will burn off the lubricating oil not only scoring the piston and rings but the cylinder wall directly above.

Liquid cooling has many other advantages: the engine is longer lasting because it runs cooler. It is quieter as the water jackets absorb some of the piston clatter. The installation is clean and easy to service as no shrouds are required. The heat is transferred to the air at the heat exchanger that may be located anywhere desired.

THROTTLING

For applications requiring efficiency and smooth operation over a wide range of throttle settings the four-stroke has the advantage. Fortunately, power required in an aircraft is quite constant and efficiency at idle less important.

In the four-stroke engine at the start of the intake stroke the volume of unburned gas in the cylinder is equal to the piston clearance, which can be very small in a well designed combustion chamber. The desired amount of fuel-air mixture is admitted by the throttle during the down stroke, this being diluted only by the small amount of residual burned gas.

In the two-stroke cycle throttling reduces the fuel-air mixture drawn into the crankcase. When the piston uncovers the transfer port, the cylinder is completely filled with burned gas. If the throttle has allowed the crankcase to only half fill with fuel-air mixture, only one half of the burned gas will be purged from the cylinder so at the end of the compression stroke ignition will be trying to light a charge of 50% fuel and 50% burned gas.

Throttling a two-stroke engine does not change the compression pressure at ignition so much as it changes the volume of combustible mixture and its ratio to burned gas. Total volume of compressed gas is essentially the same regardless of throttle setting. The four-stroking often heard in a throttled two-stroke engine is because on the first compression too much burned gas prevents ignition but on the second charge the mixture becomes combustible.

In many of the early two-stroke engines "throttling" was entirely by retarding the ignition, the flow of gas was not restricted. Now with improved combustion chamber design, smooth part-throttle running can be had by interconnecting the throttle and spark retard. The cost is a higher fuel rate at idle.

WEIGHT

The following table compares the weight of a Mercury 850 outboard to the popular 90 hp Continental. Not shown is the 40 to 60 pounds for fan and shrouding the Continental needs when used in a buried installation, or the 9 hp needed to turn the fan.

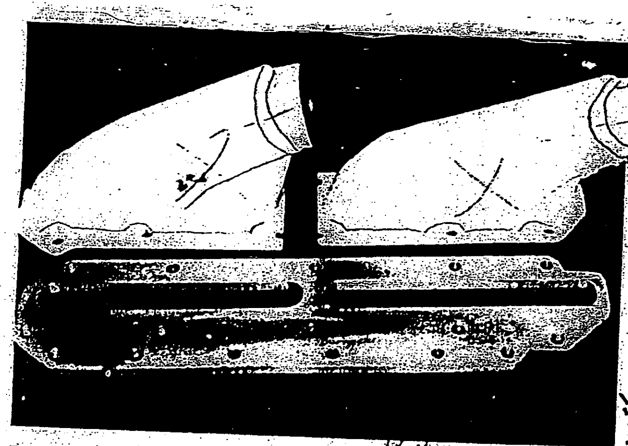

PHOTO 5 — Exhaust collectors and cover plate for water passages.

1/4" ALUM

BY OWNER

Single 'Y' Exhaust heat.

Mercury 850
85 hp at 5200 rpm

Basic	67.	
Flywheel	9.75	original with 2" standoff
Alternator	1.7	
Carburetors ~~(2) with fuel pumps~~	3.4	BY & OWNER
Starter and Bolts	8.	
Spark Plugs	.5	
Ignition, complete	3.5	
Total Engine	93.85	
Cooling System		
Radiator	8.	BY OWNER
Coolant (water)	7.	
Pump and Hose (SUBARU)	1.5	
Total Cooling	16.5	
Reduction and Drive		
Flywheel Pulley	3.	
Shaft Pulley	7.	
Shaft with Propeller Hub	7.25	
Belt Tightener and Bearing	3.65	
Belts (4 Polyflex)	.5	
Total Reduction and Drive	21.4	
Total Drive System	131.75 pounds	

Continental C-90 Series 12F
90 hp at 2450 rpm - 9 HP for fan

Basic	168.6	
Carburetor	3.	
Magnetos	11.68	
Spark Plugs	1.36	
Ignition Cable	1.82	
Starter	18.5	
Generator	9.70	
Voltage Regulator	1.68	
Total Weight	216.34	
	50	± fan
	266 ±	

EVALUATION

In evaluating the merits of the two-stroke compared to the four-stroke engine in the five areas discussed, the two-stroke leads in three, is about equal in one and not far behind in the other.

Simplicity	Far Ahead
Weight	Much Ahead
Cooling	Ahead
Throttling	Equal
Fuel Consumption	Not as good for long range flying but equal for short range.

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PRACTICAL EXPERIENCE FLYING THE MERCURY OUTBOARD

Rough up surface

Of the many two-stroke engines presently available, the only one we have found that meets our requirements is the outboard. It is highly developed and well proven in the field. Production volume is greater than any similar engine, assuring reasonable price and availability.

After working with several makes we tried, in 1960, a Mercury four in-line having 44 cubic inches displacement and rated at 40 hp. To many, working with such an underpowered flying boat seemed a waste of time, and it was time consuming. Yet pressing an engine continually to its very limit rapidly acquaints one with its frailities as well as its strong points. You don't have to wait long to find if your conversion is good or not.

I must point out here that this sort of development work should never be done in a land plane. Only a flying boat allows one to test a power unit under actual flying conditions in complete safety. There need be no concern about power failure. You are always over the runway and cleared to land.

In 1963 this engine was replaced by the next larger version, 60 cubic inches and 60 hp. This unit gave excellent performance with one person although the take-off was a little long with two. It flew several hundred hours, teaching us much about mounting and auxiliaries. Even now, some 14 years later, this same engine is driving our experimental land plane N-49888.

N-2236 was built in 1969 using the Mercury 800, a similar engine but with displacement increased to 66.6 cubic inches and power rating to 80 hp. The ignition was optically timed capacitive discharge using surface gap plugs. This engine flew two people quite well and now after seven seasons of flying is being prepared for a resonant exhaust program. The engine Mercury is building for their current model 850 outboard is particularly adaptable to aircraft use. The ignition is C. D. solid state with no distributor and the porting has been modified to give 85 hp at 5200 rpm.

This engine looked so good that we decided to put it in N-910Z and get some first hand experience with it. The following is a description of what we did, the reason for doing it and, as far as possible, the results.

Flew this one in 1969 N910Z

COOLING

The cylinders of the Mercury 850 exhaust directly into a liquid cooled plenum. The outlet of this plenum matches an opening in the top of the hollow lower housing, allowing the exhaust to flow down the housing and out through the center of the propeller. When installing this engine in an aircraft, it would be simple to use this plenum by connecting an exhaust line to it.

30% to 60% of the total heat rejected to the coolant is from this plenum — unimportant in the outboard as there is an unlimited supply of cold water. In flight coolant must be recirculated and heat removed by the radiator. We have found that by allowing the hot gasses from the exhaust ports to flow directly overboard, heat load on the cooling system can be reduced nearly 50%. A truly worthwhile saving.

Originally straight stacks went directly through the hull bottom. A simple way but one that hardly meets present noise standards. Photo 5 shows the simple exhaust manifolds we now use. Cylinders 1 and 2 and 3 and 4 must be collected separately to allow 180° crankshaft angle between port openings.

In removing the liquid cooled plenum a few simple changes must be made in some of the water passages. Photo 1 looks up at the bottom of the engine as installed in the boat. Exhaust baffles and water passage covers are removed.

1) Inlet hole marked "D" is enlarged to #22 drill and an epoxy dam built at "E". This is to insure an adequate flow of cool water past the ports and bridges. Diagonal holes are drilled through the webs at K1, K2 and K3 with ¼ inch aluminum tubes pressed in to remove trapped air from the cavities.

2) Holes C1 to C7 are reamed and tapped ⅛ pipe. All are plugged except C6 which is fitted with a tube fitting to return the coolant to the pump. Optional use.

3) Rectangular opening "G" is plugged with filled epoxy. Rough up surface.

4) A ¼ inch thick aluminum cover plate shown in Photo 5 is fabricated to seal these coolant passages..

5) Finally, each end of the cylinder block is drilled and tapped for water inlet marked "A" at the flywheel end and outlet "~~B~~" at the other end. ½" pipe

6) Also plug B small hole for original exhaust "G" "shown".

MOUNTING

A two-stroke engine should be mounted so that any flooding from priming drains out the exhaust. This gives the choice of having the cylinders vertical, or horizontal with the exhaust ports down. The vertical position placed the carburetors under the engine in the bottom of the hull, obviously not desirable in a boat. The horizontal position is much better. The carburetors are on one side and spark plugs on the other with the starter on top.

In a four in-line two-stroke engine crankshaft throws are at 90° as though it was two two-cylinder engines with the crankshaft throws displaced 90°. The same rocking moment in the plane of the cylinders is present. In the outboard this moment is absorbed by a long and relatively heavy lower housing. It is apparent that the conventional aircraft mounting with the propeller rigidly attached is not desirable. A new approach must be made.

We bolt the engine rigidly to a cradle having only two supports, one at each end in line with the crankshaft, Photo 2. This gives good rigidity in the rocking mode. By using bearings for these supports the entire cradle and engine are free to rotate about the crankshaft centerline. Engine torque is taken by a very soft shear rubber damper. This torsional softness reduces belt flapping and peak loads on the drive, resulting in good belt life and smooth operation. This system gives one other bonus, the potentiometer for the torque meter is connected across this damper providing a very simple way to read horsepower at all times.

Used fixed torque stops.

IGNITION

The alternator uses a 12 pole permanent magnet field in the flywheel. The stator is fixed to the crankcase and consists of three independent windings. Two of these supply energy to the two independent solid state CD ignition systems (each fires two plugs). The third winding furnishes single phase AC power (400 Hz. at 4000 rpm) to a bridge of clipper diodes for battery charging. Timing is by an adjustable coil surrounding a trigger magnet in the flywheel hub. In the outboard this coil is connected mechanically to the throttle linkage to provide very slow and smooth low speed running. For simplicity we lock this lever to a fixed time of 0.172 inches before top dead center.

A small aircraft battery cannot, for long, stand the output of the alternator and the excess is more than the diodes can bypass. A capacitor connected in the AC line reduces this rate to match the starter needs. A shorting switch across this capacitor brings the battery up in a hurry if it should get low. The ignition is independent of the battery so 30 pounds of electrical equipment can be saved if manual starting is acceptable. The only essential modification to the ignition is moving the coils

Used full size battery

to a location just over the plugs. A base made from 3/16 aluminum plate is bolted to the unused boss for the fuel pump and two head bolts. The coils do not need to be removed from their housing but can be bolted to this plate as a unit as can be seen in Photo 2.

POWER TAKE OFF

Power is taken from the flywheel by bolting a pulley directly to it using existing holes. The crankshaft is not capable of taking the side load imposed by the belt so the tightener loads must go directly to the pulley. This is done by placing the adjustable belt tightener between a bearing pressed in the center of the engine pulley and the combined radial-thrust bearing in the center of the shaft pulley. This arrangement can be seen in Photo 3. Thus the side load on the crankshaft is reduced by 80% at the cost of one additional bearing.

Belts have been developed to a high degree of reliability. Without long and careful testing it is hard to decide which type is best suited to this application. So far we have many hundreds of hours on the standard 3V, Gates Polyflex and Gates Powerband. Although there has been individual strand failure there has never been a forced landing from belt failure. As you see in the photos we are now testing Uniroyal HTD. After sufficient time we plan to give you a detailed report showing the advantages and disadvantages of each system.

FUEL

In making the 40 and 60 hp conversions we retained the original float type carburetors, merely turning them 90° to the engine axis. This worked fine but when tried on the 80 hp conversion there was trouble with fuel distribution to the cylinders. *

Each carburetor supplies two cylinders through a short internal "Y" manifold. If the throttle butterfly is across the "Y" it directs more fuel down one branch than the other except, of course, at full throttle. For even fuel distribution at all settings the throttle axis must be parallel with the branches. This trouble had not developed in the smaller engines because they flew at nearly full throttle.

Doubtful

This problem was solved by changing to floatless carburetors adapted to the engine by 11/16 inch aluminum blocks, aluminum being needed to conduct heat from the crankcase to prevent icing.

Mercury uses a fuel pump bolted directly to the crankcase. This is fine when cooled by sea water but in flight coolant outlet temperature is normally 180° F. Even at sea level fuel may vaporize at 110° F. Obviously, this pump should not be used, so we went to floatless carburetors with integral fuel pumps. To pulse these requires a short plastic tube to a fitting in the crankcase, J-1 and J-2 in Photo 1.

As we wanted to run these carburetors well above icing temperature and still use automobile or marine gasoline there was concern about vapor problems at altitude and idle. Fuel recirculation turned out to be the answer. A small portion of the fuel flowing through the pump and carburetor is drawn off just beyond the carburetor fuel inlet valve and returned to the tank. This keeps all passages filled with cool fuel and even should vapor form it is carried directly back to the tank. ~~Walbro~~ carburetors have provision for this return.

Best carbs + original equipment Mercury

Carbs + adapters By owner

floatless

MUKUNI 38 mm

CONCLUSIONS

The Mercury four in-line power head is light yet extremely reliable, but designed for only one purpose — to attach to the top of an outboard lower housing. I cannot advise too strongly against anyone taking this engine and just bolting it in an aircraft. It just won't work that way. It has taken us 15 years of study and flying to develop an installation where we feel this engine can perform as well as in the outboard it was designed for.

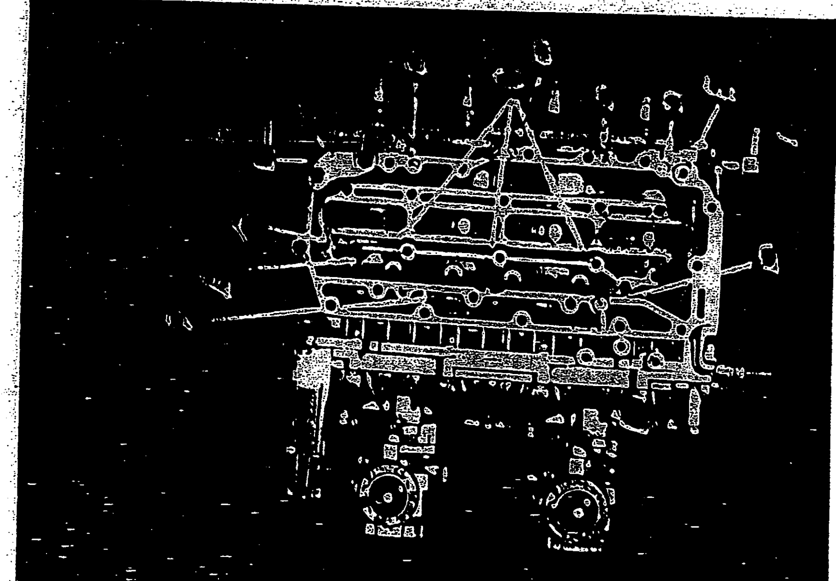
For these and other reasons Mercury Marine does not sanction this use of its engines in aircraft and specifically disclaims any responsibility for such an application.

It is my hope that this rather long discussion will point out some of the pitfalls and perhaps guide the homebuilder who would like to realize the full potential of this highly developed and well proven power in his creation.

* Replaced with larger capacity float type Mercury Carbs. original equipment best if available

* → OK to use 1/2" long machined standoffs w/ float type carbs 5/5

→ REFER TO PICTURED ON P 2/5.



PICTURE OF MODIFIED OLDER MODEL 800 [illegible]

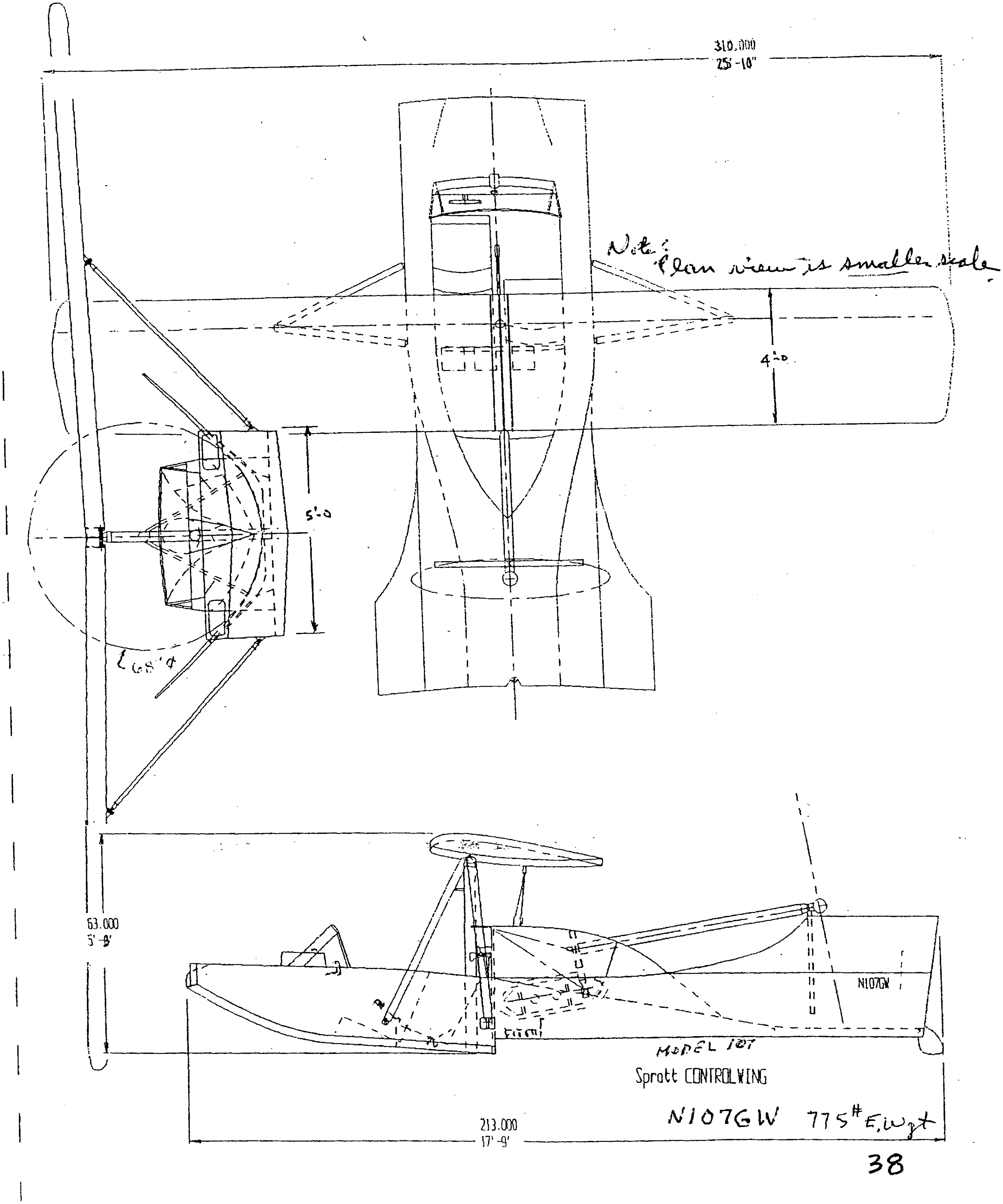
A - Enlarge #32 to #22 [illegible]

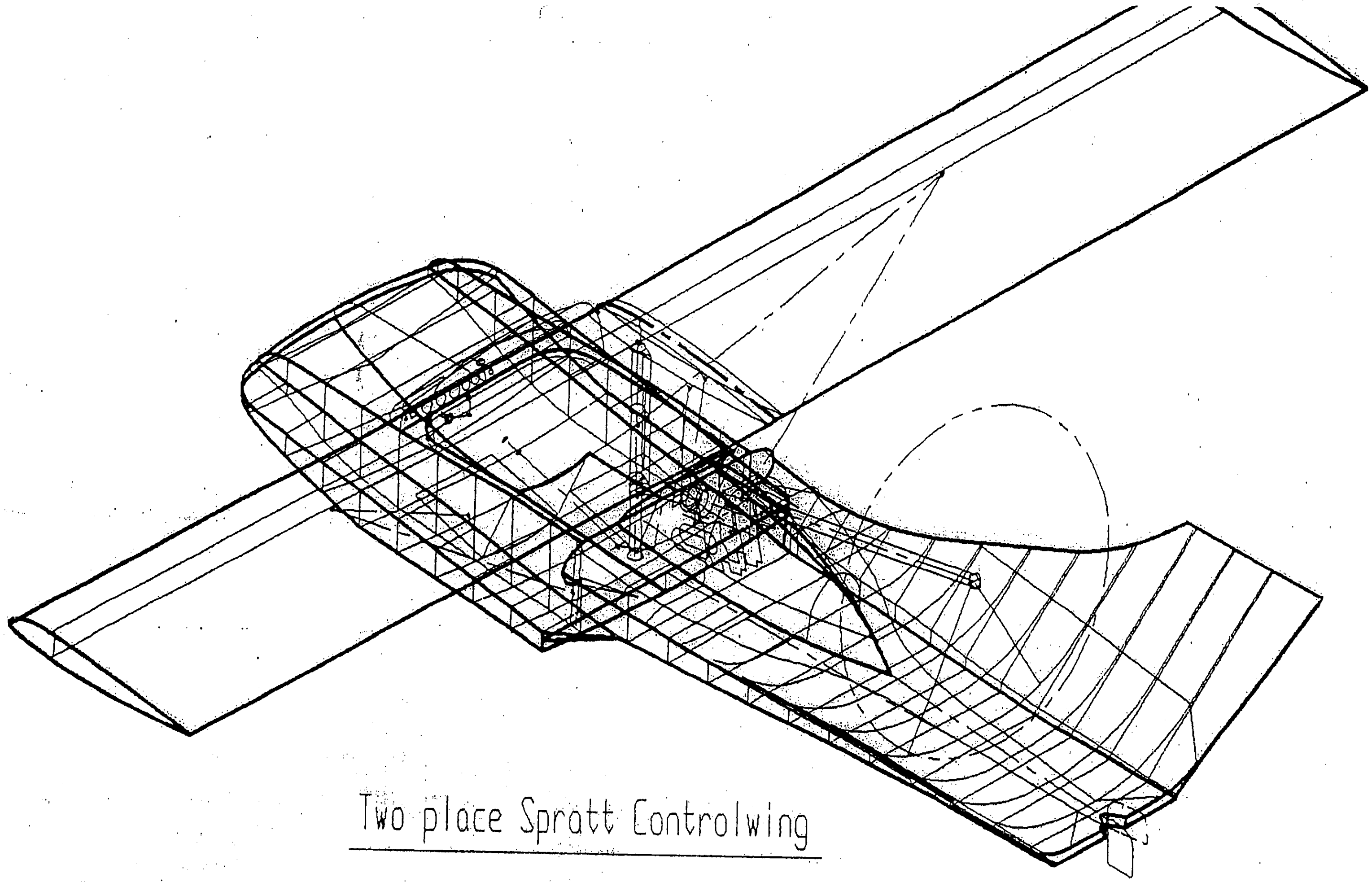
B - Fill epoxy [illegible] reinforced surfaces

C - Diagonal drill thru water + insert 1/4" alum. tubes [illegible] they don't block [illegible]

D - Drill + tap 1/8 pipe tapping 5 places + 1 on bottom. Drill + tap 1/8 pipe to place insert fitting for 1/8 / 1/8 to return to [illegible] pump.

E - 1/8 PIPE TAP + Plug.

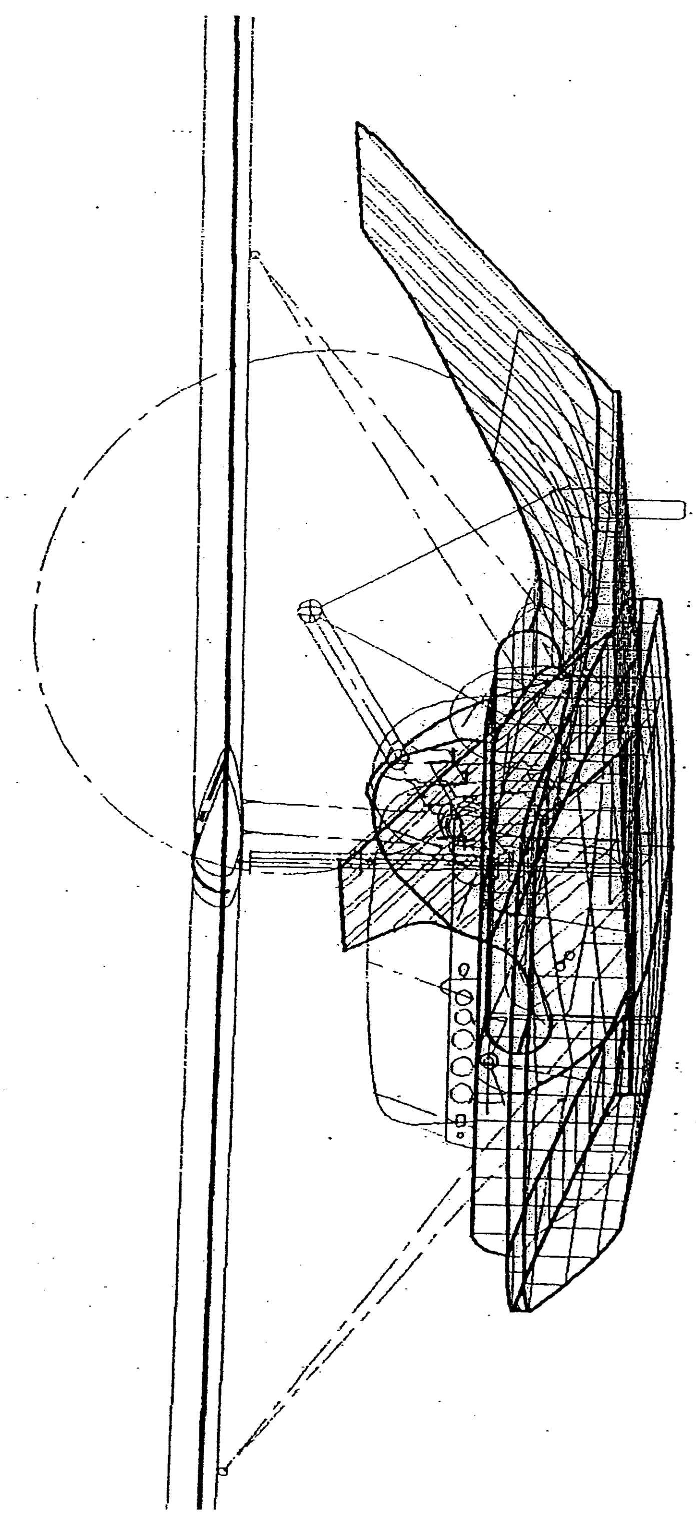

310.000
25'-10"
Note: Plan view is smaller scale
4'-0
5'-0
Lcs'4
63.000
5'-8'
N107GW
MODEL 107
Spratt CONTROLWING
N107GW 775# E.Wgt
213.000
17'-9'



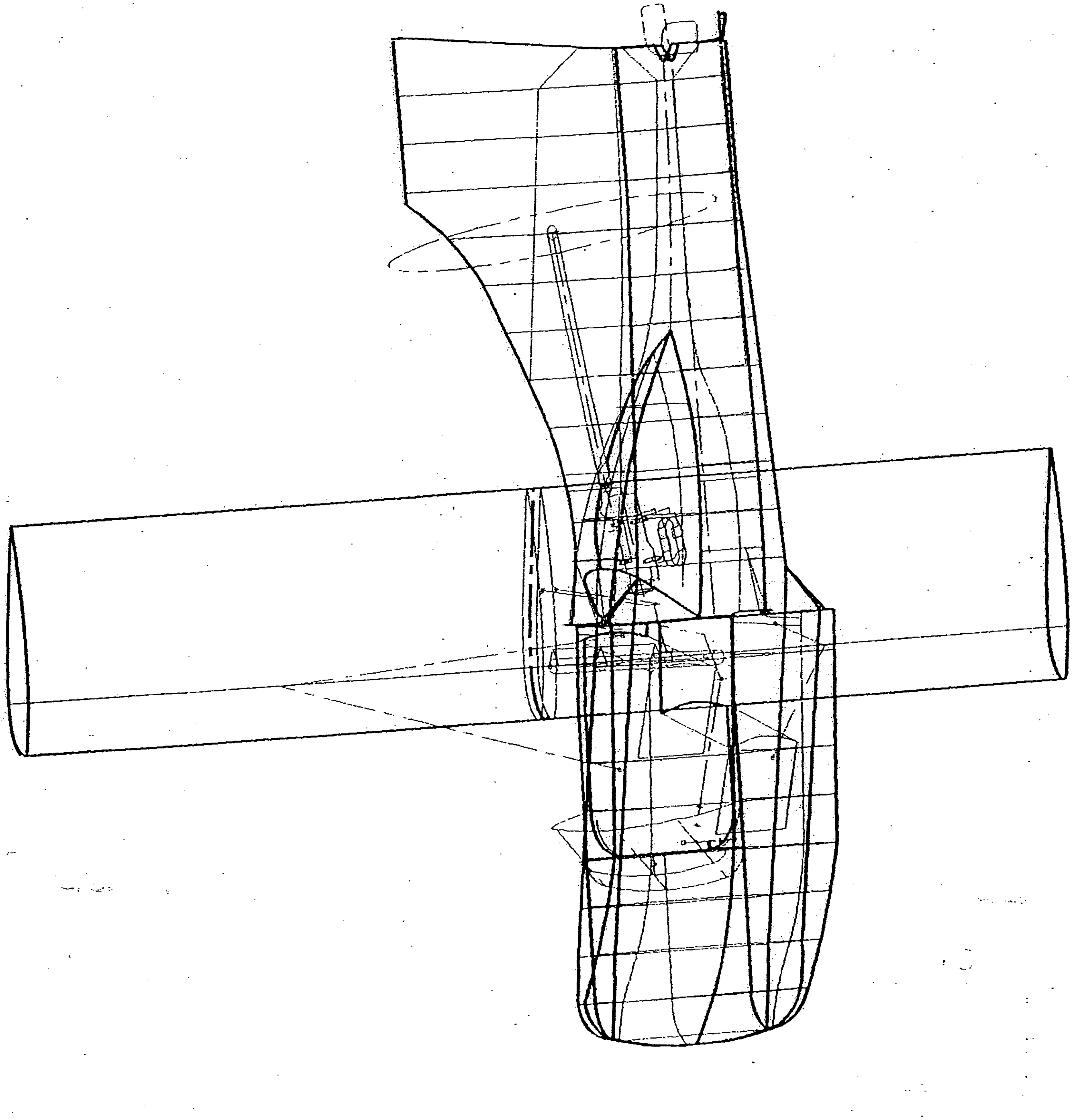
Two place Spratt Controlwing

Proposed changes to clean up the original design.
Keep sponsons, use small scoops at fwd end of fins (if reqd)
reduce cowling and bulkhead size. Flat surfaces OK
for most parts except fwd bow area, and fillets near prop arc.

Bill Wolfe '98



BW '98



BW '98

42 Spratt web sites www.georgespratt.org These show more
www.flyingflea.org Spratt + controlwing history.
www.groups.yahoo.com/group/SprattCtrlWng
CTRLWNG

Spratt Controlwing articles-

Dear Friend,

I first saw a demonstration and then flew a Spratt Controlwing flying boat prototype in 1969, immediately deciding it was the only type aircraft I would ever care to own.

For your reference, this is a listing of all the Spratt and Controlwing related flying boat articles which I have collected. Some of them (*) are included with the plans package.

Sept 1983-Sport Aviation-Reprint of George's 200#, 1936 Evinrude powered, roadable ultralight, lead aircraft in EAA's " Old Time Aircraft" video.Taxi in traffic, rotate wing then takes off. 1pg
June 1945-Popular Mechanics-The Spratt-Stout flying automobile. 2 pgs
Jan 1962-Climax MagazineThe Brain Behind the Wrights -The Dr. George A.Spratt story. 9 pgs.
June 1962-Popular Mechanics-Controlwing flying boat cover article. 6 pgs
July 1969-Philadelphia Evening Bulletin-No tail, no rudder, no ailerons, but it flys. 1 pg
Sept 1969-The AOPA Pilot-Movable Wing Controls Flying Boat. 2 pg
April 1970-Science and Mechanics magazine, Controlwing flying boat cover article. 4 pgs
July 1972-Sport Aviation-My first Controlwing experience. * 2 pgs
Dec 1973-Sport Aviation-Prototype Land plane version of Controlwing by Jack Cox. 1 pg
June/July 1974-Sport Aviation-Spratt history behind Controlwings. 12 pgs
1975 +/- Janes All the World's Aircraft Info only, no copies available.
May 1976-Sport Aviation-First plans-built Controlwing flying boat by Joe March. * 3 pgs
Mar 29-Apr 1, '77- Spratt's presentation to Society of Automotive Engrs., Wichita, KS. * 6 pgs
Mar 1978-George's instructions to modify the 85 HP Mercury outboard for C/W use. * 5 pgs
May 1980-Ultralights & Single Surface Wings by George Spratt. 5 pgs
Dec '94/Jan '95 Smithsonian Air & Space magazine. Freewing Co. and Spratt's ultralight. 1 pg
Oct 1998-Sport Aviation-My Controlwing flying boat's first magazine appearance. 1 pgs
1999-EAA Experimenter-Shown in Technical Counselor section.
Apr 2000-EAA Experimenter-Controlwing article by Harry Whiting. * 3 pgs

Chester County PA Historical Society - A massive collection of newspaper articles covering the lifetime aeronautical engineering accomplishments of Dr. George A. Spratt, especially his very generally unknown importance in developing Wright brother's first gliders and airplane. 24 pgs

Starting in 1895, Dr. George A. Spratt and later with his son George G. Spratt, experimented with and built a large number of successful gliders, flying boats, land planes and even a flying automobile as a joint venture with Bill Stout. All were aimed toward stable aircraft and safer aircraft control systems, and all of them used control wings in some fashion. The above noted Climax, Sport Aviation and CC Historical Society articles summarize these many projects.

The Controlwing flying boat consists of a boat like hull incorporating a fixed vee shape tail with a pusher prop nested close to the tail surfaces to act as a venturi to provide lift when under high power settings. The two separately hinged parasol wing panels are collectively, aerodynamically and automatically moved to maintain a relatively constant angle of attack in flight. This may be overruled by use of the auxiliary pitch stick to temporarily move above or below a stable flight path or nose high glide, to shorten a takeoff run or to flare for a smoother landing, both of which can be safely accomplished hands-off by power application alone.

The steering wheel moves the wing panels differentially to provide a gentle bank resulting in smooth turns and also steers a water rudder to enable fast turns on the water due to the wide hull, low CG and lack of outboard floats to trip over. There is no coordination required with this simplistic control system. The Controlwing is the safest aircraft in the world, a very docile aircraft, inherently stable and with no stall, spin or dive capability. Only 1/4 of the normal G load is felt in turbulence as the hinged wing will automatically spill gusts if the stick is unrestrained.

and landplane,

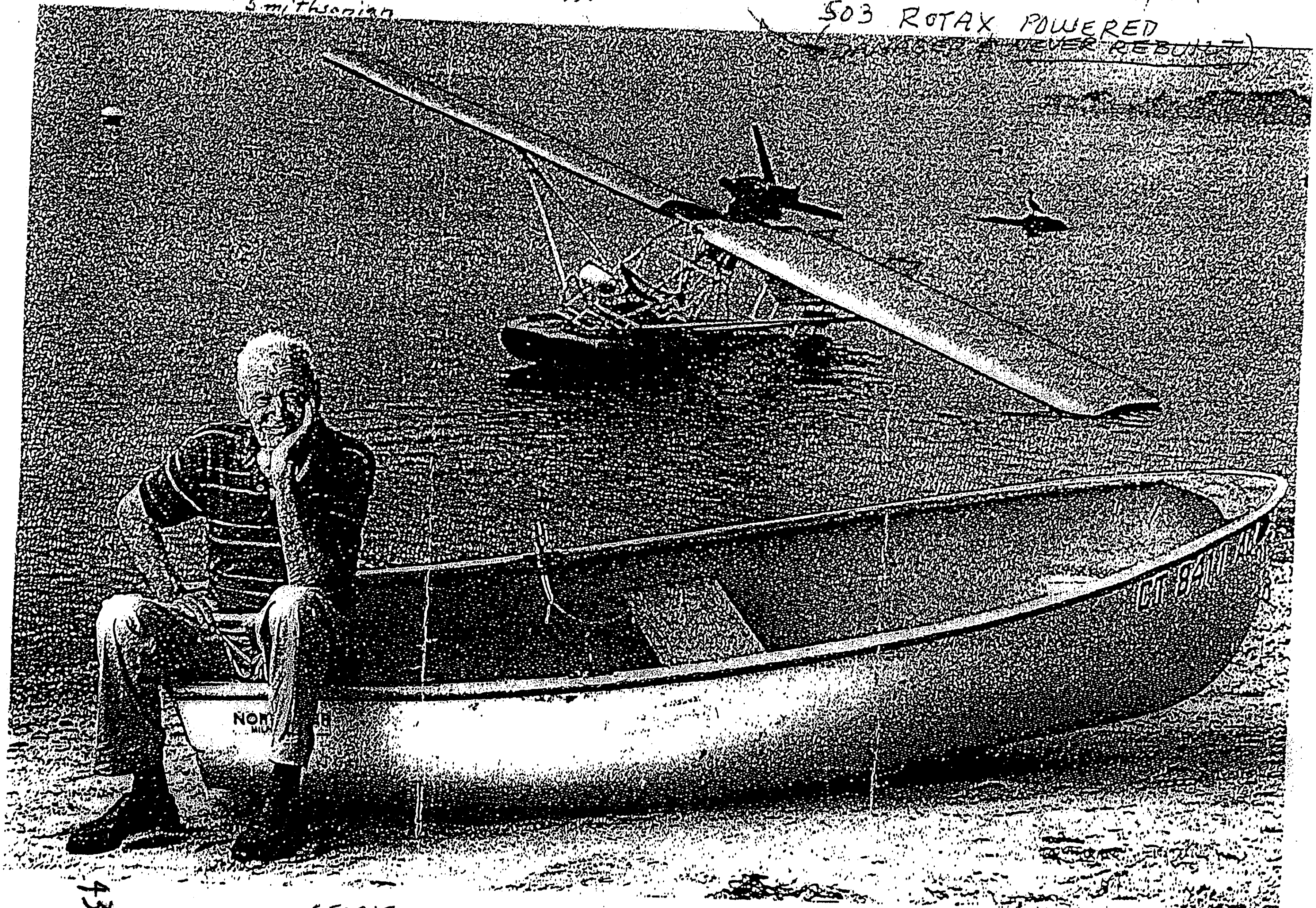
42

I offer copies of Spratt's 1973 flying boat plans with my changes marked, possible future design ideas, much general and technical material plus a 35 minute video showing operations of Spratt's prototype Controlwing flying boat, some bystander's shots of my taxi testing runs and operation of the Spratt prototype Land plane ($~~[illegible]~~ 125.00 IN US.)
and liftoff of my last flight before my medical expired.

ULTRALIGHT
NEVER FULLY DEVELOPED

From AIR & SPACE - Dec 94/Jan 95.
Smithsonian

U/L ON RUBBER FLOAT/PLYWD TAIL
503 ROTAX POWERED
(DAMAGED & NEVER REBUILT)



GEORGE G. SPRATT ON HIS LONG ISLAND SOUND BEACH. (DECEASED 1998)

Dear Friend,

Should you elect to build a slightly smaller and lighter weight Controlwing flying boat than that shown in the 1973 Spratt plans you have, I suggest reducing the overall dimensions similar to that of the early protype, N910Z, which I flew in 1969, as shown in the video and with estimated dimensions as noted on the attached sheet.

Powerplants suggested; an inverted fan cooled Rotax 503 with a C gear box or a Rotax 582 with a gear box, with its radiator placed above the aft deck just forward of the propeller. This would avoid the complications of the hull bottom radiator mounting and air ducting as shown in the plans. A 60 HP Mercury outboard engine was successfully used in N910Z for many years of demonstrations, some of which are shown in your Controlwing video. Engines such as VW, Subaru, Hirth or other similar size 50 to 85 HP range or more would be OK.

I have brainstormed now and doodled many possible arrangements for retractable landing gear on a Controlwing flying boat, but have ~~not~~ developed ~~any~~ specific design. A builder can do his own thing in respect to landing gear. The wide hull, low CG due to engine placement, and lack of outboard floats on the Controlwing flying boat permits relatively sharp, fast and safe turns while on the water.

I have several different thoughts on the Controlwing control system arrangement. The final location of the wing pivot can be determined by hanging the complete aircraft from the center mast pivot fitting with pilot aboard, so the hull angle is about seven degrees nose up. Adjust the length of the forward lift struts and position the mast on the hull to obtain this desired water contact angle. As many questions are likely to come up, I will be happy to answer them by telephone, regular mail or E-mail.

As a homebuilder, you may alter the design from existing plans and change almost any material, method of construction or powerplant installation details you care to use in your own particular aircraft so long as they are within reasonable aircraft practices and are fully acceptable to the FAA inspector or Designated Examiner who grants the experimental license for 'educational and recreational' use of your aircraft. The original designer or plans provider assumes no responsibility for individual builder's changes from the basic plans.

~~In the near future~~ See P 63, Sport Aviation ~~will publish~~ NOT PUBLISHED an updated technical article on the Spratt Controlwing. It may help you to better understand the aerodynamic principles and the reasoning behind this extremely safe and uncomplicated control system. You may already know that the constant, hands-off airspeed of a Controlwing aircraft is determined primarily by the location of the wing pivot on the NACA 23112. It was selected for the Controlwing application due to desirable aerodynamic charactaristics. A copy of the NACA 23112 airfoil information is included for your reference.

Bill Wolfe

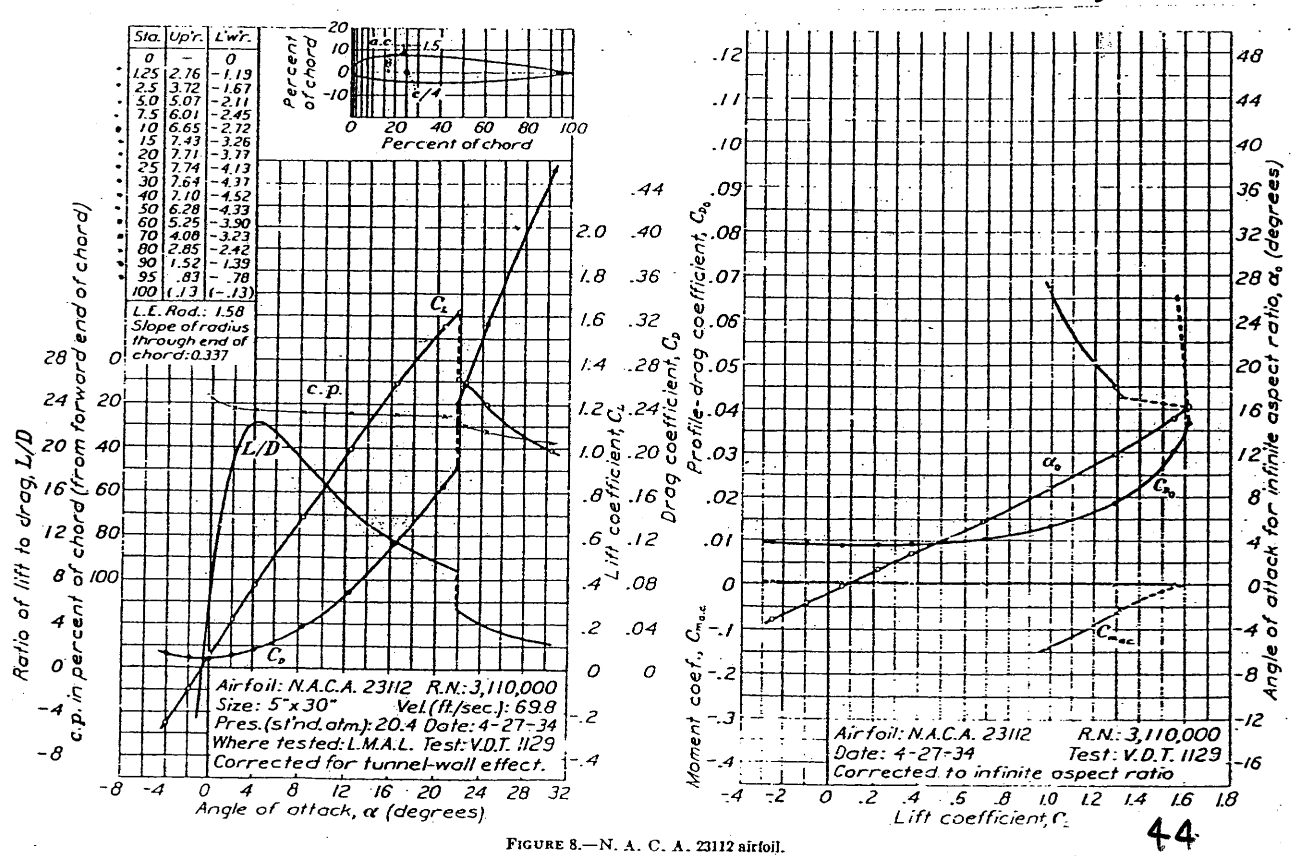
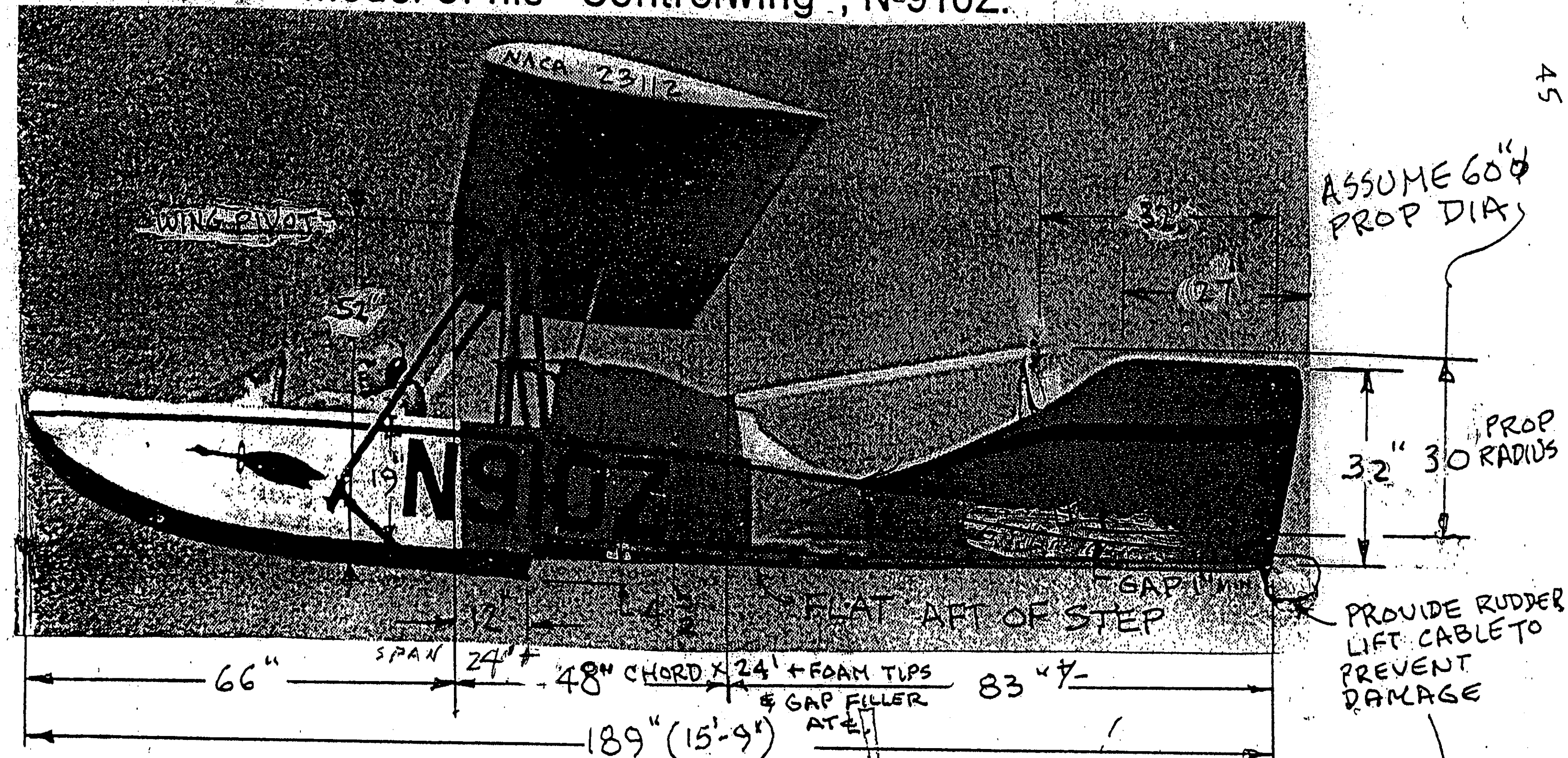
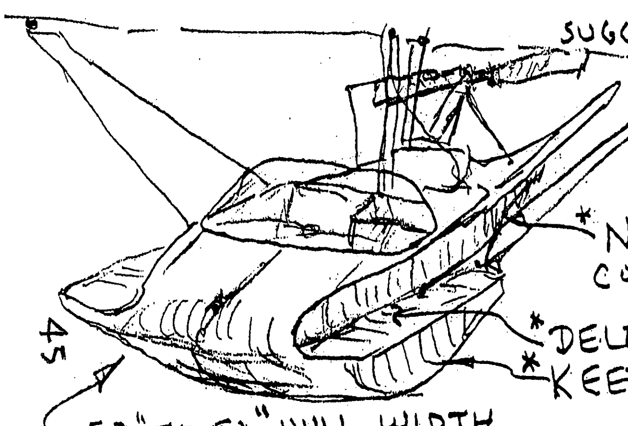


FIGURE 8.—N. A. C. A. 23112 airfoil.

ESTIMATED DIMENSIONS

George G. Spratt flying the 60-hp model of his "Controlwing", N-910Z.

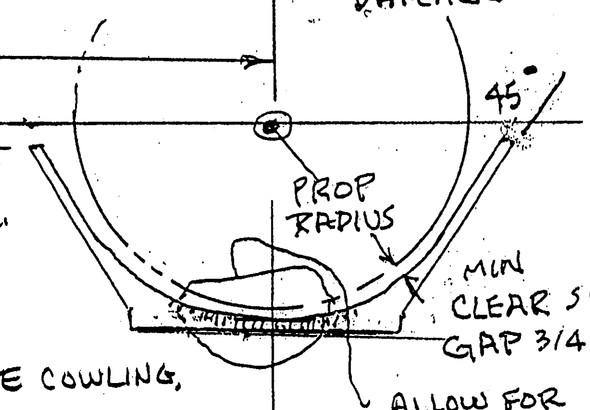




SUGGEST FAN COOLED ENGINE 503 OR 582 WITH REDUCTION GEAR.

IF RADIATOR IS NEEDED - MOUNT JUST FORWARD OF PROP NEAR DECK

1" TO 2"



*NARROW HULL AFT OF COCKPIT - NO HIGH BULKHEAD REQD, JUST SMALL ENGINE COWLING.

*DELETE AIR DUCTS

*KEEP 'SPONSONS' FULL WIDTH TO STEP

ALLOW FOR EXTRA BLADE FWD DEFLECTION AT THIS AREA

52" TO 54" HULL WIDTH.

→ 28' wing considered.

*MODIFY BASIC HULL - SUGGESTED CHANGES

See Pages 74-75

BW

Identification of photos on the next three pages:

Page 47. General views.

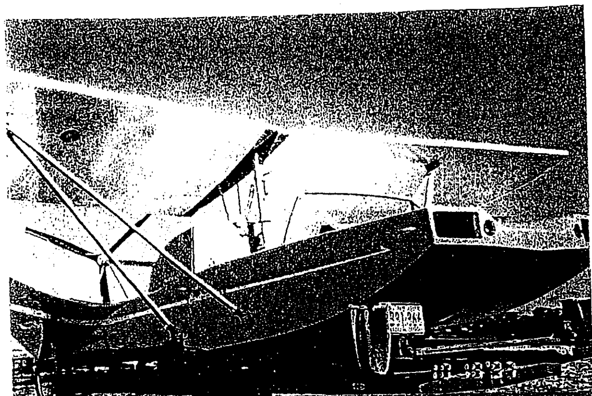
Three left corner photos were made at the time of FAA inspection at Berryville, AR.
The lower left photo shows the wooden rain covers for the cockpit, mast and for the exhaust and shaft openings in the engine cowlings.
The upper right shows the aircraft hull, wings and fin extensions on the customized boat trailer.
The center photo shows the aircraft just after first launching.
The right photo shows the wing panels being mounted and ready for strut and control link attachment on the hull.
The lower photo shows the aircraft just passing the photo boat, ready for liftoff at 50 mph.

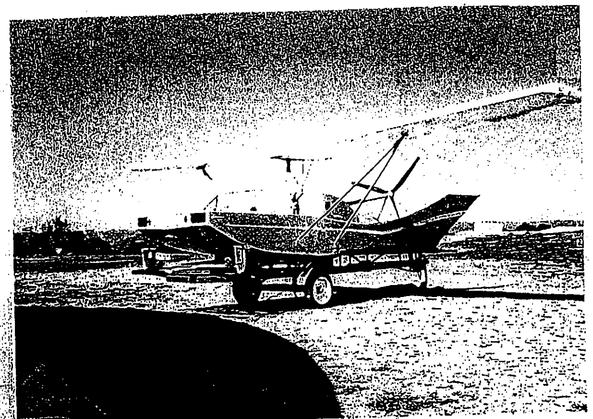
Page 48. Construction details.

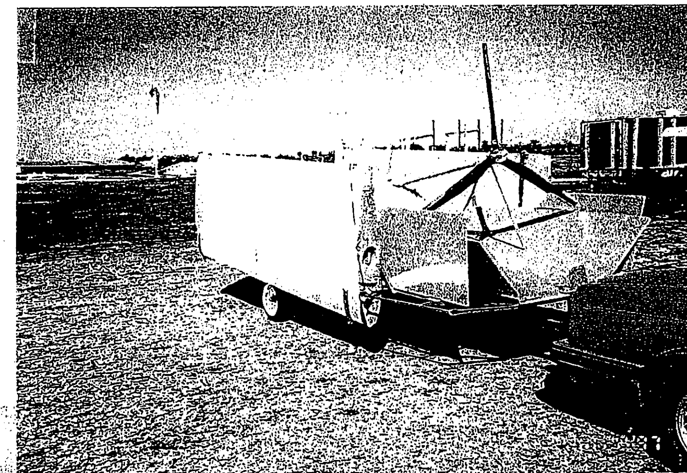
Wing box spars under construction, assembling nose ribs and the finished wing panels less inboard filler fairings.
The center photo shows the completed engine compartment with the three bottom mounted heater cores forward of a higher frame closing out the air plenum chamber. The top was closed out with a sloping fabric and fiberglass, under the water pump ~~cover~~, to direct ram air entering the forward air scoops, through the side air ducts and down through the cores aided by step suction. Direct water contact provided cooling during taxi operations.
The lower photo shows the typical fuselage construction and the tubes buried in the hull and removable fins which permitted a narrower trailer.
The cockpit photos show the 1" x 2" floor beam supports, instrument panel and welded windshield frame. The pilot seat back and seat were not installed at this time. A three gallon tank was added a cutout in the deck and mounting it above the shelf behind the seat. A five gallon tank can be located below the shelf.
The bottom curved framing members were slit, glued and clamped to a jig.

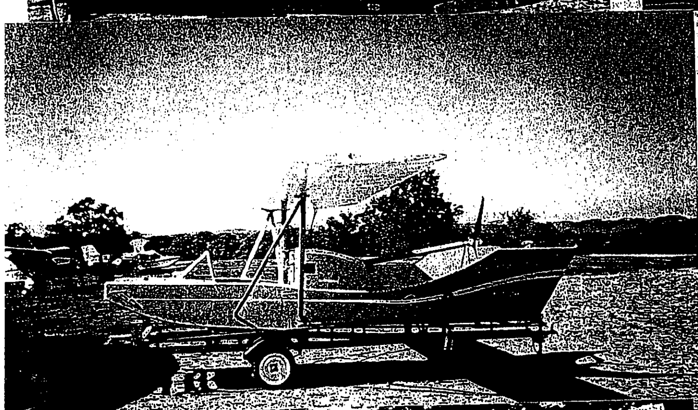
Page 49. Miscellaneous details.

The first two photos show the wing panels at max up and max down angles of incidence available before a limiting stop was placed to avoid approaching a stall angle should roll input be added to a situation where pilot input could reach the maximum positive angle of incidence at the same time.
The propeller bearing housing is a modified Toyota truck drive shaft with a 16 point internal spline and four bolt flange attached to a machined steel plate drilled and tapped to accept six 8mm bolts to attach the 68" Ivoprop and four AN 5 connecting bolts to the modified bearing housing. The 'A' frame is attached to the bearing housing with rubber bolt sleeves and rubber washers.
The left center photo shows the built in jack lifting the forward hull with manual blocking required to rotate the hull in place on the trailer for bottom maintencnce.
Two views show the 85 HP Mercury engine installation and the reduction pulleys, belt tensioner and dual powerbands. Two exhaust collectors below are 'Y'd to a single 2" stack.
The cockpit view shows the ignition switch, Hobbs, various available switches, tachometer, airspeed, altimeter, rate of climb, high and low coolant temperatures, coolant system pressure, kill switch ball, compass and tube for a built in manual air horn. Not shown is a rear view mirror and auxiliary pitch stick with twist throttle which is locked down to prevent the wing panels from disturbance gust. The battery switch is visible in the shelf and the small three gallon fuel tank is under a removable cover not shown elsewhere. The bilge, auxiliary fuel pump switch and choke knob are located in the seat back near the sidewall.
The lower photo shows the complete aircraft with me aboard to weigh the aircraft and determine the adjustment in forward drag strut length to locate the wing pivot relative to the aircraft center of gravity. When adjusted, the hull should hang at about 7° nose up, a desired angle for takeoff and landing. The passenger seat is located close to the aircraft CG.









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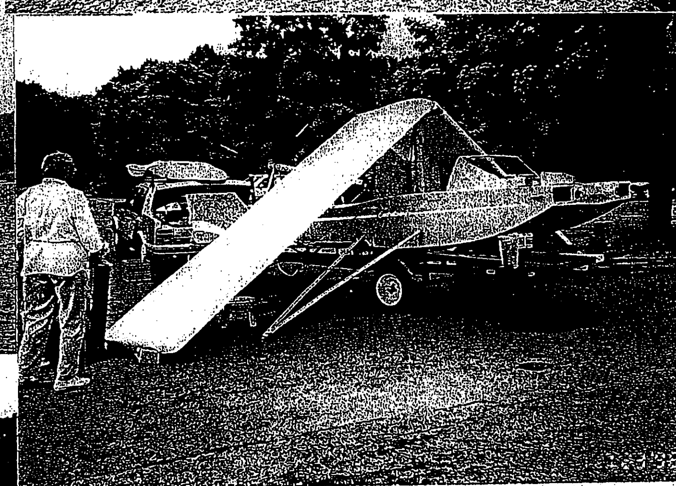
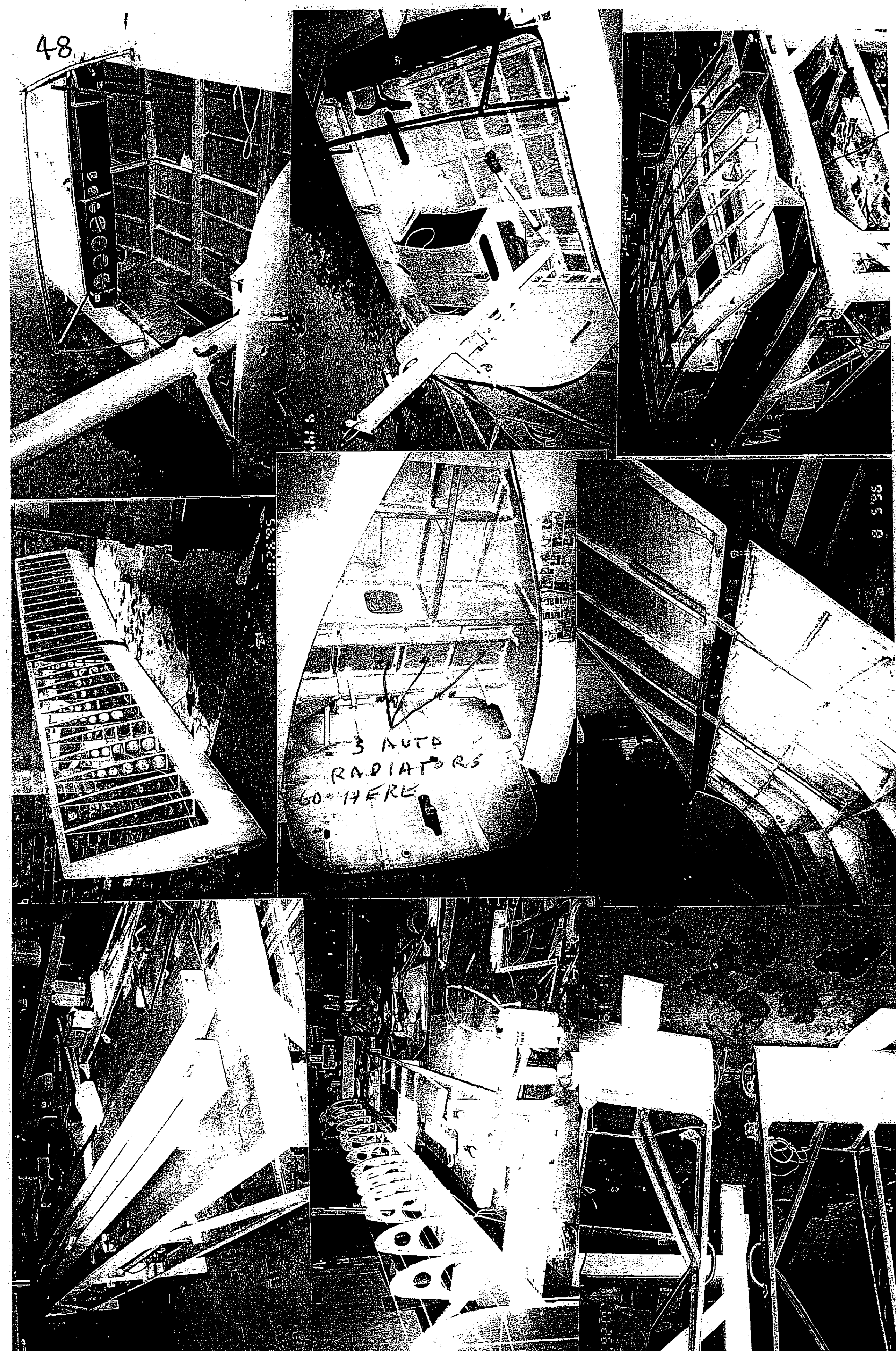
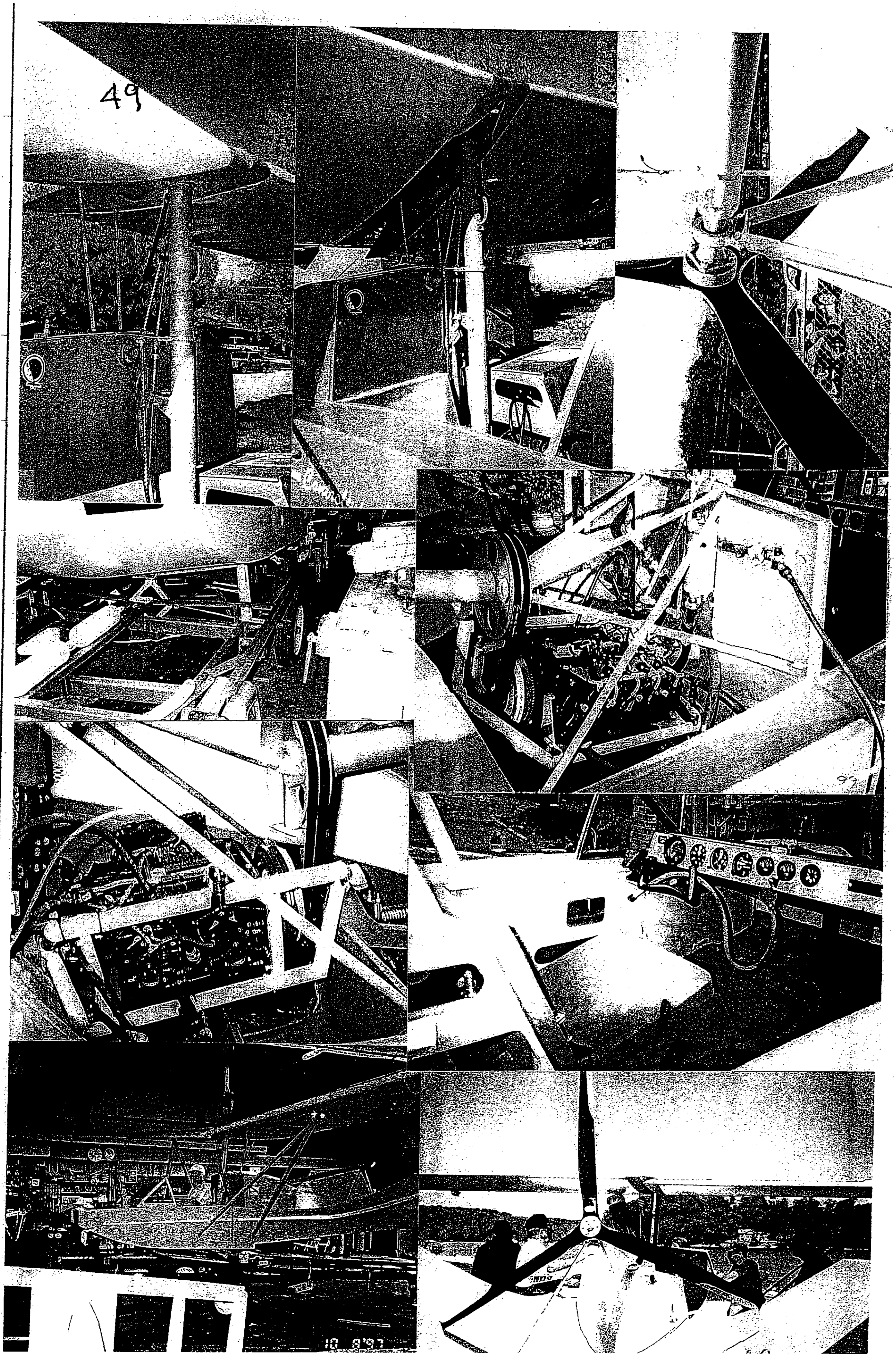
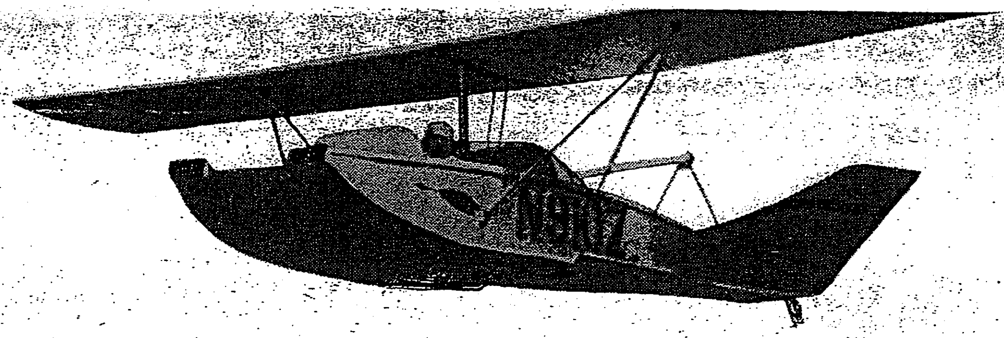


N107GW
SPRATT CONTROLWING FLYING BOAT


3 AUTO
RADIATORS
GO HERE





It's called the Blue Stoose. And don't laugh, it may just revolutionize flying!

By Dwight L. Pickard

Over the waters of Chesapeake Bay the cry of the wild goose now fades before the buzz saw whine of the Blue Stoose—an altogether new kind of airplane undergoing final test flights. To curious onlookers, the flying Blue Stoose is somewhere between fact and fantasy—for this craft, with its yellow body and silver wings, is unlike any flying machine that ever sailed through the wild blue yonder. It looks like a motorized moth or a friendly UFO. But to those aviators who have flown it, it's the plane that could completely revolutionize the aircraft industry.

No larger than a one-man glider, the Blue Stoose can be flown as easily as one drives a go-cart, or driven through the water as a boat at 60 mph. Airborne or waterborne, it's powered by an outboard motor.

Theoretically the plane, like a bumblebee, shouldn't fly. It has no rudder and no ailerons. At first glance, it appears to be without a propeller. That is, until you study the after end of the craft as it flys by at 70 mph. There, blurred and buzzing between the V-shaped, canted tail is the propeller. But, hold on. What's this? The wings are moving. Each wing acts like a wing flap. As one wing rotates, tilting forward, the other one tilts backwards, turning the plane into a new direction. Is the Blue Stoose coming apart at the wings?

Hardly, explains George G. Spratt, retired aeronautical consultant of Media, Pa.—the man who has spent over forty years developing and perfecting the Blue Stoose. The movable wing is a bit of Rube Goldberg genius that really works—a unique concept that was first advanced by Spratt's father, Dr. George A. Spratt, an aviation pioneer who got the bug to fly in 1894 and thereafter divided his time between practicing medicine and pursuing his dream that man could fly. The doctor quickly gained a reputation as an aviation expert and became a close friend of Octave Chanute, often called "the father of aviation."

In 1900, when the Wright Brothers tried to fly and failed, they came, discouraged, to Chanute for advice. Chanute, in turn, asked Dr. Spratt to join the Wright brothers at Kitty Hawk and "help the boys along." So Dr. Spratt traveled to the coast of North Carolina, his expenses paid by Chanute. While there, the doctor designed both a new wing and a new wing testing device for the Wright brothers.

Later, both Dr. Spratt and Chanute advised the Wrights to build a plane without a rudder, ailerons, or elevators and let movable wings perform the functions otherwise performed by the omitted components—advice which, like most advice, was disregarded. Chanute even designed a plane with a movable wing for the brothers to test, and sent the craft to Kitty Hawk. But for some reason the brothers never tested it and left it on a desolate beach where it was ravaged by weather. Eventually, of course, the brothers gained success and a place in history. However, Dr. Spratt and Chanute were displeased with the design of the airplane which took the first man into sustained flight.

"My father always said Orville and Wilbur Wright got off on the wrong foot," says

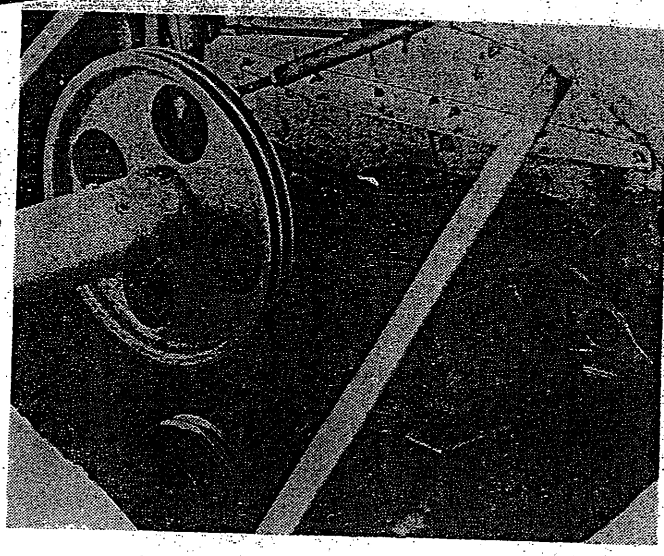
50

Mechanics
APRIL
OUT 20%
STILL 35¢

51

SCIENCE & MECHANICS

NEW $3500 BOAT/PLANE!



April 1970
Science & Mechanics

Engine is a modified 60-hp Mercury outboard for reliability and ease of repair. Engine is mounted horizontally instead of vertically, as in the outboard configuration. 2.5:1 reduction pulleys drive shaft which extends back to pusher propeller.

N 9107

he died in 1998 @ 93.

Spratt, a tall, handsome, 65-year-old gentleman who's still as trim as an athlete. "They built a plane with a rudder and ailerons and a fixed wing, and conventional airplane builders have been making planes that way ever since." This, according to Spratt, is a serious mistake.

The problem with conventional aircraft, he notes, is that they are controlled by ailerons and elevators and a rudder and are, therefore, susceptible to going into stalls and tail-spins. At slow speeds, they tend to over-react. "If," explains Spratt, "you have an aircraft with a speed ratio of three, you have to design it so it either has nine times too much control at top speed, or only one-ninth enough control at minimum speed."

On the other hand, the Blue Stoose is "so simple it can't stall or spin." or dive! Simple, indeed. On the dash in the cockpit there are only three gauges: a speedometer, a tachometer, and an engine heat indicator. In flight, the Stoose is controlled by a throttle and a small steering wheel that moves the wings. That's all. You can take off without touching the steering wheel. You just slowly open the throttle, increasing the flow of gasoline to the ~~X~~ 60-hp outboard engine mounted behind the cockpit. The power is transmitted through a shaft to the propeller that pushes the craft over the water or through the air.

"In rough weather," says Spratt, "you just let go of the steering wheel and the plane takes care of itself." In gusty, buffeting weather, the movable wings act like shock absorbers on a car—that is, the wings take the pounding while the fuselage remains stable. "In fact," says Spratt, "the plane pretty near does everything on its own." If it reaches what would normally be a stall speed, it simply slides into a glide, the movable wings preventing either a stall or a tail-spin.

In 1928 Spratt and his father started in earnest on the first Blue Stoose. "Our original concept," recalls Spratt, "was to design a plane for underdeveloped countries where there are no highways, no airports, no railroads . . . and a plane that could also operate as a boat on rivers. A plane that you could learn to fly in 2½ hours or much less.

"Right now, for instance, you'll find that up in Alaska and in northern Canada many small boats and outboards are being used by prospectors and surveyors and people who have to be there. Their big problem is getting from one river to another and then getting back to home base.

"With the Blue Stoose, they would have the added advantage of a good boat to get around on the water, and then they could pick up and fly to home base in a few minutes."

Over the years many people, on seeing the Blue Stoose, have reacted to it like a child reacting to a toy. They would like to have one, just for the fun of flying it around, flying it solely as a sport plane. So now Spratt sees the Stoose as having two markets —one in the hinterlands where it will be used as a working aircraft and boat, and one in more populous areas where it will be a pleasure-and-fun craft, a boat and an air plane merged into one.

51

Prior to 1939 all of the Blue Stoose forerunners built by Spratt and his father were gliders. In 1939 Spratt built the first Stoose powered by a gasoline engine. Selecting the right engine presented a problem. Spratt recalls, "I kept thinking what kind of engine would be best for underdeveloped countries, where there aren't any aircraft engine parts and where no one knows anything about aircraft engines."

The answer? An outboard motor. "You find them everywhere," says Spratt. "So I built up an engine using all outboard components. There's always somebody around who can fix an outboard."

Presently, Spratt has three patents that protect the Blue Stoose's movable wing concept. Over the years, the test pilots who have flown various models of the Blue Stoose have been especially intrigued by the movable wings. All pilots have echoed the sentiments of test pilot Robert F. Townsend, who flew an earlier model at Elizabeth City, N.C., on a windy March day in 1945. Townsend reported: "After two hours in the air, I began finding out the new-type feel of this ship and became quite fascinated with its performance. The rough air characteristics of the Spratt plane is the feature that intrigues me the most. This can be a great contribution to the flying world."

"All the test pilots have been enthusiastic," says Spratt. "But the greatest booster I ever had was Bill Stout, the fellow who built the Stout Ford Trimotor airplane. He was very excited about my project."

Spratt, as if honoring the memory of his friend and supporter, Stout, who died in 1956, decided to call his plane the Blue Stoose because "Stoose means stout goose." Also, the emblem of the blue stoose—a goose with one, wide-open eye and a circle around its neck—was painted on the planes flown by the early aviators. "We early aviators," says Spratt, "had our necks in a noose, but our eyes were wide open."

Spratt particularly delights in comments he overheard one day while he was below decks in his ketch, *Quest III*, with the Blue Stoose tied up alongside. "A boat came alongside with an aeronautical engineer and another man in it. The aeronautical engineer looked the plane over for a few minutes. Then he said to his friend, 'The man who built this has got a lot to learn yet. He's got to find out about ailerons and elevators and rudders.'"

Spratt's a modest man. So he didn't ascend the ladder to the main deck to inform the young engineer that he, Spratt, had worked over forty years in airplane stability, that his ingenuity had earned him patents for helicopter innovations, undersea warfare devices and for airplanes, and that, indeed, he knew all about ailerons, rudders and elevators but that he, unlike the Wright brothers, had elected to forget about them.

When empty the Blue Stoose weighs 500 lbs.; the maximum gross weight it can carry is 1000 lbs. It's wing span is 24 ft., length 17 ft., beam 5 feet. The hull, wing, and propeller are all made of plastic. Only the engine and replaceable fittings are metal. The front portion of the wing (the leading edge and about 30 percent of the wing area directly aft of it) is made of glass epoxy formed in a large mold specifically designed for this purpose. After this section is molded, the leading edge ribs are pressed in and bonded, followed by the spar, the trailing ribs, and the trailing edge.

Next, this assembly is removed from the cavity and jig, and unshrunk dacron fabric is bonded to the after portion of the leading edge. After the dacron is heat-shrunk to the proper tension, it is impregnated with a neoprene-based mixture, especially prepared by Spratt for this job.

The ribs are constructed from urethane foam, coated with glass epoxy and cured in a heated aluminum mold. The spar is made in a different mold from stretched glass fiber, which is cured in epoxy. "Very much like some fishing rods," says Spratt.

The boat/plane's engine is a Mercury 60-cubic-inch outboard that is rated at 60 hp. Although the engine has been modified, it still contains all of the original dynamic parts, including the crankshaft, rods, pistons, and valves. The two original fuel pumps are still used but the original water pump has been replaced by a Jabsco water pump. The engine operates in a horizontal, instead of a vertical position. The ignition has been modified so that the leads are more direct and a fixed advance, instead of speed control, is used.

The lower crankshaft main bearing support has been removed and replaced by an adapter that drives the pulley which transmits power to the propeller shaft.

The engine burns approximately four gallons of fuel per hour. Oil is mixed with the fuel at a ratio of 50 parts gasoline to one part oil.

Jan 1970

$3500 Boat/Plane

(Continued from page 59)

From the engine to the propeller there is a 2.5 to 1 reduction. The engine is liquid cooled from a radiator, which is a standard automotive core. When the boat/plane operates as a boat, the radiator—which is mounted just off the step—is cooled by contact with the water. "In the air," says Spratt, "step suction gives enough air flow that a fan is not needed."

The exhaust system has been modified too. Four separate exhaust stacks are used to pick up hot gases directly from the cylinder ports so that the stacks don't need cooling by water. On the unmodified engine there are only two exhaust stacks.

How soon can others share the fun of Blue Stoosing? Spratt hopes to have the Stoose on the market in about a year. Not about to put a ridiculously high price tag on it, he wants to produce it for $3500 retail per plane—or, roughly, the cost of a new automobile.

So, today, if you ever stop by the Sea Mark Marina, near Northeast, Md., and look out over the docks to where the big sailing boats are anchored, you'll see a beautiful white sailing craft. If you look closely, you'll also see a very erect man with bronzed features, perhaps steering the *Quest III* down the channel, and towing a toy-like airplane. George G. Spratt, a man who accomplished the goal he set out to achieve some forty years ago, is towing the Blue Stoose down the bay for another day of testing.

"If it's a pretty day," says Spratt, "I'll just anchor the boat in the test area and take off in the Blue Stoose and fly right down the bay, landing every now and then to gas up at a Marina. Now, it's a funny thing," he adds. "Every time I land for gas and pull up to the dock, the man there—the man who has already seen me fly in and land—will ask me, 'Will it fly?'" ●

Deceased 1998.

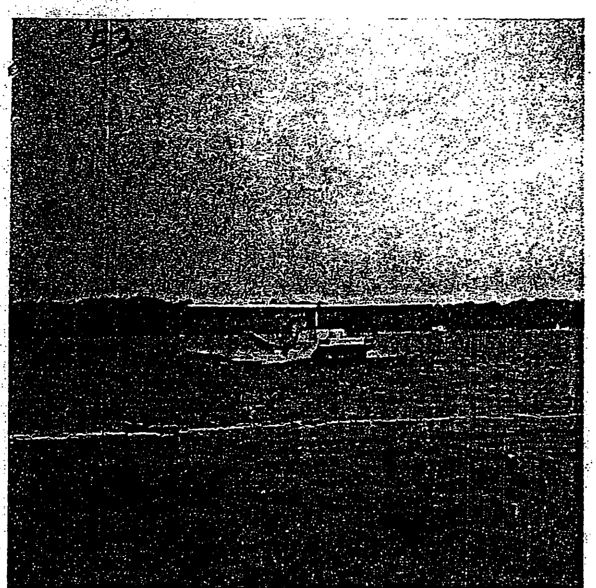
Reportedly, General Dynamics' proposal to build nuclear-powered submarine tankers is under consideration by several oil companies.

Incidentally, the idea of operating cargo-carrying subs under the Arctic ice isn't new. British explorer Sir George Hubert Wilkins suggested it some 40 years ago. Way back in 1931, the Wilkins-Ellsworth Nautilus Arctic Submarine Expedition went under the North Pole.●

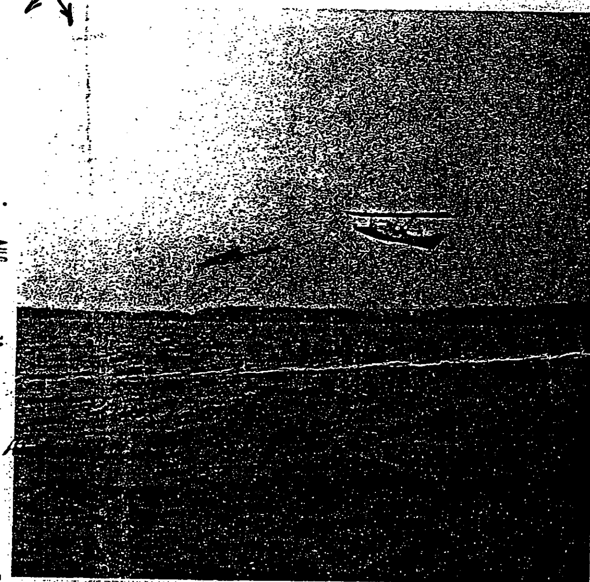
! interesting

53

N910Z



AUG 1969

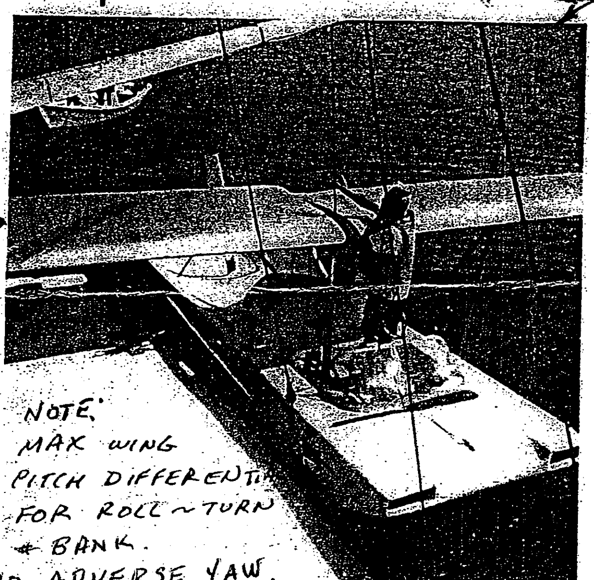


N2236

TYPICAL NOSE HIGH, HANDS OFF GLIDE, POWEROFF

WITH GEORGE SPRATT.

1969-1973 ON CHESAPEAKE BAY



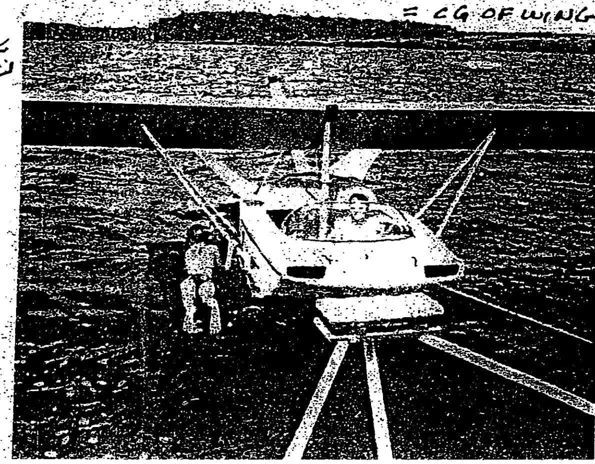
NOTE:
MAX WING PITCH DIFFERENTI[AL] FOR ROLL ~ TURN & BANK.
NO ADVERSE YAW.
NO AIR RUDDER NEEDED

NOTE!
55' ARC WELDED HOMEBUILT 'AIRCRAFT CARRIER'

NOTE: SPRATT HANDMADE FIBERGLASS PROP BLADES

N910Z

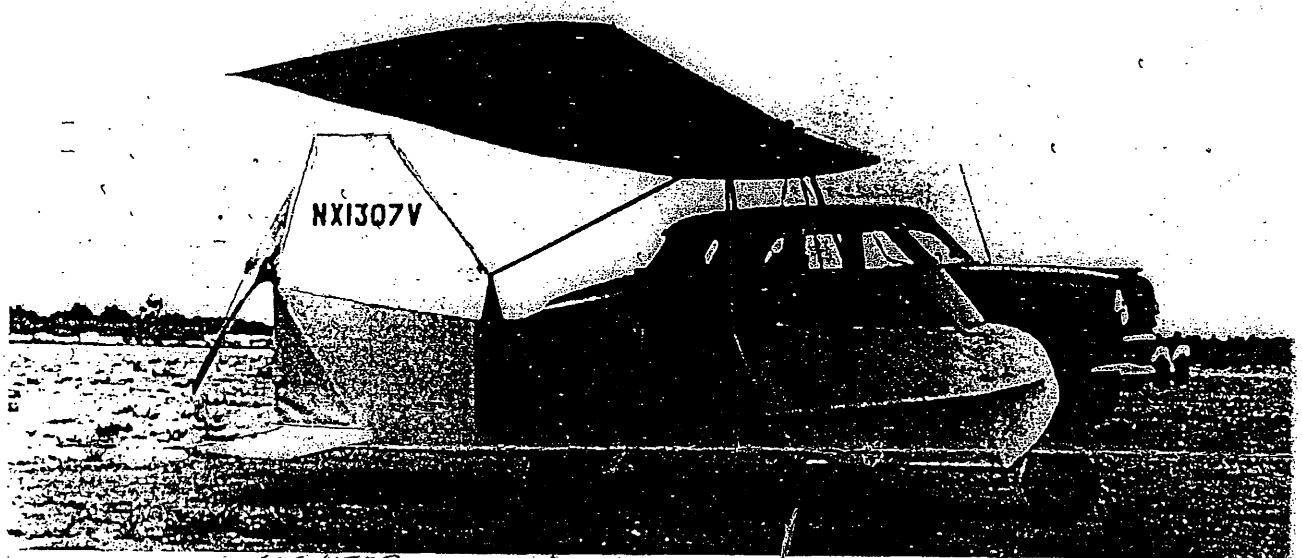
FREE WING - WIDE PITCH RANGE
ASSUMES CORRECT ATTITUDE AT
FLIGHT SPEEDS ~ PITCHING MOMENTS OR
= CG OF WING



53

Aug 69

NOTE: APRIL 2000
EAA EXPERIMENTER
CONTROLWING ARTICLE



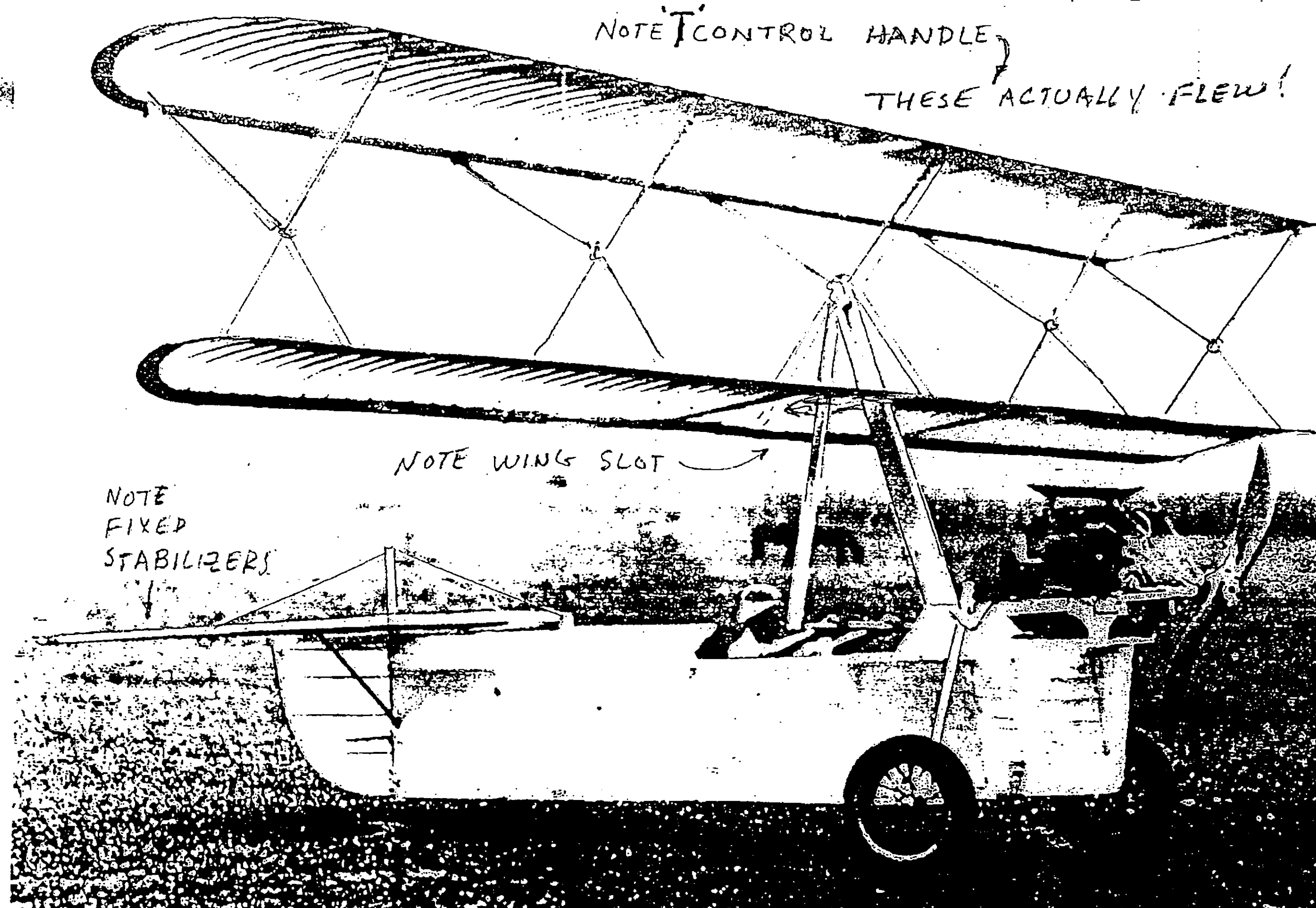
OR ELEVATOR
NO RUDDER HERE main wheels nose wheel DATES?

wing control cables don't show

OTHER EARLY SPRATT C/Ws

NOTE T CONTROL HANDLE

THESE ACTUALLY FLEW!



NOTE WING SLOT

NOTE FIXED STABILIZERS

To all Spratt Controlwing plans recepients,

I have been in contact with two knowledgable Controlwing parties who have had or learned of a possible safety hazard in the single rubber float based Spratt Controlwing Ultralight and the prototype Spratt Controlwing Landplane, but NOT in the Controlwing Flying Boat from which the plans you have were derived.

Don Paulson, builder and test pilot of the Spratt designed, single rubber float mounted Controlwing ultralight, states that immediately after making a liftoff he was in a gentle left turn and while attempting to tighten the climbing left turn with added differential input, the right wing panel stalled and suddenly dropped into the water to cause a cartwheel. The aircraft ended upside down, damaging the structure which was never repaired, but the pilot, wearing his PFD, was only very cold and otherwise unhurt.

The left turn initially may have been due to torque and water accumulation in the foam wing tip since that aircraft often sat with the wing tip in the water. With the fuselage attitude probably several degrees up in a gentle climb, the wing incidence may have been in the 10° to 12° range in the initial gentle climbing left turn and the additional few degrees of differential angle of attack on the right wing panel reached the stalling angle of about 16° to 18° or more, depending on how you interpret the wind tunnel measurements.

Bob Quaintance, builder and test pilot of the only prototype Controlwing landplane, told another party, a knowledgable friend known to Don, George Spratt and to me, that a sudden stall situation was experienced which caused a substantial loss of altitude from which a recovery was made. No other specifics were ever mentioned by the recently deceased builder and test pilot. In a conversation with him a month before he died he only told me that more developement and experimentation was required before releasing the landplane design as it existed to the general public without any specifics.

In discussing this with the Don, we concluded that the same combination of fuselage or hull angle plus the wing incidence and then adding differential angle in a climbing turn was probably the unmentioned certain hazardous stall entry condition. To my knowledge, no other pilot ever flew the landplane during its 40 hour test plan and none since.

15 to 18° max - DO NOT USE TOO HIGH

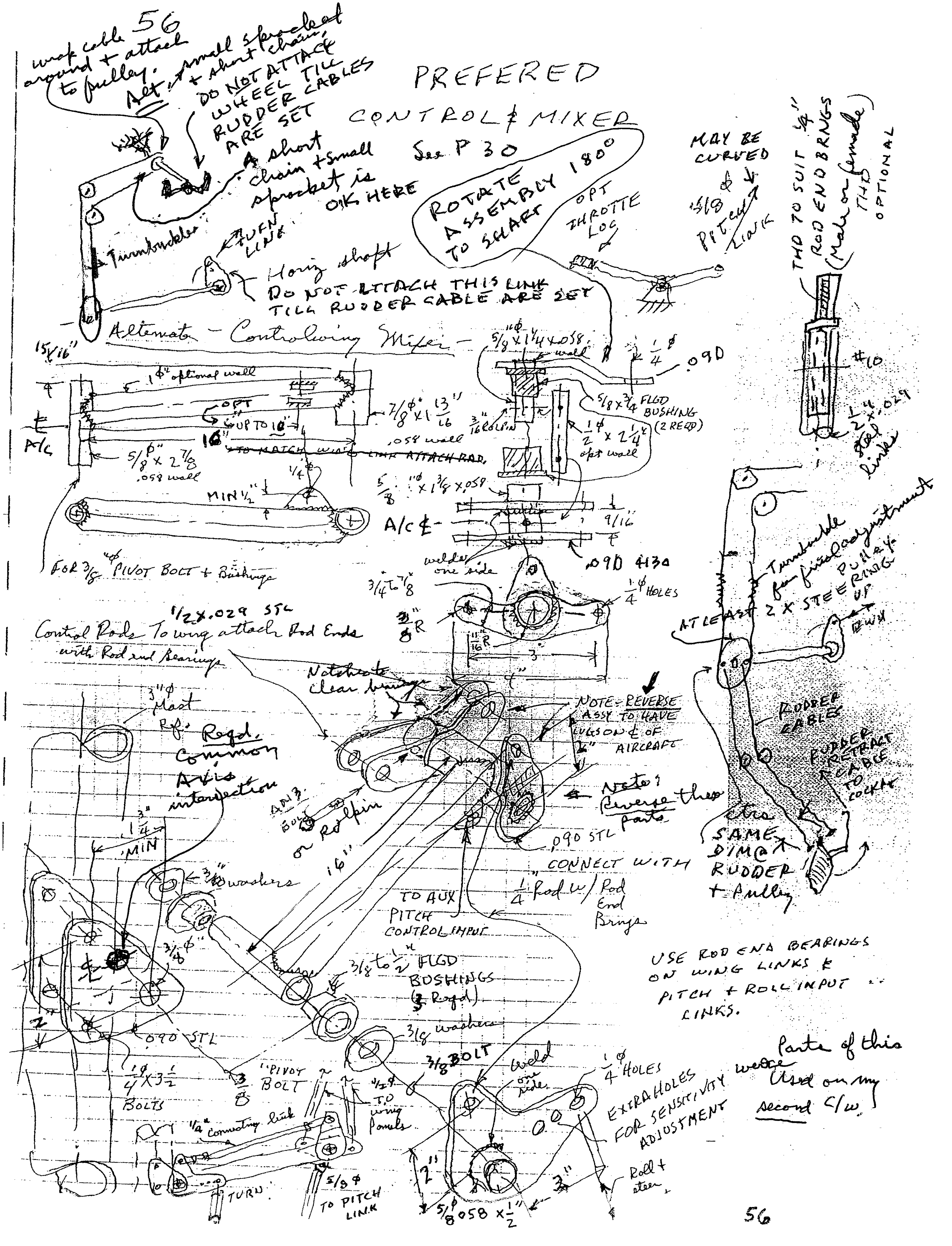
BE SURE TO PLACE POSITIVE MECHANICAL STOPS IN THE COLLECTIVE ANGLE OF INCIDENCE AUXILIARY PITCH SYS (Say only about ~~10° to 1~~2° or less) TO INSURE THAT THE HULL ANGLE OF ATTACK, PLUS THE WING COLLECTIVE ANGLE INCIDENCE, PLUS ANY ADDED DIFFERENTIAL ANGLE INTRODUCED IN A TURN WILL NEVER REACH OR EXCEED THE ANGLE OF ATTACK FOR THE 23112 AIRFOIL USED ON THE SPRATT CONTROLWING AIRCRAFT! (The absolute stalling 23112 airfoil varies depending on which wind tunnel information is interpretted).

The Spratt Controlwing flying boat protypes of the late 60s to mid to late 70s were flown for several hundred accident free hours by over 100 different pilots. There were no wing pitch stops in N910Z, the most often shown and flown protype. The automatic aerodynamic positioning of the wing never gave any problems and was stall free throughout its useful life. The differential angle is limited to only a few degrees by design, enough for a gentle bank. NOTE: Increasing the differential angle to obtain tighter turns can be hazardous to your health. 15°

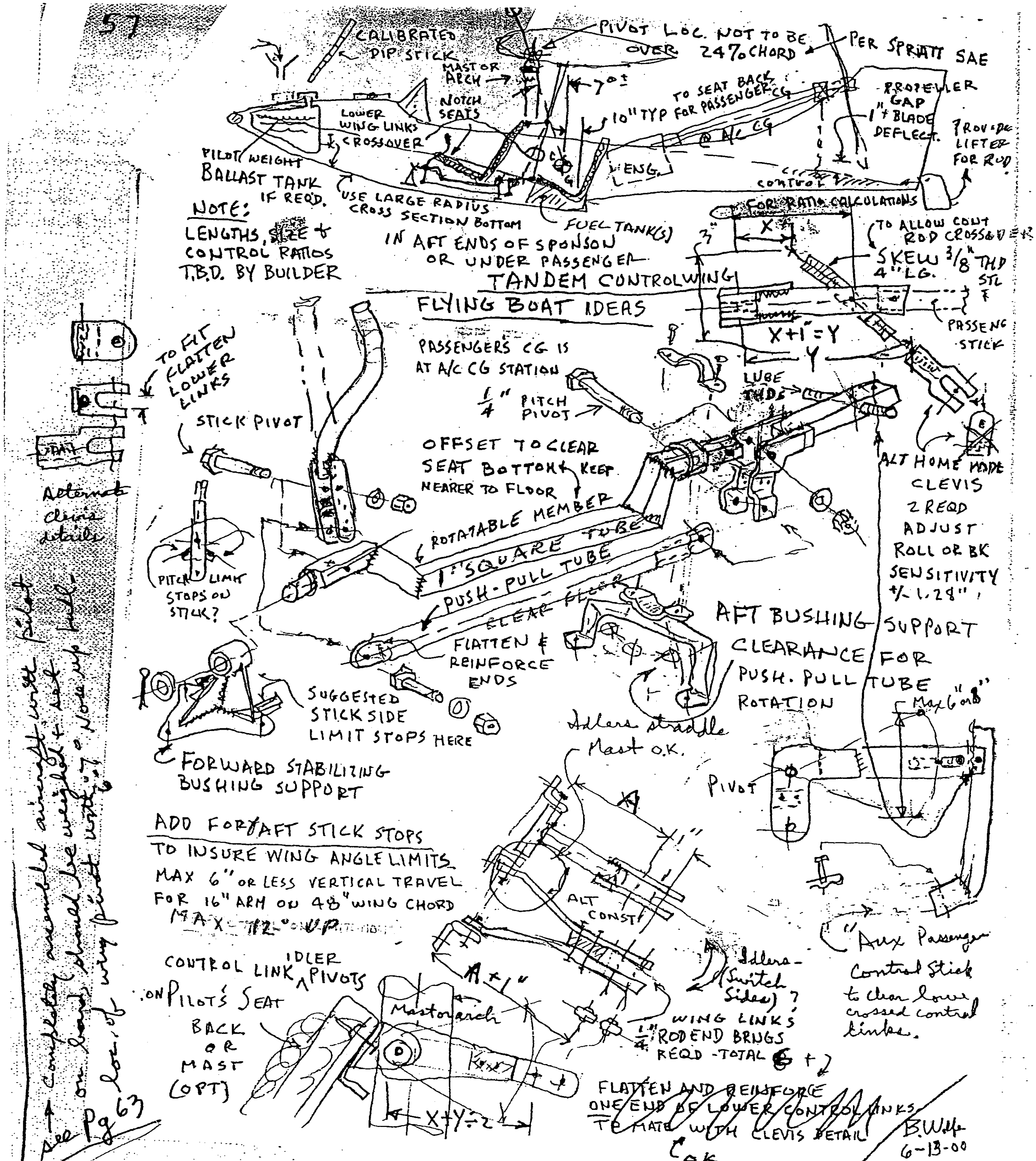
The 'Wing Dinghy', an early Spratt Controlwing flying boat which used a single panel wing manipulated by cables for turns, was the cover article for the June 1962 Popular Mechanix magazine. That aircraft was damaged in its first flight attempt. After liftoff it rotated more than expected so the pilot reduced power, but the rotation continued till an apparent stall and it dropped into the water. That aircraft, unknown to me for many years after I first saw and flew N910Z in 1969, still exists. The first plans built Controlwing flying boat was operating with a prototype, but was destroyed in a water collision. Another older Controlwing flying boat is still stored in Florida. Mine is only the third flying boat known to have been built from Spratt's 1973 plans. No other aircraft is known to have been built from Spratt's 1973 landplane plans.

I have changed to a third set of new Mercury outboard carburetors in another attempt to obtain maximum performance from my 85 HP Mercury outboard engine. Stay tuned as this problem will get worked out and flight testing will be resumed.

Any questions? Just ask and I will try to answer. Bill Wolfe (479) 621-5822



PREFERED
CONTROL & MIXER
See P 30
wrap cable around + attach to pulley.
Alt. small sprocket + short chain,
DO NOT ATTACH WHEEL TILL RUDDER CABLES ARE SET
A short chain + small sprocket is OK HERE
Turnbuckles
TURN LINK
Horiz shaft
DO NOT ATTACH THIS LINK TILL RUDDER CABLE ARE SET
ROTATE ASSEMBLY 180° TO SHAFT
OPT THROTTLE LOC
MAY BE CURVED
3/8 PITCH LINK
THD TO SUIT 1/4" ROD END BRNGS (Male or female) THD OPTIONAL
Alternate - Controlling Mixer -
15/16"
1" optional wall
OPT UP TO 16"
16"
7/8 x 1 13/16 .058 wall
A/C
5/8 x 2 7/8 .058 wall
1/4
MIN 1/2"
FOR 3/8 PIVOT BOLT + Bushings
5/8 x 1 1/4 x .058 wall
1/4
.090
5/8 x 3/4 FLGD BUSHING (2 REQD)
3/16 ROLPIN
1/2 x 2 1/4 opt wall
5/8 x 1 3/8 x .058
A/C
9/16
.090 4130
weld one side
3/4 to 7/8
1/4 HOLES
3/8 R
11/16 R
3
4"
#10
1/2 x .029 steel links
Turnbuckle for final adjustment
AT LEAST 2 X STEERING PULLEY
UP
DWN
1/2 x .029 STL
Control Rods To wing attach Rod Ends with Rod end Bearings
Notch to clear bushings
NOTE - REVERSE ASSY TO HAVE LUGS ON ℄ OF AIRCRAFT
2"
Note: Reverse these parts
RUDDER CABLES
RUDDER RETRACT CABLE TO COCKPIT
3" Mast
Ref. Reqd. Common Axis intersection
AN3 Bolt
or Rolpin
.090 STL
SAME DIM @ RUDDER + Pulley
3"
1 1/4 MIN
3/8" washers
16"
CONNECT WITH 1/4" Rod w/ Rod End Brngs
TO AUX PITCH CONTROL INPUT
3/8"
3/8 to 1/2" FLGD BUSHINGS (3 Reqd)
USE ROD END BEARINGS ON WING LINKS & PITCH + ROLL INPUT LINKS.
2"
.090 STL
3/8 washers
1/4 x 3 1/2 BOLTS
3/8" PIVOT BOLT
3/8 BOLT
1/2
TO wing Panels
weld one side
1/4 HOLES
EXTRA HOLES FOR SENSITIVITY ADJUSTMENT
Parts of this were used on my second C/W.
1/4" connecting link
TURN
5/8
TO PITCH LINK
2"
3"
5/8 .058 x 1/2"
Roll + steer



ADD FOR/AFT STICK STOPS TO INSURE WING ANGLE LIMITS
MAX 6" OR LESS VERTICAL TRAVEL FOR 16" ARM ON 48" WING CHORD
~~MAX 12° UP~~

B. Wolfe
6-13-00
11-24-00

NOTE: ~~Pitch~~ WING LINKS → ~~Alt~~ - NOTSKEWED 3/8" THD ROD
MUST CHANGE SIDE TO OPERATE CORRECT WING
CROSS OVER WING LINKS INSTEAD

POSSIBE TANDEM SEATING ARRGT IDEAS ~~NOT USED~~
ALT CONTROL & MIXER 57

I'm ~~Planning~~ to use ~~this~~ on 2 Pl Controlwing

If you are serious about building a Spratt Controlwing flying boat, you probably studied the drawings extensively and have raised many questions. The original 1973 Spratt plans are somewhat minimal, have many gray areas and some of the construction details leave an awful lot to the builder's imagination and who to ask?

Mimi and I ~~are now approaching~~ reached our upper 70s. — now 83 & 84 We are getting tired and must shift our priorities after spending five thousand hours and five years almost constantly immersed in the aircraft project. We need more time to smell the roses and decided to offer the project for sale last month. As some of you may already know, on October 4th, 2000 we took the aircraft to Beaver Lake to accomplish what was intended to be a final short test flight just to get in-flight photos and video since none were available from earlier operations. One photo was taken just as liftoff was imminent and the video shows the liftoff up to 50 feet or more, then the aircraft blended into the background, out of sight. Video captured no part of the landing.

11th day at the lake. (continued from page 4)

On the first run the engine did not reach full rpm, the second run reached full rpm, but I ran out of usable open water ahead. While towing the aircraft to a larger open area east of the marina, I noticed water had accumulated on the floor of the engine compartment. I bailed most of it it out before attempting the next run.

After what seemed like an extra long run, I lifted off the very rough choppy open water several feet to get a feel for the control forces on the auxiliary pitch stick. As I reduced power to set back down, the tail lost its aerodynamic lift and the hull rotated well beyond the normal 7 degree nose high glide attitude due to a sudden unexpected aft CG shift! I added power just to try to lift the tail, but still continued to climb as high as 50' they tell me. After reducing the power, I pushed on the auxiliary pitch stick to rotate the wing angle of incidence down to initiate the landing glide. Additional drag due to the extreme hull angle slowed me down so much that the landing glide slope was very steep and I failed to add power soon enough so no landing flare was made resulting in a hard pancake type touchdown. During this short flight I was too pre-occupied to read any instrument or gage.

During acceleration step suction had apparently drawn water into the plenum and it overflowed into the engine compartment floor and I had temporarily moved the large marine battery to the passenger seat location instead of it's position under the forward deck. Both contributed to a slight aft CG shift. Some repairs were needed.

12th time out:
Since my medical had expired and will not be renewed, an experienced EAA Flight Advisor from out of town was interested in the Controlwing concept and volunteered to take his first seaplane ride as a Controlwing test pilot. He did a lot of familiarization taxiing before opening the throttle to try for a liftoff. He heard what sounded like a backfire then noticed both temperature gages pegged and shut down. A siezed bearing in the engine pulley caused a small screw in the belt tensioner to break. This allowed the tensioner to change geometry and the large propeller shaft pulley struck the tensioner itself. The pulley was repaired and re-installed.

An inspection at home revealed a leak from a cooling system heater core hose which was stopped by re-tightening all accessable hose clamps. Only one would require lifting the engine for access. I also noted the water level did not show so I started to refill the system and was shocked to see the water squirt out only a few inches away in the short four year old plastic hose used as a visible fluid level. It is the only plastic tube in the cooling system.

13th time out:
My volunteer test pilot again tried for liftoff. With engine winding up to 6000 rpm, he was just getting up on the step when he suddenly shut down since he smelled hot rubber. Upon close inspection we found that a 3/4" square dogleg tube attached to a bearing in the engine pulley had sheared out the side of the 1" square telescoping tube of the adjustable belt tensioner. This changed the geometry and allowed the large propeller shaft pulley to rub the tensioner, get hot and heat up the powerbands. The repair was a small welding job.

These incidents should in no way cast a shadow on Spratt's no spin, no stall, no dive and soft riding Controlwing design. They were solely the result of the ongoing and difficult developementof a reduction drive system by one person with neglible outside assistance from knowledgable or interested persons. All incidents were the result of the lack of personal experience installing and maintaining engine and propeller belt driven systems and flight operations.

Dear friend,

Test flights are needed to check out such things as the proper CG location with respect to the Controlwing flying boat wing pivot, the wing's response to the automatic pitch down feature when power is reducedor to to idle, pitch control forces and roll control response. I used several bungees to help balance the wing, but apparently not enough to obtain the automatic pitch down feature when power was reduced. I had too much tip fairing, center filler fairing and wood trailing edge weight resulting in a wing CG located 4.6" from the pivot. One of Spratt's all foam and fiberglass propotype wings had the CG only 3" from the pivot axis, a noticable difference. More down force on my pitch stick was needed due to the unfavorable wing CG and negative pitch control ratio from stick to wing which was not per the Spratt plans. I now know better in all these areas and will advise anyone who is serious about building and especially those attempting to develope Controlwing kits. Spratt did not explain these important features in his plans and did not discuss them with me when I visited several times whileworking at Sikorsky in CT when he was still in fairly good health before he deteriated and died in '98 at 93.

Over a year ago I pulled the engine out of my aircraft for inspection after noticing a screw from a carburetor choke plate was missing. Fortunately the missing screw was found in an engine cavity where it had done no harm, but the stator needed to be replaced. Just for convienence I placed my hefty marine battery in the passenger seat location after removing it from another temporary location aft of the engine, rather than put it back where it was, farther forward under the deck in a less accessible location. It was there when I originally weighed and balanced the aircraft to determine the appropriate wing pivot location to obtain the desired 7° nose up hull attitude when the complete aircraft with me aboard was hung from the wing pivot.

This central battery location plus some unwanted water sucked up through the radiators by step suction and retained on the engine compartment floor nudged the CG aft a bit, but the effect was not noted on the inclinometer installed in the cockpit during my last brief flight as I was too busy trying to sense what was happening.

On that flight the result was a higher power off nose up hull attitude which slowed the aircraft even as it was still climbing since the automatic pitch down function did not take place and the wing remained at about 15° angle of incidence. As this reduced airspeed and only at about 50' elevation, all that was needed to prevent the hard pancake landing from happening was to re-apply power immediately. I was asleep at the switch, or throttle. I simply forgot "speed and altitude is money in the bank" and had neither during the one or two second window of opportunity during which I failed to add power immediately after forceing the wing angle down to initiate a glide.

The importance of the proper wing pivot location with reference to the Controlwing CG, the wing CG location being as close as possible to the pivot to insure the automatic pitch down feature and a favorable auxiliary pitch control ratio are very crutial to the safety and simplicity of Controlwing flight and must not be overlooked during construction. Control mixer modified for better automatic operation.

The angled propeller shaft is used to keep the engine and CG low and keep the thrust line aimed near the CG so no adverse pitch change is caused by power variations.

For questions, contact:

Bill Wolfe EAA # 5716 1520 W. Ash, Rogers, AR 72758 ~~billwolfe-2@juno.com~~
(501)621-5822
(479)

60 this one was destroyed in a water collision.

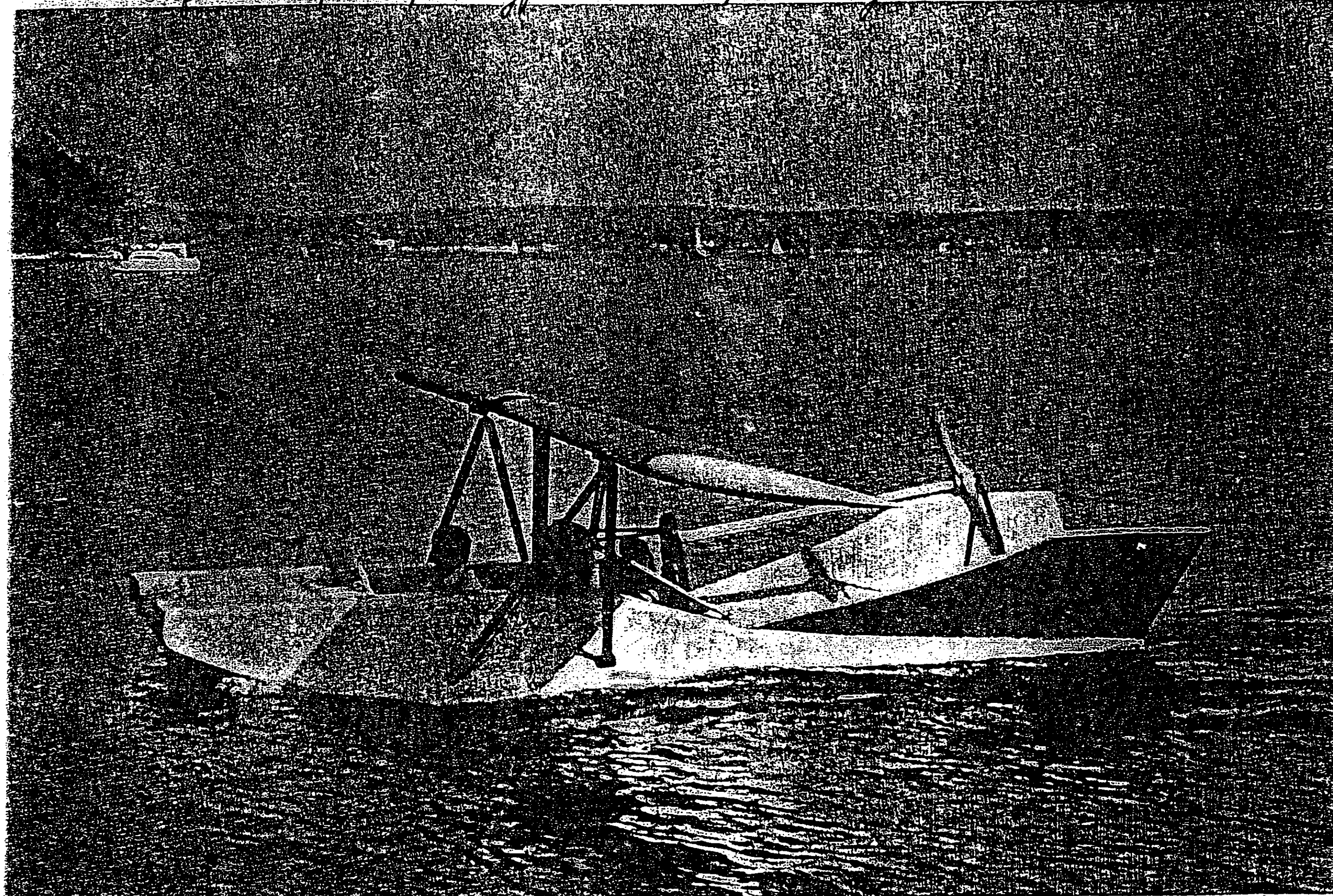
May 1976
Sport Aviation

FIRST PLANS-BUILT

By ~~Joseph March (EAA 70091)~~ Died 1994 in an accident

Spratt Controlwing

I flew a Spratt prototype on Chesapeake Bay the summer of 1969.



Joe was marina operator when Spratt moored his aircraft carrier "Quest II" on Chesapeake Bay '73

AFTER SEEING MR. George Spratt fly his Controlwing during the summer of 1972, I started to think more about having one of my own. I like to fly, boat and fish and here was a chance to do all these things in one vehicle. The more I thought about this aircraft the more interested I became. Finally, I decided to buy the license and plans and start building.

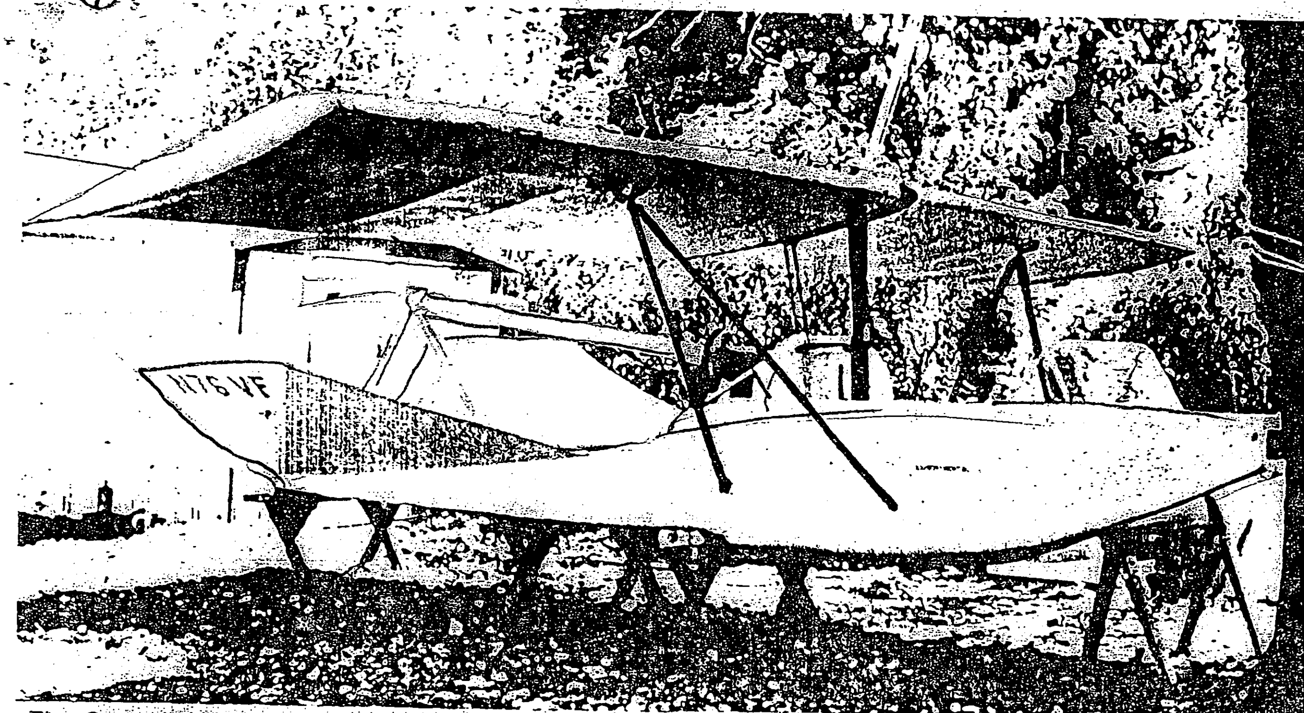
In March of 1973 I called Mr. Spratt at his home, told him of my decision and that I would be down to pick up same in a couple of days. I spent the next couple of months reviewing the plans and started making a model Controlwing using Styrofoam and epoxy to learn how to work with these materials. I made many test pieces and took them to Mr. Spratt to see what he thought of the materials I was using. After getting his approval, I started ordering Styrofoam and epoxy from a dealer close by and started the hull section. By this time summer had arrived and with the usual yard work, repairs, etc., progress on the plane slowed down and did not resume

During the fall of 1973 the materials to make the Controlwing's machined parts arrived so I switched from plastics to metalwork.

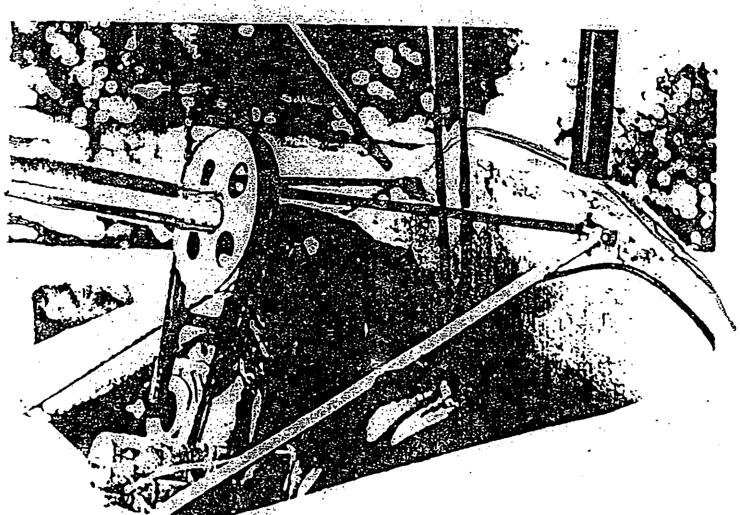
In December my job required me to be away for several days of each week, so, again, my progress ground to a halt. This went on for many months until I started to take parts with me on trips and worked on them at night. Some of the companies I visited had machine shops and would let me use them at night.

By June of 1974 I was able to again get my thoughts together and start work on the hull once more. At this point about 75% of the hull was completed. In early July my plans for the installation of a Volkswagen engine were near completion so I started making the necessary parts to adapt the VW to the airframe. This involved the engine mounts, cooling system, fuel system and drive coupling. 60

By Oshkosh '74 all plans and drawings were complete and by November of that year I had built up and tested my powerplant. This was a stock 1600cc VW with the addition of dual ports and a Posa carburetor. In Decem-
ber of 1974 I again visited George Spratt, this time



The Controlwing set up in the author's yard prior to the first flight.



VW engine installation detail.

to talk over my conversion from his 80 hp Mercury outboard engine to my 59 hp VW. He was concerned about my cooling and thought I might have a problem in this area. I went back and did some more testing, the results of which were to my satisfaction.

Over the next few months, I could see my airplane grow . . . and gain weight. At this time I thought I could be testing by June, but suddenly, it seemed, it was July already; then August and off to Oshkosh. During the Convention, my thoughts were back in Pennsylvania, so after the week was over I was happy to be heading back to get to work. I was getting excited and wanted to finish my airplane. I worked every night and came home every day at lunch to do some work. Things were looking up and some of my friends started to show up to help. September went by rapidly and on October 3 a friend from northeast Maryland came to help me load my Controlwing on a trailer and take it to the bay so we could start taxi tests and get some idea whether the thing would fly.

On the way to Maryland the trailer caused some damage to the hull which had to be repaired that evening so we could meet Mr. Spratt the next morning and start testing.

Arriving the next morning in his Controlwing, Mr. Spratt looked over the situation and decided to fly back to get his sailboat to use as a base for our operations. After his return we put my airplane into the water, determined it had no leaks, filled the gas tank and started the engine. It idled O.K. but started missing as the rpm reached about 2500. We removed the plugs and found they were fouling — the result of a defective carburetor. We found there were no threads on the metering adjustment so that it constantly changed as the engine ran. We made a temporary fix which allowed the engine to come up to the expected revs.

By this time it was about 3:30 p.m. and my friends were starting to get hungry and tired and I was just about ready to call it a day. My plane was on Mr. Spratt's boat at the time and he asked what I wanted to do. I replied that I wanted to do some more taxi tests now that the engine was running O.K. — so we lowered the Controlwing into the water and I started the engine.

Starting down the bay, I came to full throttle but was not able to get on the step. I was pushing too much water before the bow and this caused too much drag. I throttled back, climbed back behind the seat and tried again. Same result . . . except that I made a circle and, coming around, slipped up on my own wake. The speed immediately picked up and the ship left the water for the first time. I throttled back and it came back down on the water. Now that I had found how to get on the step, I sat back down in the seat and proceeded to try again. I made a pass downwind, made my turn and increased the throttle to full power. After two S-shaped maneuvers and a run of about 400 feet, we lifted off.

The ship rose to about 20 feet and stayed there until the air speed reached about 65 mph, then it started to

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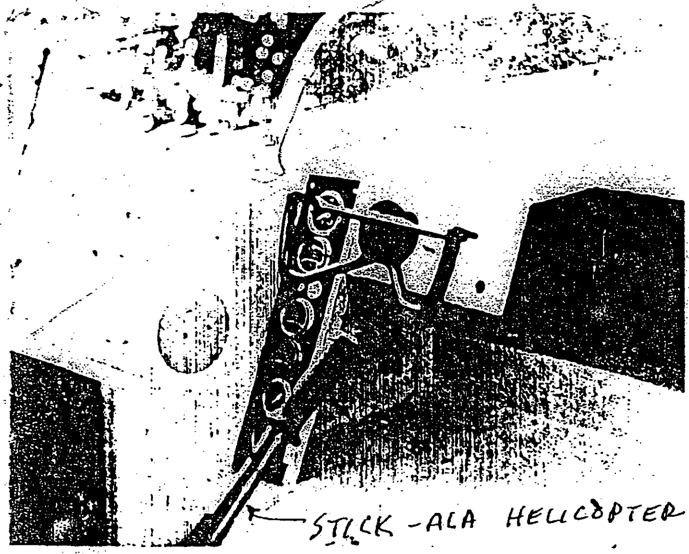
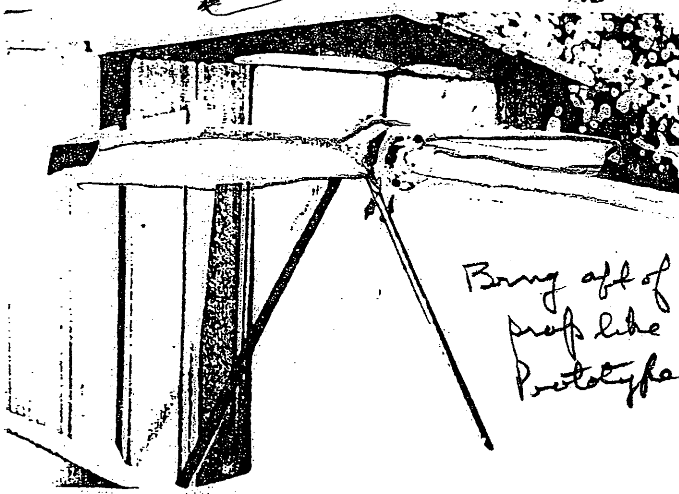
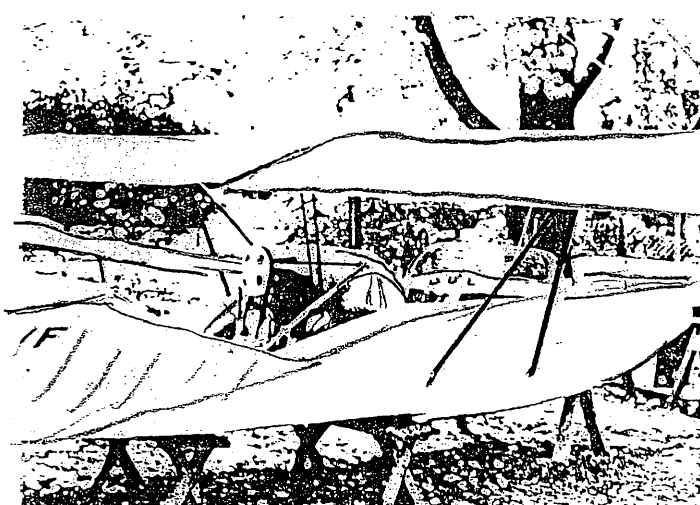


The spartan "front office" of Joe March's Controlwing. Note the lack of rudder pedals. The Controlwing is a two-control airplane with the wheel handling the pitch ~~and~~ turning functions. and the STICK handles



Pusher prop and driveshaft mount detail. This is about as simple as you can get.



Wonder how long it will be before the author installs a canopy so he can fly year round?

torque! + pilot on left

climb rapidly. Before I knew it, I was up to 450 feet and still climbing. Wow! This was great . . . but what now? The plane was out of trim enough that I had to hold almost full right wheel to fly straight. All my turns were, of course, to the left.

I reduced power to 2000 rpms and started to descend. The rate of sink built up rapidly and when I realized that, I smoothly applied full power and made my flare out to land. The recovery was fine and I skipped across the water and taxied over to Mr. Spratt's "aircraft carrier." I was so proud I could hardly talk when I climbed on deck. My friends and my wife made a big fuss over me and that was great. I was shaking and nervous now. There were many questions to answer.

Mr. Spratt had the look of a new father on his face and I knew he was pleased. Later that day, we sat down and went over the test data we had gathered. Still later, my friends got together and we had a little party to celebrate the first flights.

The next morning I was up about 8:00 a.m., had a light breakfast, jumped into my plane and took off. I circled once then flew up the northeast river to the spot where Mr. Spratt's sailboat was moored. As I got closer, I saw him in his Controlwing preparing to take off. He taxied back to the boat, tied up and waited for me. We hoisted my plane up on deck and gave it a full inspection. We found some small cracks in the hull, probably caused by the first bad landing the previous day. They were not in an area that adversely affected the airworthiness or seaworthiness of the plane so I was able to continue flying for the rest of the day. I made many short flights and performed a number of tests.

The next day I loaded my Controlwing on the trailer and drove home. During this winter I have been making some changes that I know will improve the performance — like an 85 hp VW. Come spring I will be ready to go again.

During the five hours I was able to put on the Controlwing before cold weather set in, I found the airplane to be all George Spratt has claimed for it. I am a low time pilot but was amazed at the ease of flying the ship. In turns I could release the controls and it would simply return to straight and level flight. I feel Mr. Spratt really has something great going for him.

I will be happy to try to answer any questions readers may have on the Spratt Controlwing if they will drop me a card.

MARCH VW CONTROLWING

Performance
Source: Joe March

Dyno H.P.	59 at 3900 rpm
Engine rpm at T.O.	3950
Propeller rpm at T.O.	2450
T.O. Distance	400 ft.
Rate of Climb	800 fpm
Cruise Speed	75 mph
Rate of Descent	400 fpm
Cruise RPM (Engine)	3300
Cyl. Head Temp. - T.O. and Climb	350°
Cyl. Head Temp. Cruise	275°
Oil Temp. - Cruise	150°
Oil Pressure - Cruise	45 lbs.
Lift-Off Speed	47 mph
Landing Speed	55 mph
Fuel Consumption	2.4 gph

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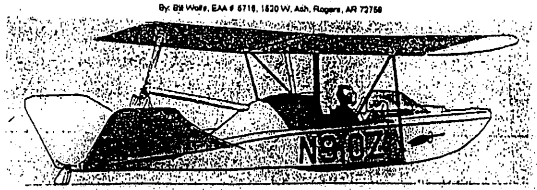
The Spratt Controlwing Flying Boats

By: Bill Wolfe, EAA # 6718, 1820 W. Ash, Rogers, AR 72758



After Dr. George A. Spratt aided the Wright brothers with design improvements enabling them to fly, he and his son George. G. Spratt spent their lifetimes developing and experimenting in aircraft safety, stability and control. One outstanding popular example was the 1960s Controlwing flying boats successfully demonstrated for hundreds of accident free hours and flown by 100 pilots during a period of ten years or more. I was fortunate to have that enjoyable opportunity over thirty years ago.

The late George G. Spratt often asked, "Did you ever see a fixed wing bird?" To that I add, "Did you ever see a low winged bird or one with a rudder?" The Controlwing flying boat has a two piece movable parasol wing mounted above a boatlike hull with a wide vee-shaped tail to help keep it guided in one direction like tail feathers on a bird or an arrow.

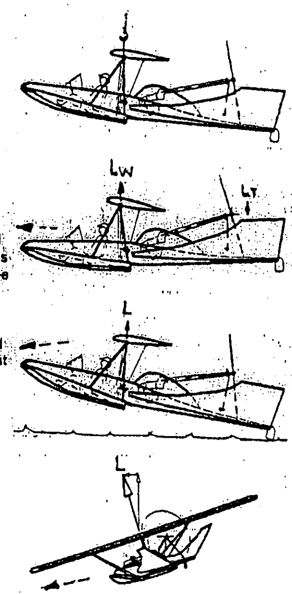
Standard aircraft wings have a fixed angle of incidence with elevators, rudders and ailerons used to move the aircraft about it's center of gravity using three axis controls to direct the aircraft to climb, dive, roll, yaw, turn, do stunts and other maneuvers.

In a Controlwing, the center of gravity is located behind a fixed wing pivot and the two parasol wing panels collectively have a variable angle of incidence. No rudder is required since a small differential angle between the two wing panels provides a banked attitude adequate for making gentle turns without producing adverse yaw.

Controlwing aircraft have no inherent stall, spin or dive charactaristics, and when flown through turbulence, hands-off, the wing will automatically alleviate gust loads to about one quarter of those felt in other aircraft.

The fixed vee-shaped tail provides enough lift during powered flight to hold the hull in a relatively level attitude due to the venturi action of the high velocity slipstream produced by the closely nested pusher propeller and also keeps water and bystanders clear of the prop. With power reduced or off, the tail loses most of it's lift and the hull automatically assumes a stable nose high attitude, literally hanging on the wing pivot, and the wing angle of incidence automatically adjusts itself for a stable glide. The wide hull, low center of gravity and lack of tip floats on a Controlwing flying boat permit the small water rudder to make fast, and safe banked turns on the water and can even pivot the aircraft about a wingtip touching the water.

The throttle, not the auxiliary pitch control stick, is the primary vertical flight control. The auxiliary pitch control stick is needed only to temporarily overpower the automatic aerodynamic wing pitch feature to move the aircraft above or below an existing flight or glide path, shorten a takeoff or flare for a smoother landing. The 23112 airfoil was selected for Controlwings due to the smaller horizontal movements of it's resultant lift vector. In flight, all the aerodynamic loads of the wing pass through the wing pivot along with some added tail lift which varies with airspeed. Adding power above cruise power will cause the aircraft to climb and reducing power will cause it to descend, while still maintaining the same speed.



The basic design feature is the location of the wing pivot with reference to the aircraft center of gravity. When suspended from the wing pivot the hull angle of the completely assembled aircraft, with an average weight pilot aboard, should be about 6° to 8° nose up. This provides a safe hull takeoff and landing angle. This pivot location is obtained by adjusting the forward drag strut length and the position of the center wing mast pivot.

In flight, wing lift is aided by the tail lift to hold the hull generally in a level attitude after an initial nose high liftoff. The wing angle of incidence and hull angle of attack will both automatically adjust to accommodate airspeed changes unless influenced by the pilot's pitch control input to climb or descend. The hull of a Controlwing can never be forced nose down.

Power reduction alone can initiate a descent or glide. In this case the angle of incidence of the wing will automatically change to a neutral or a slightly negative angle while still retaining a positive wing angle of attack and hull angle of attack relative to the glide path. This nose high hull angle adds drag to help reduce the landing speed. Safe, hands-off water landings can be made if desired.

In a turn, the lift vector which is always normal to the wing, is tilted. Some vertical lift is lost and converted to a side slip which puts a side force on the tail to initiate a gentle turn. Some altitude loss may occur unless the pilot pulls up a little or a cam in the control mixer system corrects this small altitude change.

All wing lift and drag loads are carried through the mid-span lift strut fittings. The heavier aft member of the 'A' frame wing strut transfers the primary lift loads into through hull tie rods and the forward member transfers drag loads into hull fittings. The wing spars carry resulting compression loads from the mid span fittings to the center mast. This mast carries little if any other load except when the aircraft is lifted. In high powered, low powered or idle gliding flight, the vee tail is always providing some lift, but it is never loaded downward.

It is desirable to have the wing center of gravity as near to the pivot as practical. The wing panels could have more heavy material and nose skins forward of the main spar and the lightest possible aft ribs and trailing edge structure. This preferred wing CG location will reduce the auxiliary pitch control stick forces needed when the pilot elects to vary the flight path above or below an existing flight path, shorten a takeoff or flare for a smoother landing.

The throttle location is optional. At least four Spratt flying boats had twist throttles very conviently located on a centrally located auxiliary pitch stick mounted low like in helicopters. The throttle could also be a push/pull knob on the instrument panel or be mounted on the cockpit side wall using cables, linkages or flexible cables to mate with an engine control.

Two Spratt flying boats used modified Mercury outboard engines from 60 to 85 HP. Two other all wood, plans-built aircraft used fan cooled Volkswagon engines. Many newer 2 cycle, 4 cycle and rotary engines are now available in this HP range.

Steering is accomplished using a wheel, a side stick rudder control or incorporated into the auxiliary pitch control stick, all with cables attached to the water rudder. The actual configuration of the auxiliary pitch control stick and control mixer was different for each flying boat built. They all worked because they all had a common point through which all control inputs passed without any crosstalk or feedback between pitch and roll input or output.

All flying boats to date had a two place arrangement with the pilot located forward, primarily to balance the aircraft, with the passenger located at or near the CG. A tandem arrangement is also possible.

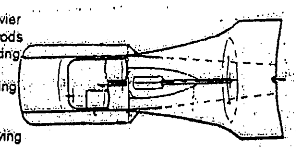
A favorable design factor for Controlwings is their very low structural loading. Maximum momentary G loads can only be obtained by a sharp pull up by the pilot or from gust loads in turbulence, but never in a dive. As a result, the Controlwing structure can be lighter in weight than standard aircraft with design loads of 3 to 6 Gs or more.

Ultralight Controlwings may be unable to meet the minimum legal weight requirements because their one piece pivoted wing panels must be heavier in order to take torque loading, unlike the usual two spar, externally braced wings found on many ultralights. Should a Controlwing be considered for use on another kit or standard aircraft, the hybrid combination may not be efficient and possibly questionable since the aerodynamics are vastly different.

Anyone who understands that the throttle alone can control the altitude and hull attitude and can steer left and right should easily fly this type of aircraft without the usual control coordination required in standard aircraft. Only a bare minimum of training is required to master this simplistic control system.

In addition to being the safest aircraft in the world, the kinder, gentler and easy to fly Controlwing flying boats would make ideal kits for the homebuilder, for student pilots as well as many seniors who have no further desire for stunts, high speeds or expensive aircraft.

Only one Spratt Controlwing landplane prototype was built. With no rudder to counteract crosswinds, it's normal nose high flight attitude allowed the extreme aft main gear to touch down first causing the aircraft to automatically rotate to line up with the ground path before the steerable nose wheel touches down. No amphibious Controlwing are yet developed.



This is a suggested updated Controlwing flying boat configuration retaining the 5 foot wide sponson hull with an 18 foot radius forward hull bottom and narrower body to cockpit width. The forward portion of the hull could have a slight vee shape for better seakeeping while retaining the radius for better turning and crosswind response. At low speeds a Controlwing will tend to weathervane into the wind.

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The wing panels of a Controlwing may be folded as shown without disconnecting the panels from the mast bearings. This arrangement is OK for sheltered storag but not reliable for unprotected windy outside storage.

The mast top bearings must be located a few inches farther apart and the inboard edges of the approximate 4" or wider center fairing must be notched to allow the wing panels to clear the mast itself when first rotated with trailing edges up and then folded aft to rest on a pair of appropriatly padded supports on the aft stabilizing cross beam.

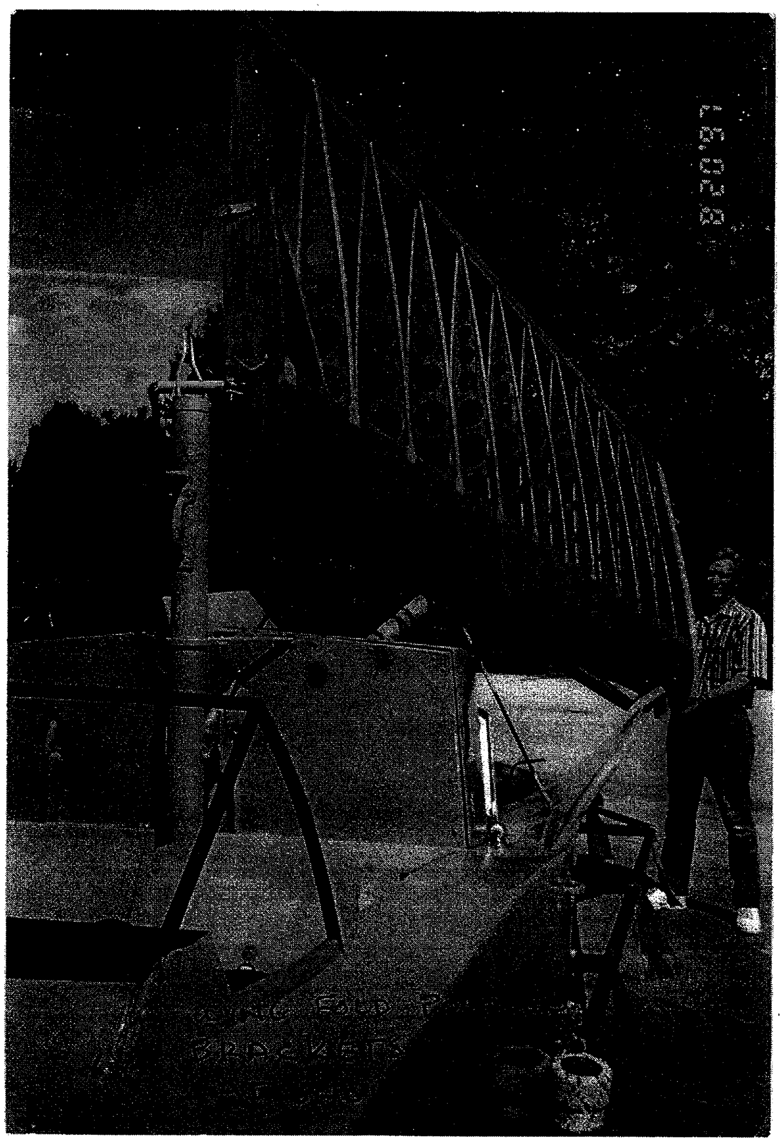
These padded support bracketss are required at the leading edge fittings mounted on each side of the cross beam and with an vertical mounting structure straddling the prop shaft and two padded vee shaped brackets above over the trailing edge for stabilizing the aft end of the wing panels.

The cross beam is anchored with a pair of nesting tubes inserted through the beam into the existing buried tubes in the stub fins. A single through stub boltthrough the nested tube on each side will hold the beam securely.

A square tubular socket anchored inside the mast top can accept a nested square tube extending up to a pair of appropriatly padded, vee shaped trailing edge fittings or a short cross piece attached to both wing link fittings. This will hold the forward end of the panels against side wind. Another sidewind bracket will also be needed for the aft end.

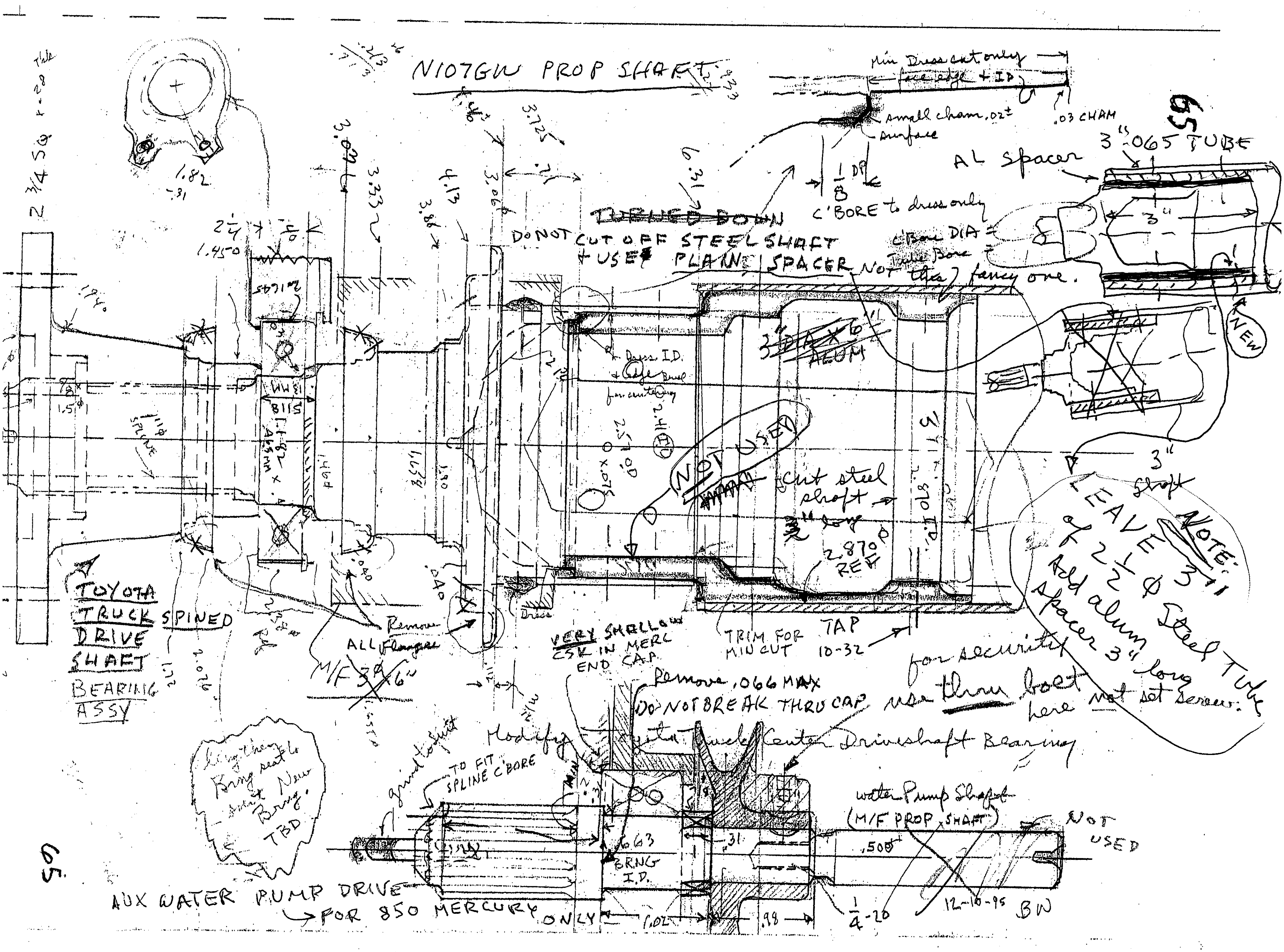
With a three blade propeller, the suitable pair of padded leading edge supports can be located only outboard of the stub fins to clear the prop shown. With a two blade prop the cross beam may be bent down to permit lowering the aft end of the panels.

The side mountings for the fin extensions may require a more forward mounting location to clear the cross beam. Some layout work will be required to accomplish thiswing fold for each individual Controlwing.



FOLD EASIER
W/ 2 BLADE
PROP

NOT FOR
OUTSIDE STORAGE


N107GW PROP SHAFT
Toyota truck spined drive shaft bearing assy
Do not cut off steel shaft + use plain spacer not the fancy one.
~~Turned down~~
C'BORE to dress only
AL Spacer
3" .065 TUBE
NEW
NOTE: Leave 3" of 2 1/2 ⌀ steel tube. Add alum 3" long spacer
Not used
Cut steel shaft
2.870 REF
Trim for min cut
TAP 10-32
Very shallow CSK in Merc end cap
Remove ALL flanges
Remove .066 MAX. Do not break thru cap
for security use thru bolt here not set screws.
Modify Truck Center Driveshaft Bearing
water Pump Shaft (M/F PROP SHAFT)
Not used
To fit spline C'BORE
BRNG I.D.
AUX WATER PUMP DRIVE FOR 850 MERCURY ONLY
12-16-95 BW

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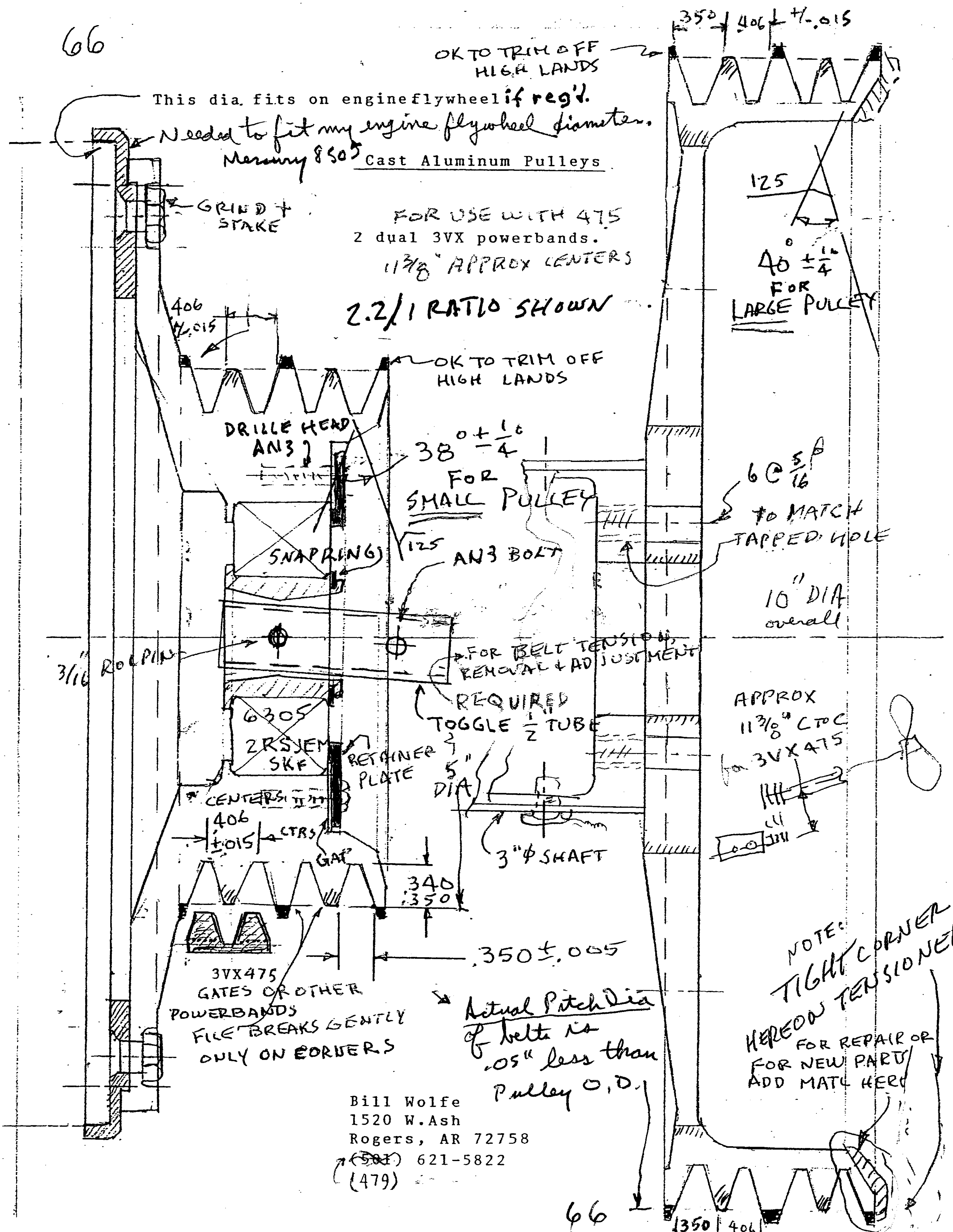
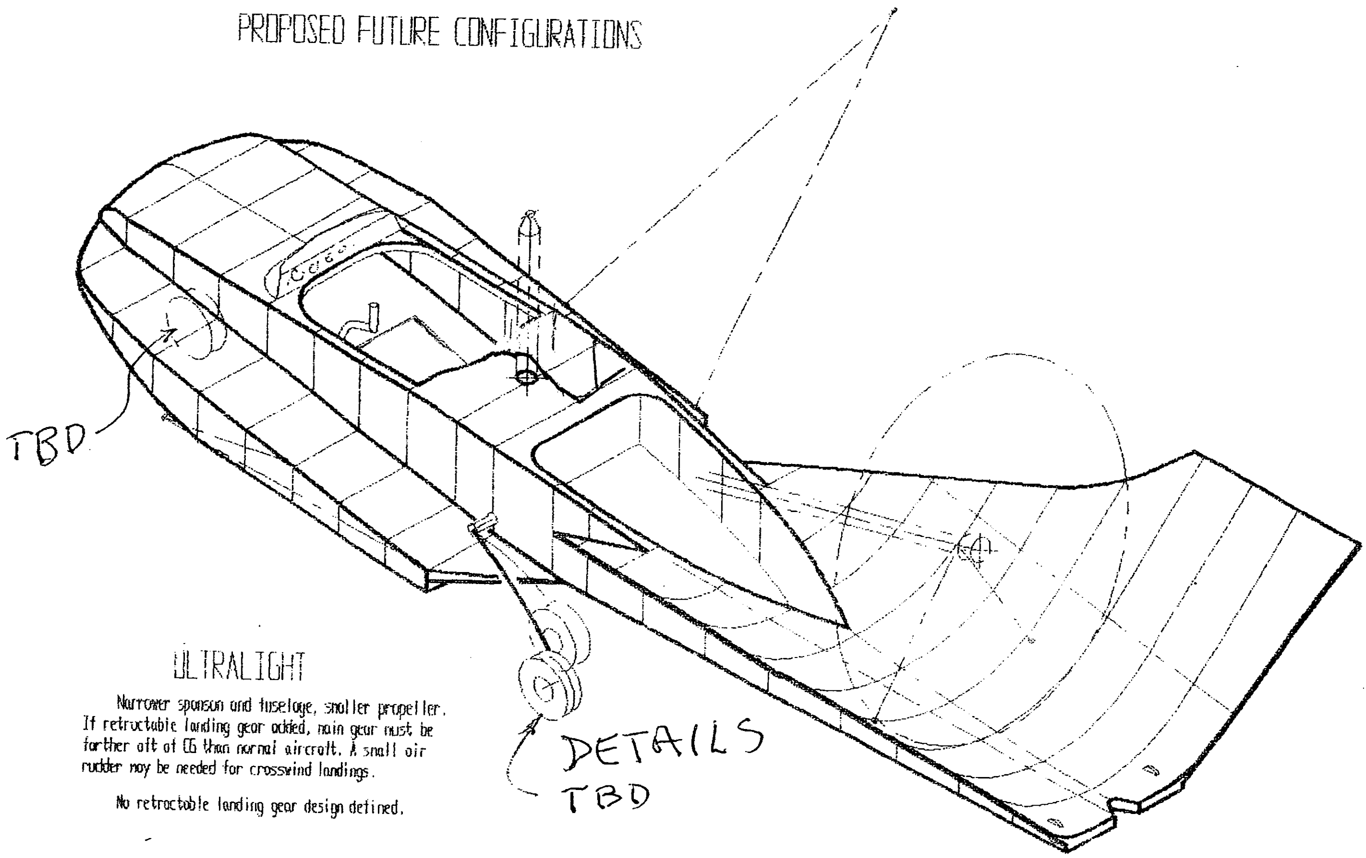


Bill Wolfe
1520 W.Ash
Rogers, AR 72758
~~(501)~~ (479) 621-5822

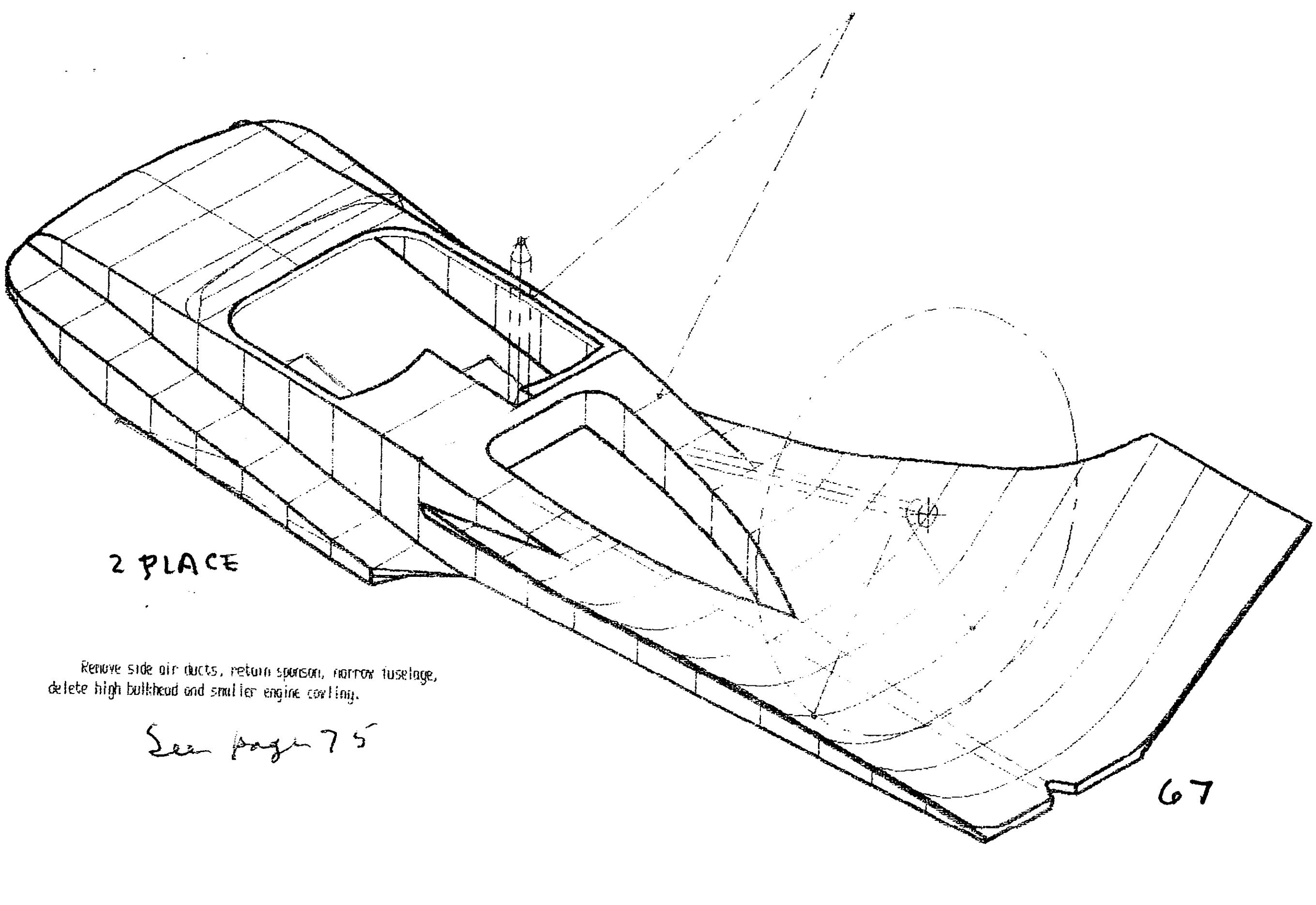
PROPOSED FUTURE CONFIGURATIONS



ULTRALIGHT

Narrower sponson and fuselage, smaller propeller. If retractable landing gear added, main gear must be farther aft of CG than normal aircraft. A small air rudder may be needed for crosswind landings.

No retractable landing gear design defined.



2 PLACE

Remove side air ducts, return sponson, narrow fuselage, delete high bulkhead and smaller engine cowling.

See page 75

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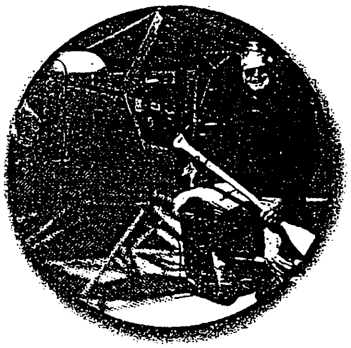
EAA EXPERIMENTER APR 2000



You would enjoy talking with Harry about Controlwing

RECIPES

Food for thought...

by Harry & Pat Whiting, 1(501) 825-6958
154 Bondair Road East, Greers Ferry, Arkansas 72067

Lost in Time — Almost

Here we are three months into a brand new century and already we're seeing an array of mind-boggling new inventions and systems that will affect our everyday lives greatly. If you consider the monumental advances in aviation in the last 100 years, you understand my meaning.

However, in the early days of last century, there was a design idea that could have affected aviation most profoundly; an idea most of us in aviation were totally unaware of— or at least I was.

In the early 1900's Dr. George A. Spratt proposed and proved his theory of a simple to control, free-floating wing design. He did this by inventing a wind tunnel with instruments to measure both lift and drag. He worked with Wilbur and Orville Wright, and redesigned their glider wing, which wouldn't fly, to a design that could be controlled. These Spratt designs resulted in the Wright's first successful controlled flights.

These early days of aviation history, the interplay of personalities, and the how's and wherefore's of historical data are subject enough for a complete story, and we will discuss those items in a future column; what history got wrong and/or left out is a fascinating tale!

Our story now begins with 36-year aerospace engineer Bill Wolfe (EAA 5716) showing up on the doorstep of our home. This gentleman, whom we had not met before, came laden with good tidings, armloads of books, and an airplane story that I had never heard.

In 1969, some of Bill's fellow EAA friends at Boeing-Philadelphia invited him on a Sunday outing to see the late

1

George Spratt in 1969

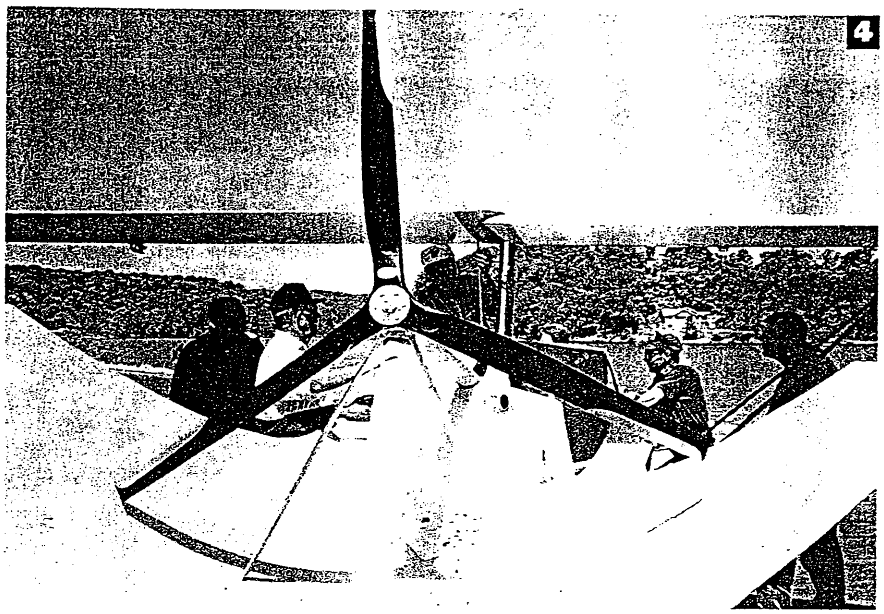
2

I and 100 others flew this sale by just asking!

68

3

4



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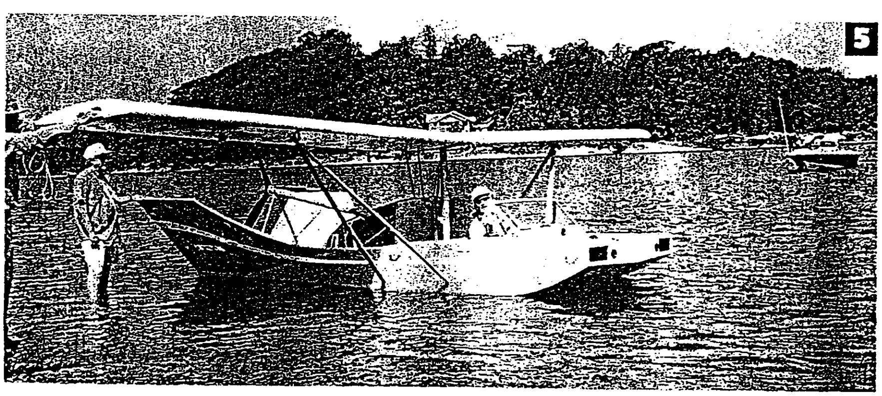

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George G. Spratt's Controlwing airplane, previously unknown to Bill. Spratt's sailboat, a large steel homebuilt, was located on Chesapeake Bay and carried the Controlwing by davits. Spratt and his father held several patents and were always thinking of new ideas. This day was to have a profound effect on Wolfe's life. Meeting Spratt was a pleasure for Wolfe. Spratt was a cordial, pleasant, athletically trim man of 65, completely unaffected by his accomplishments. As Mrs. Mimi Wolfe said to me, "Mr. Spratt could explain things so even a non-aircraft person could understand."

After a tour of the boat designed and built by Spratt, a thorough explanation was made of the Controlwing while still on the deck. The small, two-place aircraft was carefully lowered over the side to the water, and **Photo 1** shows Spratt at the controls. **Photo 2** shows Spratt banking the aircraft nearby.

After the demonstration flight, Spratt gave Bill Wolfe, a low-time pilot with less than 100 hours, a single instruction—"watch the temperature" —and Bill put the Controlwing through its paces. **Photo 3** shows Wolfe after his first flight, his life changed forever.

In Wolfe's own words, here's a description of the Spratt Control-wing:

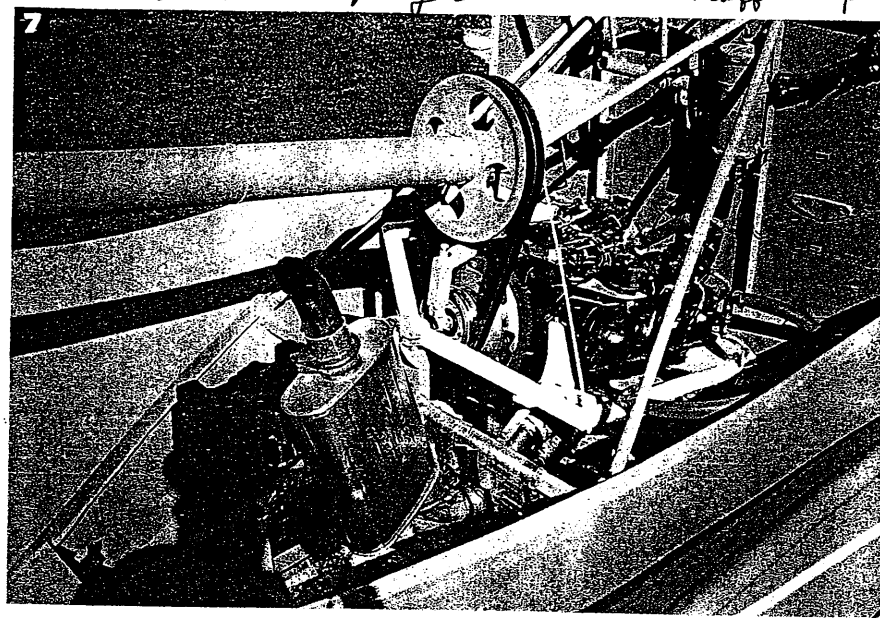
"Normal aircraft have a fixed angle of incidence with elevators, rudders and ailerons to move the aircraft about its center of gravity, in order to direct it to climb, descend, roll, yaw or turn. The Controlwing's center of gravity is located aft of the fixed wing pivot, with the wing having a variable angle of incidence. No rudder is required since a small differential angle between the two parasol wing panels provide a gentle banked attitude for turns, without producing adverse yaw.

69

"The V-shaped tail shown in **Photo 4** provides enough lift in flight to hold the hull in level attitude, due to the venturi action of the high velocity slipstream, produced by the closely nested pusher propeller. With power off, the tail loses its lift

70 See June + July Sport Aviation 1974 for detailed history of Spratt projects.

Muffler optional.



and the hull automatically assumes a nose-high attitude, literally hanging on the wing pivot, as the angle of incidence automatically adjusts to accommodate a stable glide slope which may be continued to a safe, hands-off touchdown on the water. The auxiliary pitch control is needed only to temporarily move the aircraft above or below a stable glide path to make smoother flared landings. A small water rudder provides capability for fast, safe, banked turns on the water.

"The throttle, not the auxiliary pitch stick, is the primary flight control. The airfoil Spratt used was chosen due to the small horizontal movement of the lift vector position. While in level flight with cruise power this lift vector passes through the fixed wing pivot, located at a point chosen to establish the desired cruise airspeed. Increasing power will cause this lift vector to move forward of the wing pivot, and the wing angle of incidence will automatically increase to initiate a climb while maintaining the same airspeed. When cruise power is reduced, the lift vector moves aft of the pivot to decrease the angle of incidence, and the aircraft will descend steadily at the same air speed.

"Anyone who can steer left or right and understands that attitude is related to power input, should be able to fly a Controlwing with a minimum of pilot training. The Controlwing has NO inherent stall, spin or dive capability. In addition, hands-off flight in gusts will allow the wing to automatically pitch down and alleviate gust loads to one quarter of those felt (1/2) in other aircraft. Unlike other aircraft, there is no coordination needed between the simplistic flight controls.

"Upon retirement, I decided that a Controlwing was the only aircraft I would ever care to own, since I first saw and flew one over 30 years ago. I have dedicated over five years almost singlehandedly building, modifying, adjusting fuel systems, reduction belts and pulleys, exhaust system and trying a variety of carburetors, needles and jets. I got airborne only [redacted]. Unfortunately, no photo or video record was made." **Photo 5** shows Wolfe's Controlwing on the water; **Photo 6** shows the cockpit.

briefly before medical expired

Bill Wolfe had two big problems. Because of the rocky shorelines of local lakes and possible reactions to fiberglass resins, he chose to build an extra heavy wood hull. Spratt used simple foam construction, much quicker and lighter in weight. Wolfe's second and main problem was a cranky modified outboard motor for power (**Photo 7**). Just think of the ease today, to install a Rotax or other modern powerplant, and have the power there when you need it.

Wolfe continues, "Since Spratt's death I have assumed the mission of keeping the Controlwing designs alive and have gathered numerous design ideas for improving and simplifying the aircraft. I also have experience I would happily share with seriously interested parties, especially those who will recognize the opportunity and have the capability to develop Controlwing flying boats and amphibian kits, and supply these kinder, gentler aircraft to a receptive home-builders' market."

After hearing Wolfe's description and explanation of the Controlwing, there is no question that it would fit in with our light planes today. With its simple and safe construction and using the engines available today, what a great machine it could be, and a natural for the kit plane market. Being personally involved with ultralights and light planes, I can tell you that the reduction of the effect of turbulence on light aircraft would make the airplane worth building.

Next time we'll look at some surprising aircraft history, and some recipes to help your two-cycle engines run longer.

Until then, fly safely.

Editor's Note: If you'd like more information about the Spratt Controlwing, contact Bill Wolfe a (479) ~~501~~/621-5822.

-- 70 --

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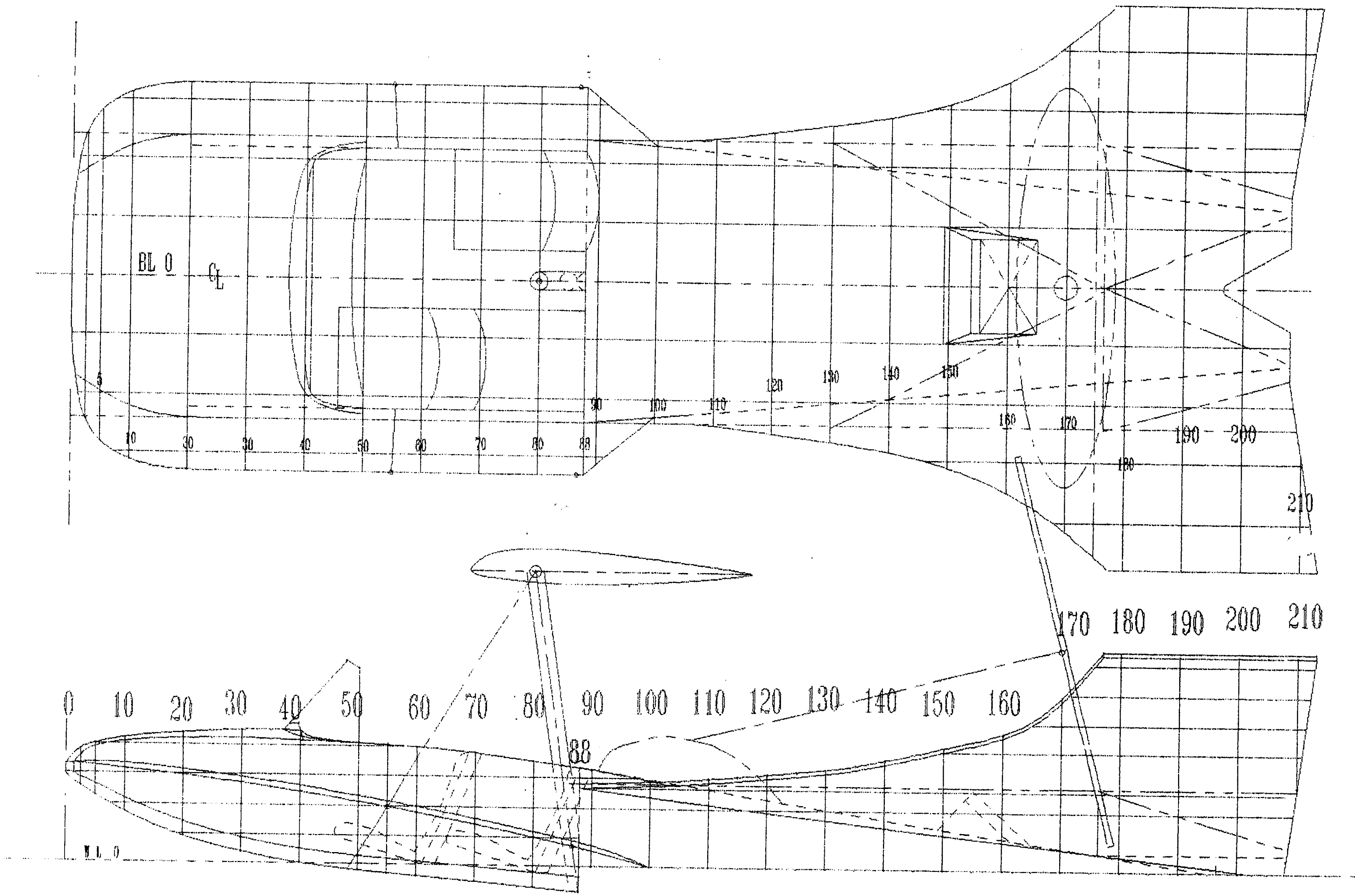
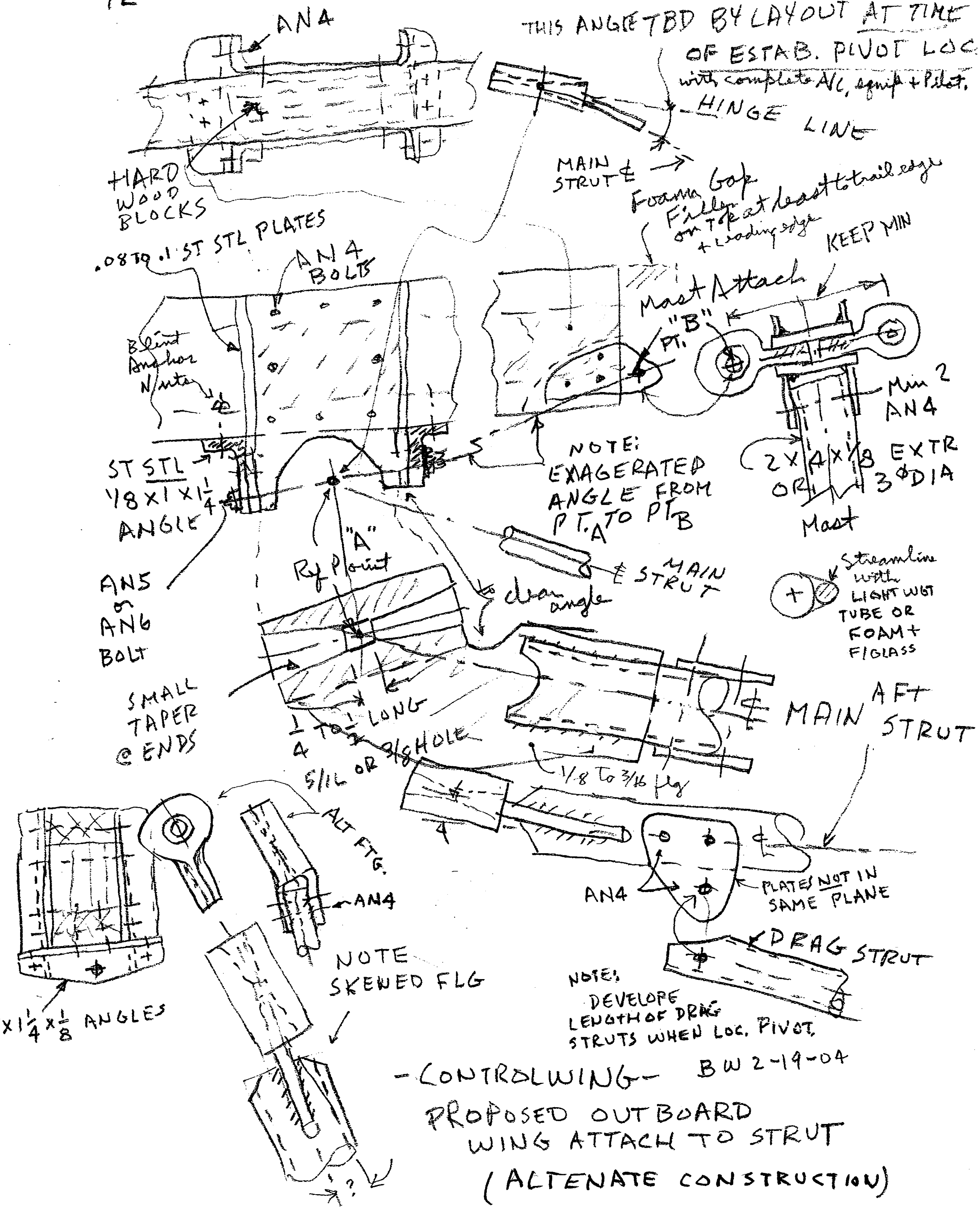


Proposed CONTROLWING Flying Boat Hull

See P 75

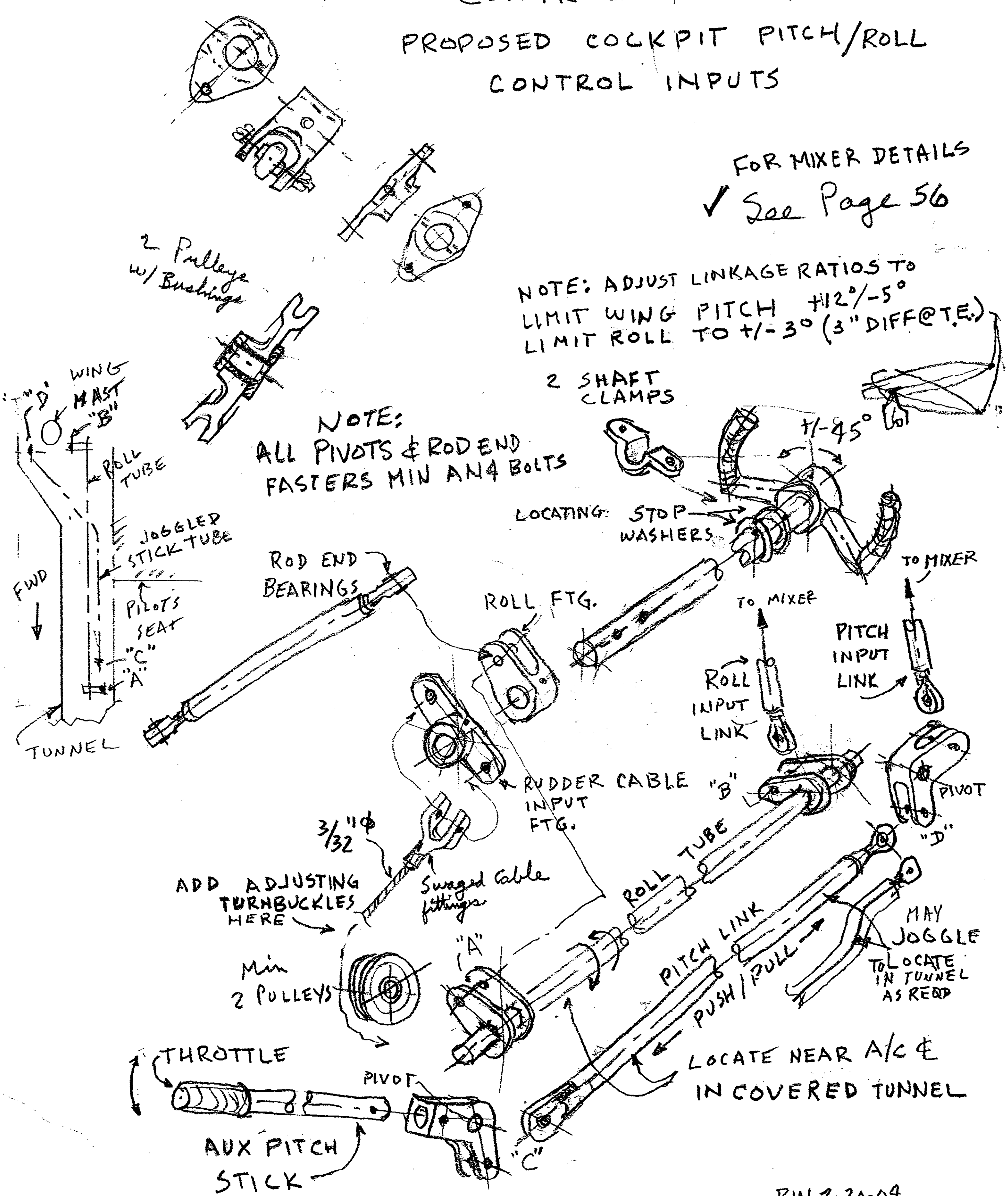


-CONTROLWING- BW 2-19-04

PROPOSED OUTBOARD WING ATTACH TO STRUT

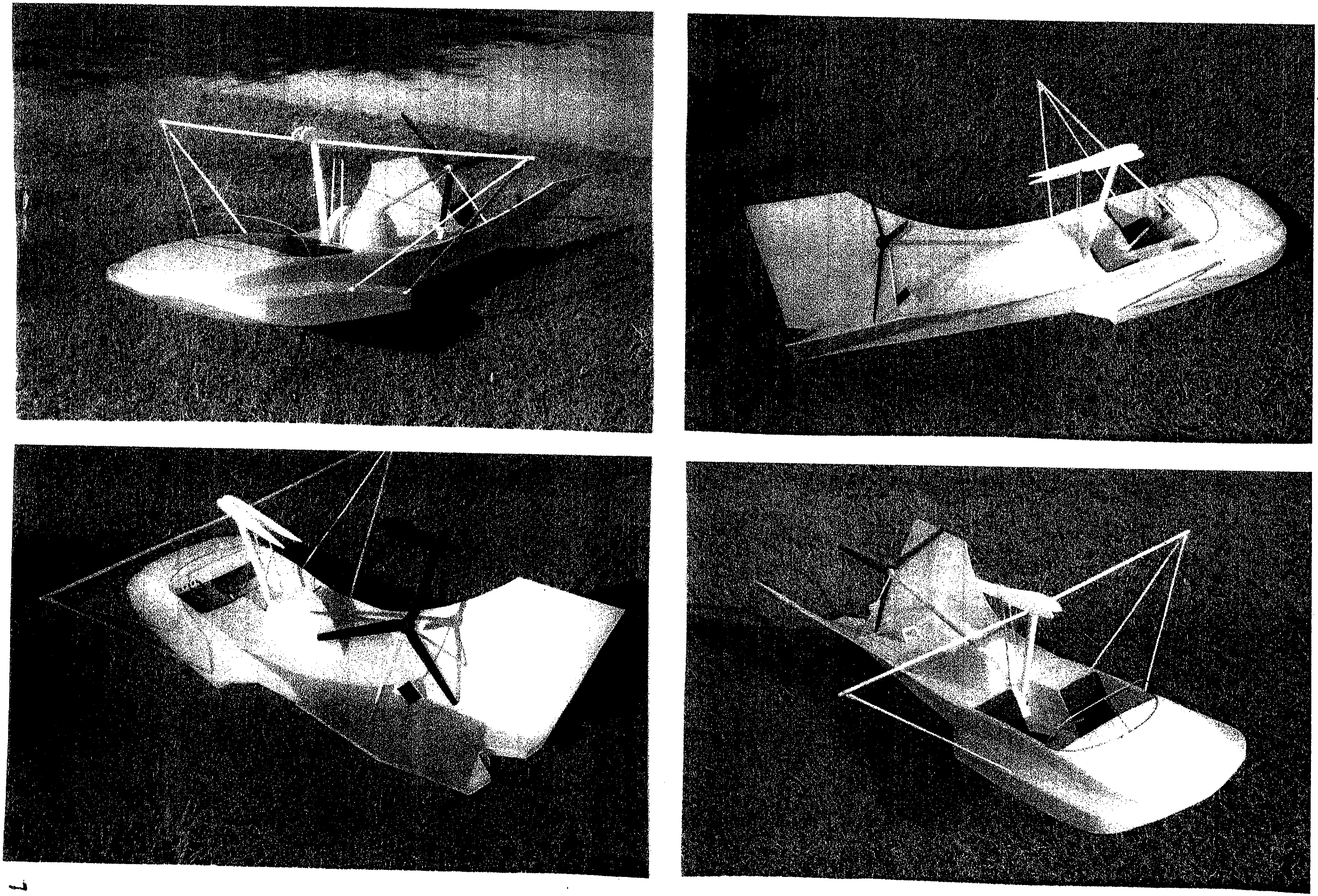
(ALTENATE CONSTRUCTION)

- CONTROLWING - ALTERNATE
PROPOSED COCKPIT PITCH/ROLL CONTROL INPUTS



BW 2-20-04

NOTE: RUDDER CABLES CAN BE ROUTED AFT THRU PLASTIC TUBES



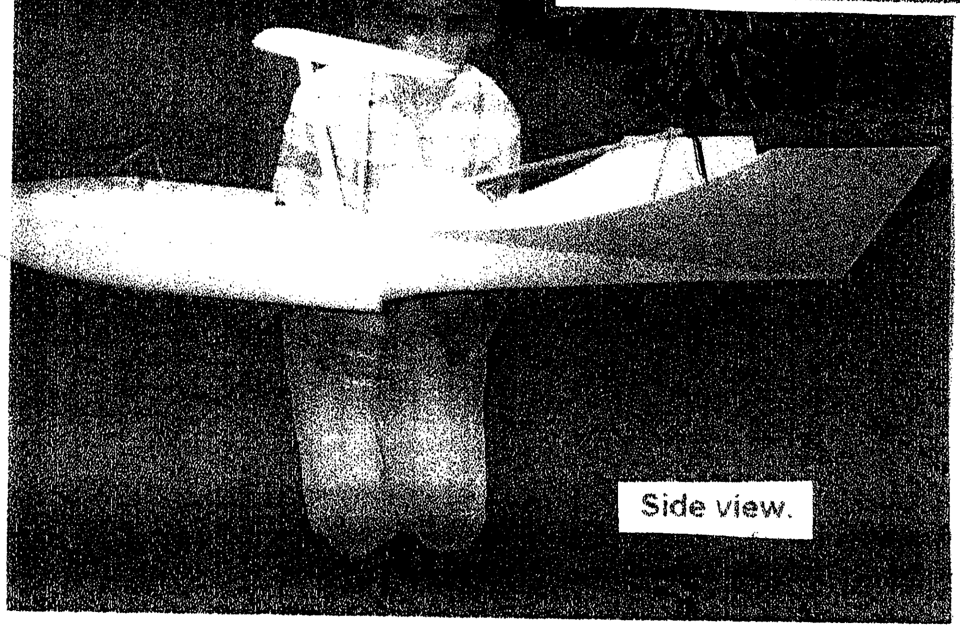
<u>**The SPRATT Controlwing flying boat**</u>

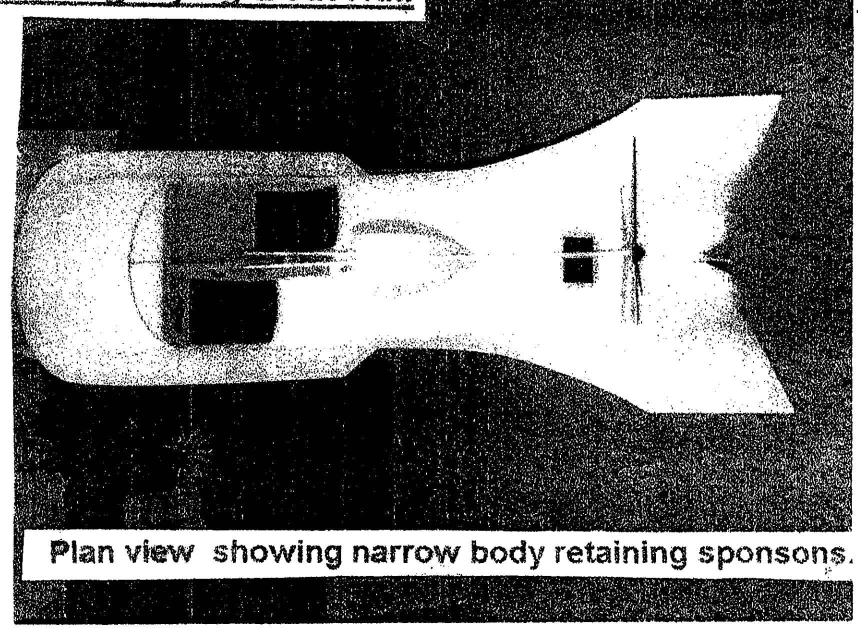
1/4 Scale, 53" long model of a proposed future hull configuration

bw 6-18-04

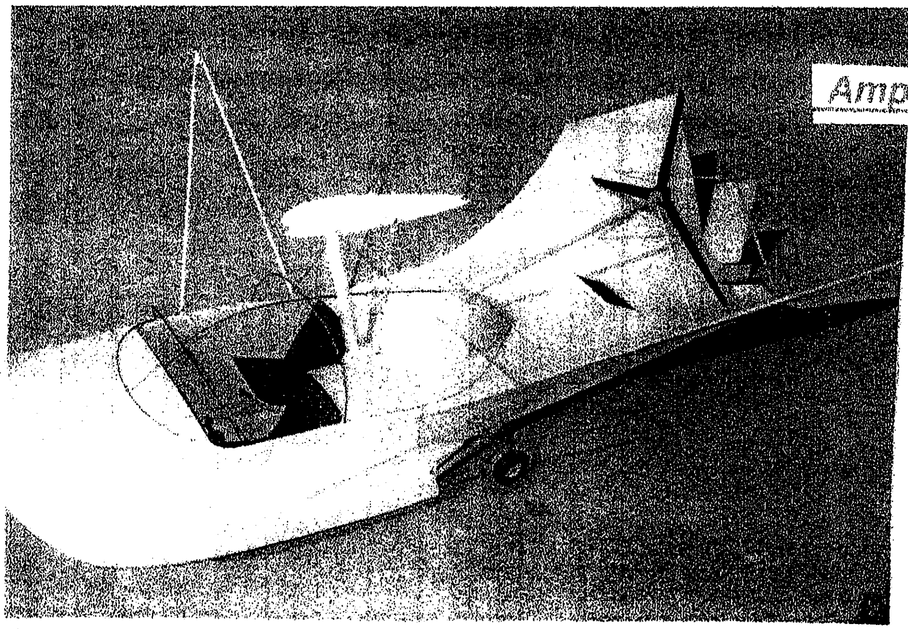
See Page 71

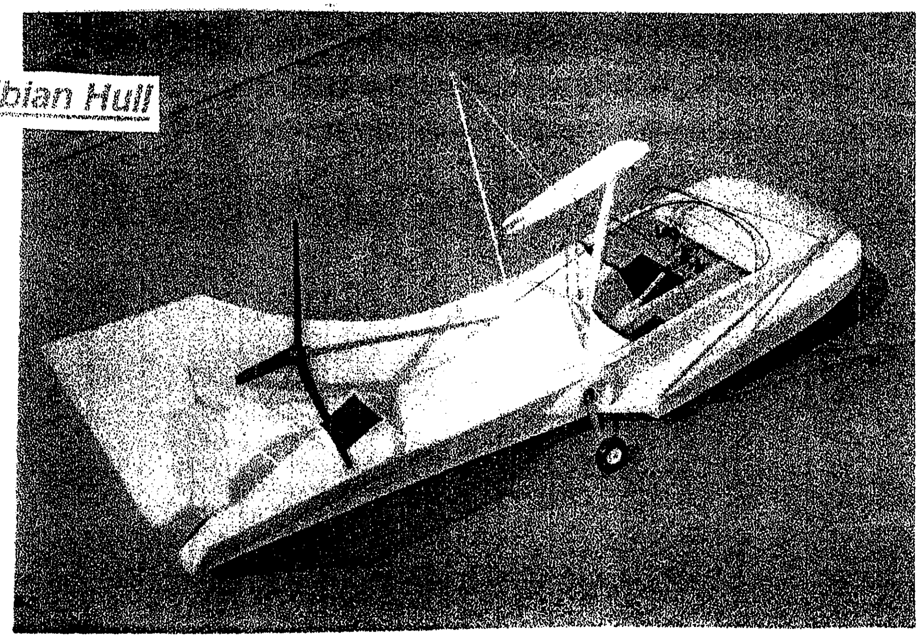
Proposed SPRATT Controlwing Flying Boat Hull


Side view.


Plan view showing narrow body retaining sponsons.

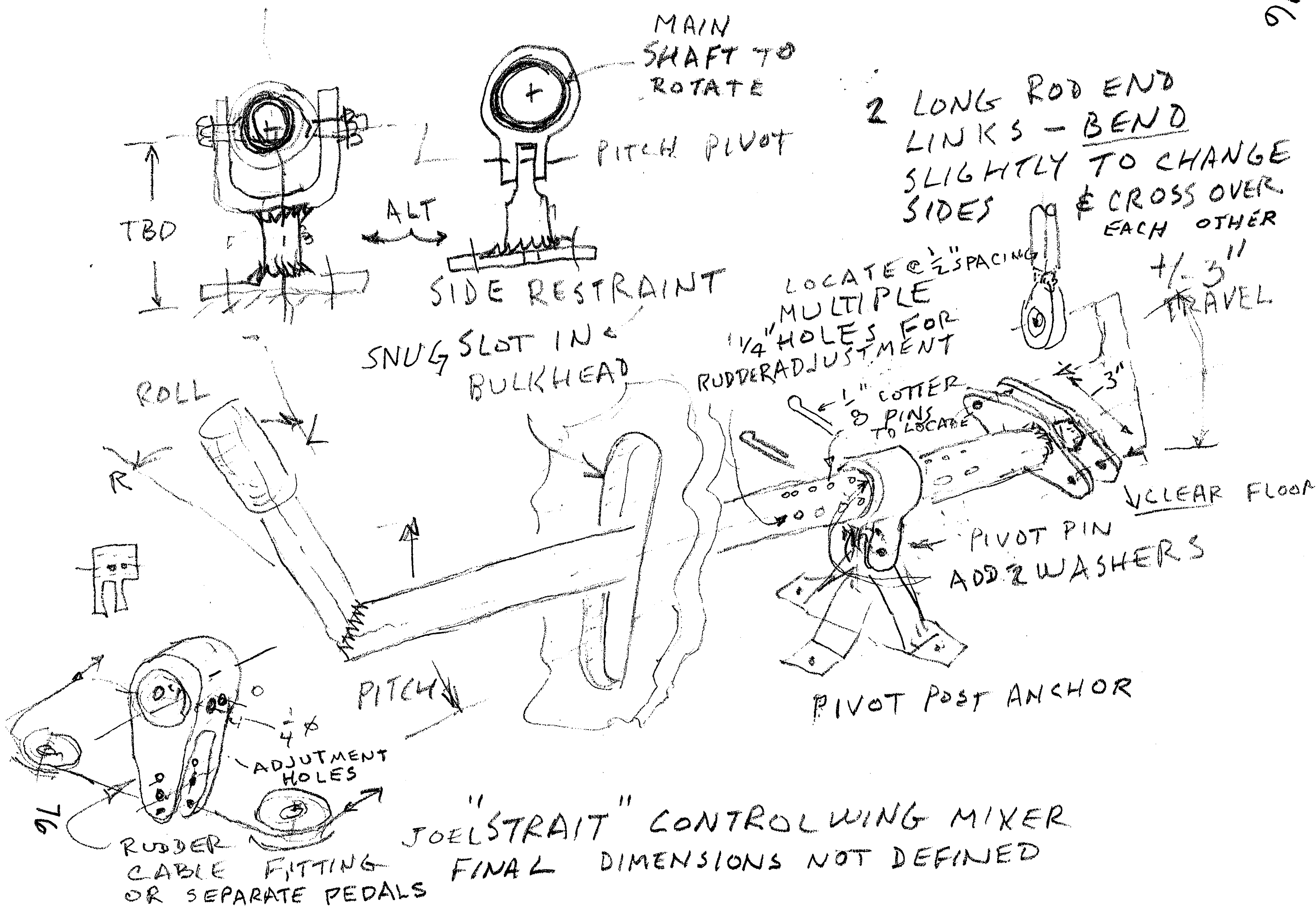
Amphibian Hull





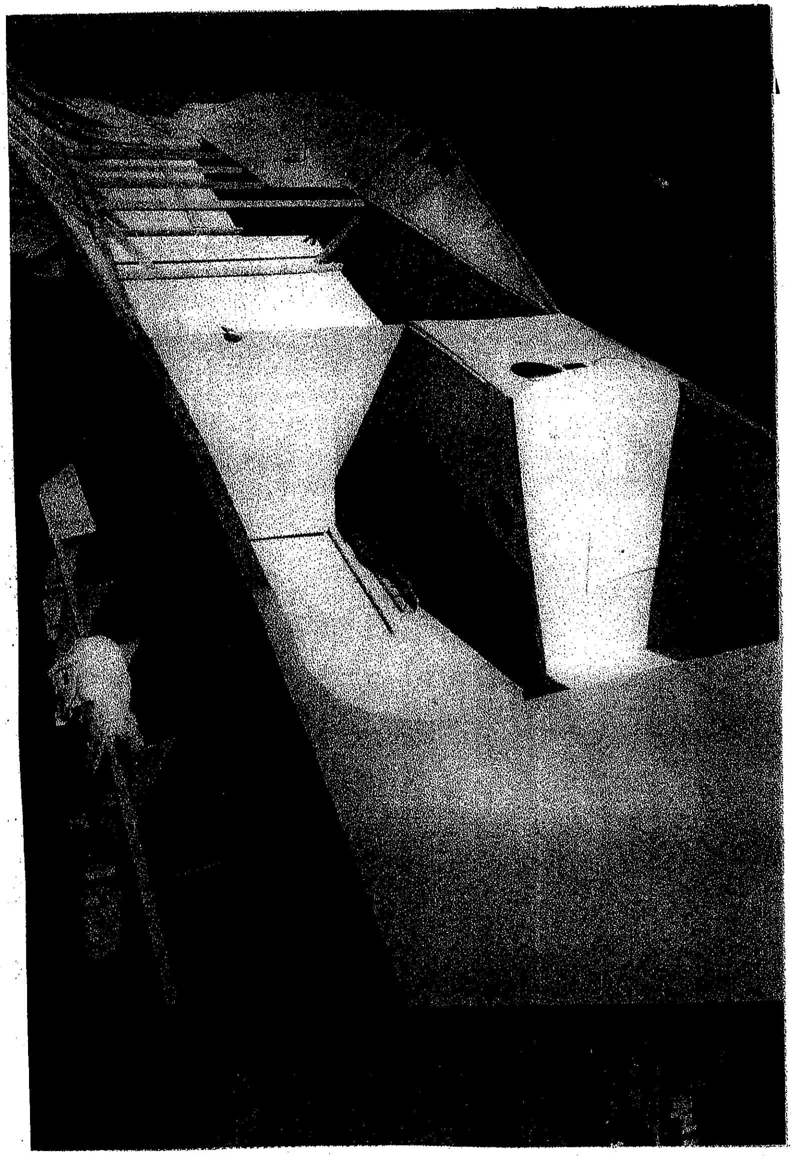
Add canopy cover, air rudder and rudder pedals. Opt main gear rotates forward to stow in aft end of sponson, and one with a fairing extenting on on a square strut. Partially exposed retracted nose gear used as beaching bumper.

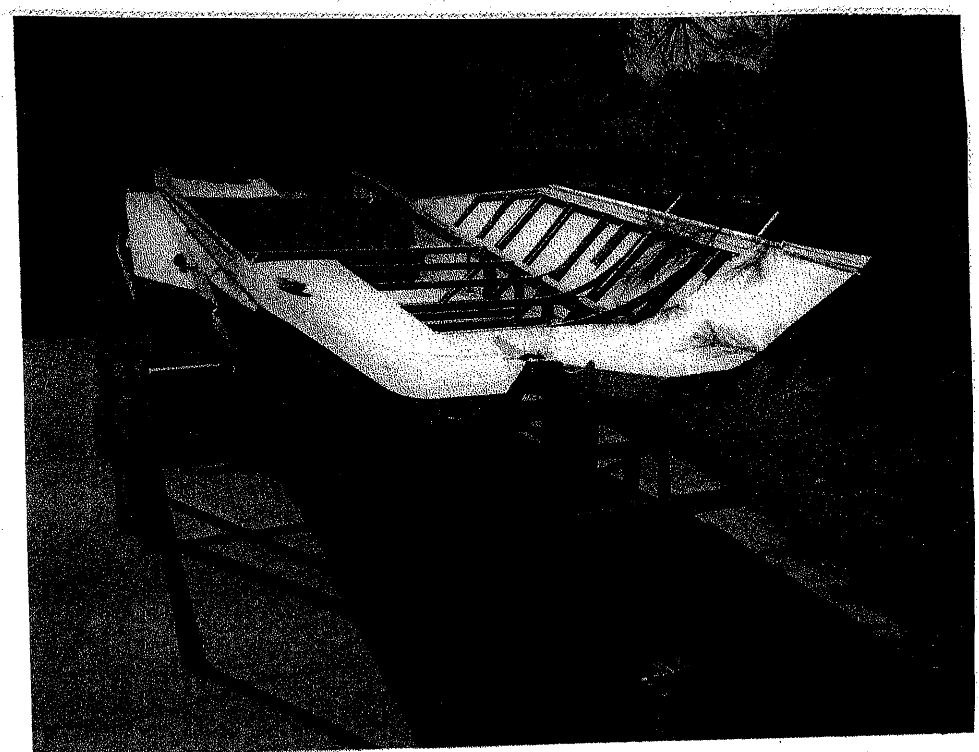
Just ideas...

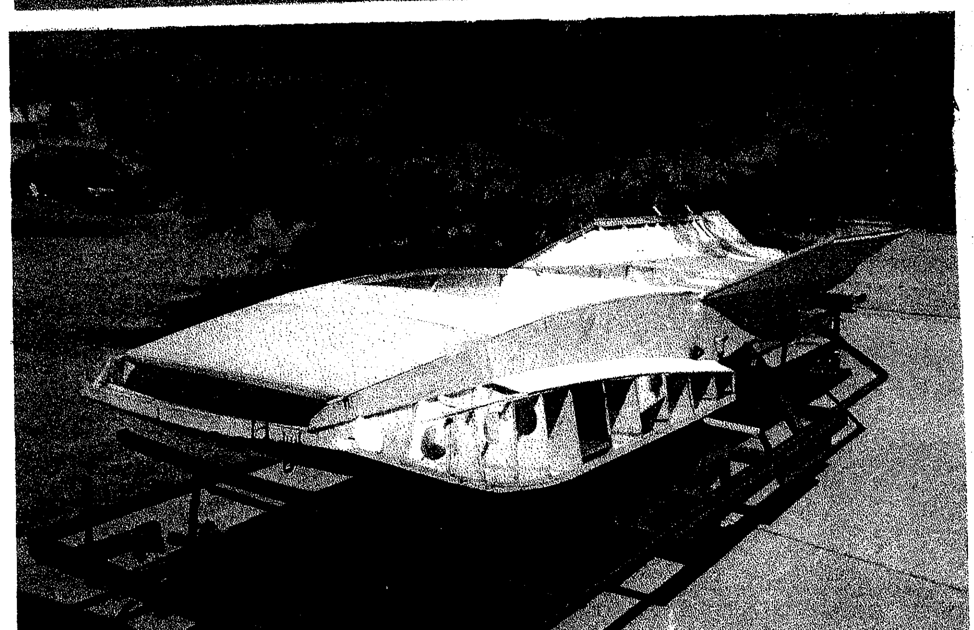


JOEL "STRAIT" CONTROL WING MIXER
FINAL DIMENSIONS NOT DEFINED

Partially finished hull of my second Controlwing.







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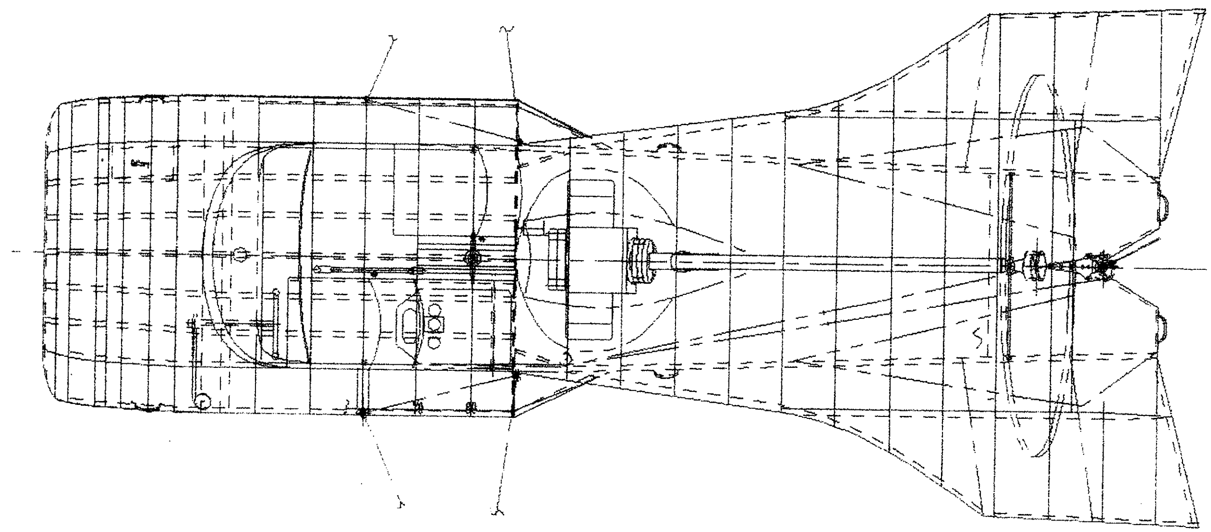
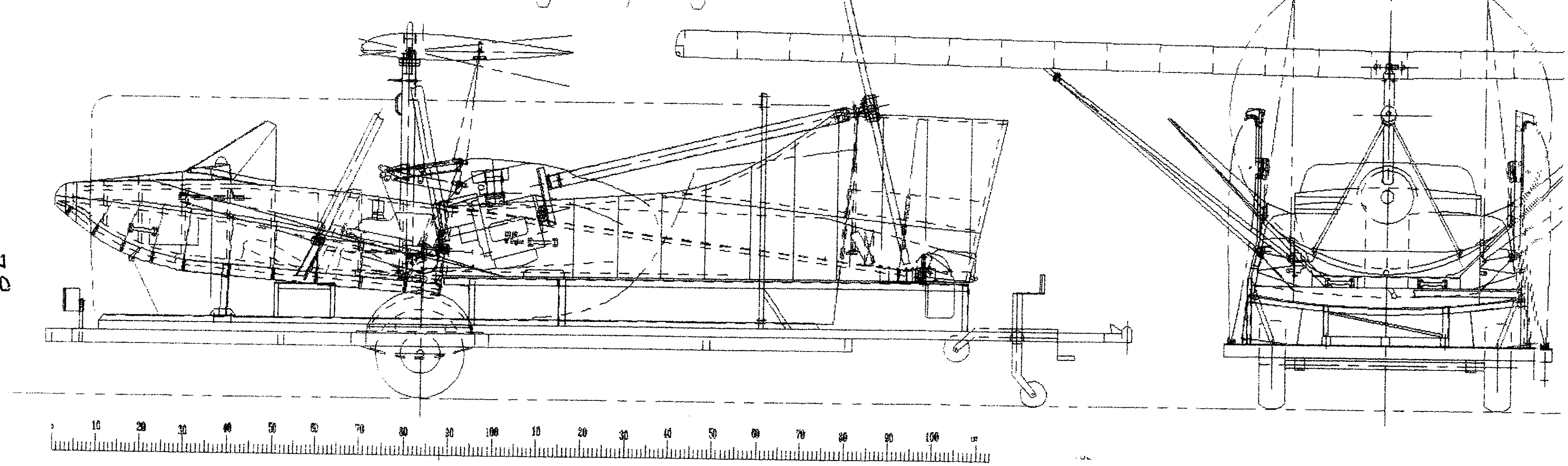


Proposed new Controlwing flying boat



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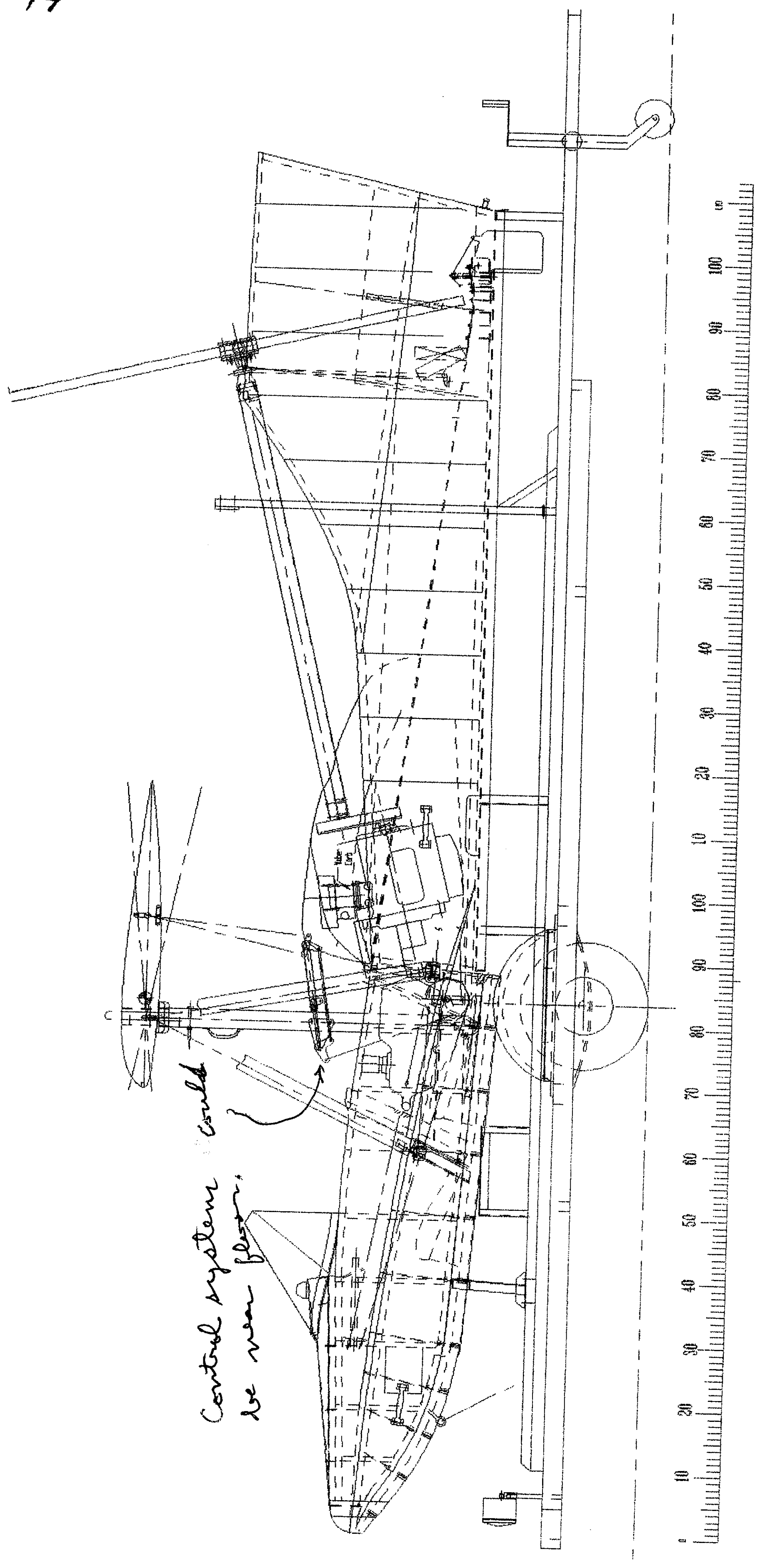

PROPOSWED CHANGES