
NASA
1AJS

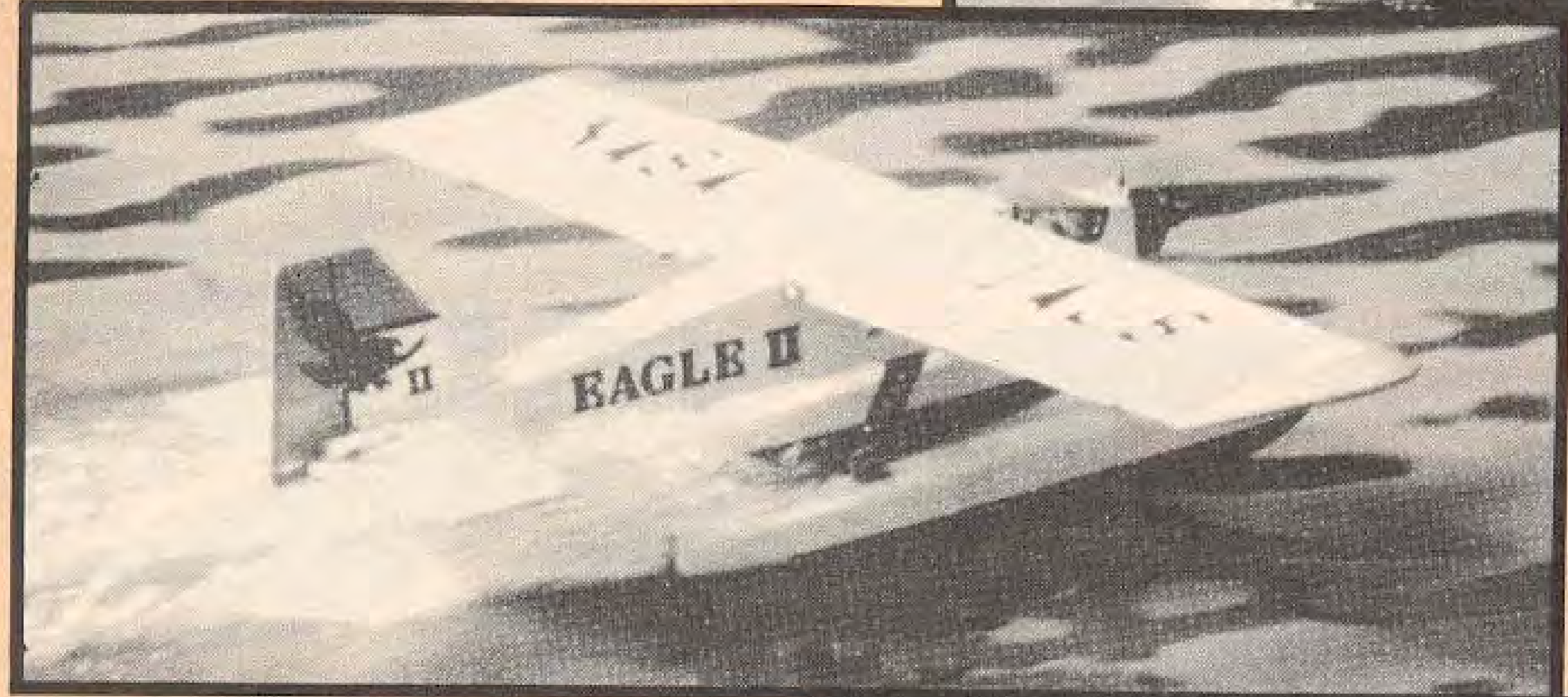
NORTHROP EAGLE II

John Sullivan has written a superb fantasy story around the design of his Northrop Eagle II. After reading his story, we're sure you will want to get involved with the N.E. II.

By John Sullivan

In my opinion, the Northrop AJS Sea/Land reconnaissance plane is one of the most exciting aircraft manufactured in recent years. The "A-Jays" were first conceived early in NASA's space capsule program when it became apparent that a fast, waterborne aircraft, capable of reaching downed capsules in somewhat unpredictable locations, was of the highest priority. Northrop was selected as the prime contractor and, within 6 months, the first, the 1AJS or Eagle II, had been built, tested and pressed into service.

The "A-Jays" (four of them were eventually built) are a classic study in single purpose, high technology aircraft and, owing to Northrop's choice of components, they represent a modeler's dream come true. Their gleaming carbon fiber airframes, the 58 foot span symmetrical airfoil wing, a massive 3000 horsepower Graupner Northrop engine and titanium float gear practically beg to be scaled down to a 1"-to-the-foot balsa, MonoKote and aluminum model powered by the remarkable O.S. Wankle.



My first exposure to the Eagle II occurred shortly after its completion when my son Adam and I were assigned, from California, to photograph the splash-down of the Eagle capsule approximately 200 miles east of the Bahamas for *National Geographic*. The sense of immediacy that sustains and surrounds an operation like this is an experience never to be forgotten. Foss had been orbiting the globe for 72 hours when a small $14.00 resistor in the primary navigation system blew and he was forced to switch to backup. Within seconds, every horn, klaxon and siren on the carrier Emeraude was blaring. Adam and I sprinted across the deck to the Eagle II's crane

ABOUT THE AUTHOR

John Sullivan returned to model aviation in 1978 after a 24 year hiatus. His primary interest is in radio control and several of his designs have recently appeared in the modeling press. John lives in Northern California's Napa Valley and divides his workdays between a woodworking business and photojournalism.

pad. Clouds of exhaust and the whine of the turbines from the Sikorskies teathered nearby filled the air as we scrambled up the ladder and into the cockpit. In quick succession the canopy folded over us, the six Navy frogmen disappeared up into the bomb-bay hatch and we were lifted, swung over the edge of the carrier's deck and lowered to the surface some 65 feet below.

We drifted away form the Emeraude as the pilot, Navy Captain Bob Alren, established radio contact with operations. It was determined that Foss would be coming down 175 miles south of the epicenter of the fleet which was spread out in a 100 mile circle. Splashdown would occur at 0615 and we were located at the fleet's northeast quadrant, which meant we had to cover 255 miles in less than 40 minutes in order to rendezvous with Foss.

We listened to the chain of transmissions until we heard "Eagle II" on the headset and our coordinates flashed on the viewer. Alren gave notice to the bomb-bay crew while a throbbing whine emanated from beneath the cockpit floor and the Wankle's huge black prop flipped over, wrenching the ship as it went through compression and then disappeared in a blur. Alren waited only seconds for the engine temperature to rise, then throttled up and advanced the pitch. The Eagle II surged forward and lifted in the water.

You can identify with the workings of this craft in its environment by feel. The huge thick wing exerts a pendulum effect as it swings into the wind. The floats send shocks through the fuselage, first ponderous and spaced and then sharp and slapping as the Eagle II accelerates and comes on step. The Wankle's acceleration is instantaneous and the incredible thrust it exerts pulls the plane into the air in a trajectory unmindful of the elements. Everything behind the prop is simply baggage.

Alren banked the Eagle II and shot back high over the Emeraude just as the first Sikorsky cleared its deck. Our indicated airspeed showed 395 knots or just over 450 miles per hour. In 34 minutes we would be flying in pattern over the splashdown site, watching overhead for the first glimpse of the Eagle capsule, lofting out of the grey Atlantic sky on its white and orange chute . . .

I hope the reader will excuse the foregoing stretch of imagination. The real Eagle II exists only in my, and my son Adam's, mind. My wife accuses me (very sweetly, of course) of living vicariously as a modeler. And she's right (again, of course) with one important difference. As modelers we not only gaze for hours at our beloved creations and dream of endless perfect flights, we also fly these creations with our knees knocking and hands shaking, and our experience at that point is very real indeed. I am reminded of the story "The Secret Life of Walter Mitty" wherein the hero would steal off to a private place and imagine participation in another's experience. **This** is living vicariously, and Walter Mitty never held a 6 channel Airtronics transmitter in his hand and watched a model with 3 months of work in it plummett toward earth.

There's another, very personal, reason for this flight of imagination. I've been modeling for six years now and my efforts have produced a line of high wing trainer types that perfectly satisfy my love for the Golden Age of aviation. But my son Adam, who in reality has just turned 13, has expressed little interest in models of aircraft that pioneered the skies 40 years before he was born. He has dutifully followed me to the fields and lakes and even learned to fly, but the inspiration to really grasp this hobby and all the enjoyment it can provide has eluded him. I determined that if Adam was to ever develop an interest in model aviation, the model would have to be of a plane that kindled **his** imagination and the dream of the Eagle II was born.

This spring I found myself staring at a just completed Fairchild Ranger 24. I was totally exhausted from having built it, so, as any good modeler would do, I sat down for a minute and began to ponder the next plane. Adam was in the shop and I called him over for what was the first of many rewarding experiences with this project. As we began to page through our collection of catalogues and 3-views, the parameters for the project quickly evolved. Adam could decide how the plane would look, but he would bow to the determinations I had to make in order to give him an airplane he could fly. By the end of that first session, we had a plane on the drawing board that met our criteria. The model was basically a sheep in wolf's clothing. Our spirits were high, and we were ready to begin building.

Within a week, all of the boxes had arrived at our doorstep but it was the

NORTHROP EAGLE II
DESIGNED BY:
John & Adam Sullivan
TYPE OF AIRCRAFT
Shoulder Wing Floatplane
WINGSPAN
58¾ Inches
WING CHORD
11¾ Inches
TOTAL WING AREA
690 Sq. In.
WING LOCATION
Shoulder Wing
AIRFOIL
Modified Symmetrical
WING PLANFORM
Constant Chord
DIHEDRAL EACH TIP
0
O.A. FUSELAGE LENGTH
37⅞ Inches
RADIO COMPARTMENT SIZE
(l) 10" x (W) 3" x (H) 3½"
STABILATOR SPAN
21 Inches
STABILATOR CHORD (Incl. Elev.)
7½" (Avg.)
STABILATOR AREA
157½ Sq. In.
STAB AIRFOIL SECTION
Flat
STAB LOCATION
Center of Fuselage
VERTICAL FIN HEIGHT
9 Inches
VERTICAL FIN WIDTH (Incl. Rud.)
7¾" (Avg.)
REC. ENGINE SIZE
30 Wankle/.40 2-Stroke
FUEL TANK SIZE
6 Oz.
LANDING GEAR
Floats/Taildragger
REC. NO. OF CHANNELS
4 Minimum
CONTROL FUNCTIONS
Rud., Elev., Ail., Throt.
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa & Ply
Wing	Balsa, Ply, Redwood
Empennage	Balsa
Floats	Blasa & Ply
Wt. Ready To Fly (Land)	**72 Oz.**
Wing Loading	**15 Oz./Sq. Ft.**
Wt. Ready To Fly (Floats)	**100 Oz.**
Wing Loading	**20.8 Oz./Sq. Ft.**

tested the temperature during the later stages of break-in, running lean, and found that the engine itself never reaches any sort of critical temperature (nothing over 300, which is quite acceptable) and that if you lean it out too much, it simply starves and stops running before any damage could even begin to occur. The muffler on the Wankle gets hot. Ours had turned a toasty brown from the castor oil being baked on it, but, again, don't worry. My mentor and test pilot, Fred Constantine, told me that if the heat has to go **somewhere,** it's better for it to accumulate in the muffler where it can dissipate without harming the engine.

The second characteristic of the Wankle is its sound. It's relatively quiet (closer to a 4-stroke than a 2-stroke) and at idle it sounds not unlike a Vespa motor scooter with its intermittent "ping pinging." Our first taxi tests were conducted at a small lake nearby (we live in California's Napa Valley) and the woman who owns the lake came around to watch. Her first remark was that she **liked** the sound and that it was much quieter than our other engines. The largest engine we had ever run on that lake prior to this was an H.B. 15 with a muffler! The Wankle also has internal gearing which turns the propeller three times for every complete revolution of the three-lobed disc inside, so you are going to hear mechanical emanations not associated with 2-strokes. It's different.

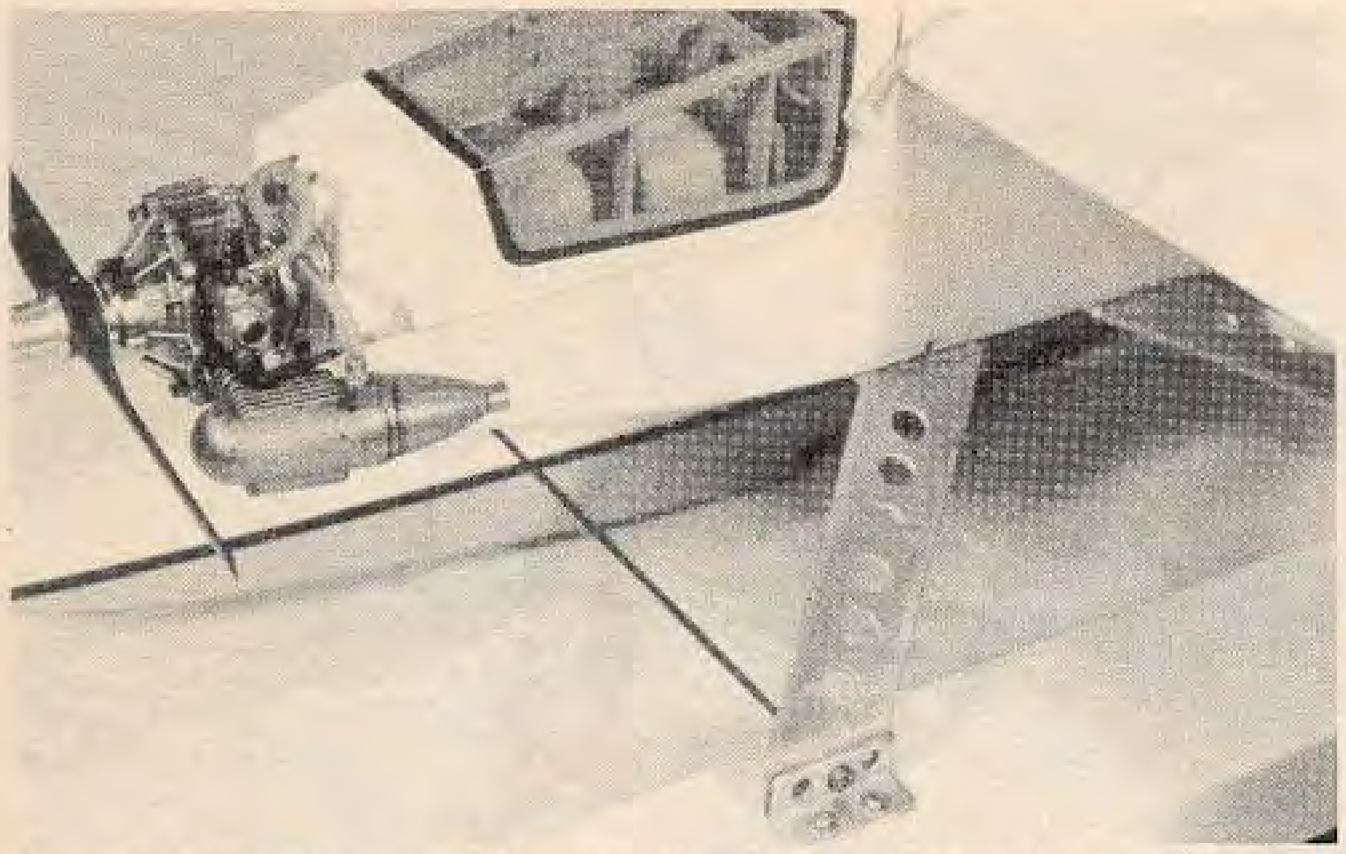
As I stated earlier, the Wankle was mounted for testing with the muffler low and on the left. I felt that this put the muffler, and particularly the carburetor, in a rather vulnerable position, given the rather steep angle of attack landings we are sometimes capable of. I was also concerned with the unexplained presence of a nipple sticking out of the Wankel's crankcase. I determined that this was either a crankcase breather which couldn't be used to pressure the fuel tank, or a pressure fitting that could. So, before going on with the construction of the plane, I built another test stand to accommodate the Wankle with the muffler and carburetor on the right (facing the engine). The benefits of this system were immediately apparent: the tank could now be positioned in the fuselage so that the topped-off fuel level was even with the spray bar (O.S. recommends this elevation) and the engine ran beautifully in its new position.

Finally, with the engine at 1/3 throttle, I pushed the vent line from the fuel tank over the mystery nipple. The engine immediately began to run

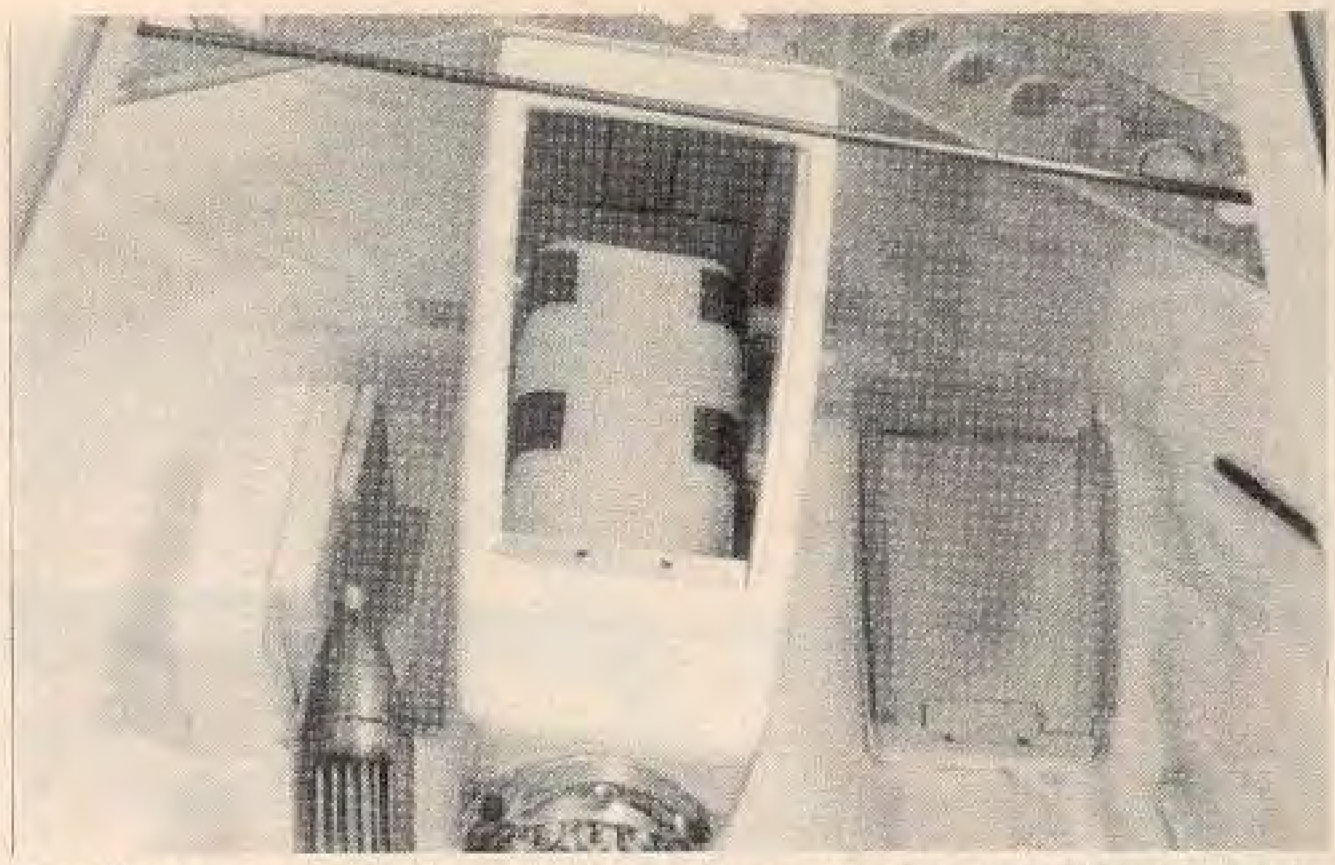
O.S. Wankle that we opened first. I must admit to being only a novice regarding 2-stroke engines and a total stranger at the time to Wankles. O.S. provides an informative booklet giving proper break-in procedures, fuel and prop requirements, maintenance and a brief history. However, they provide no data as to the internal workings of the engine and this is somewhat disconcerting when you find little wrenches in the accessory package that won't fit anywhere on the outside of the engine. I suspect the wrenches are used, at some point, to adjust or replace the spring loaded rotor tip seals that provide the compression but that's only a guess. This is a fine, powerful, quiet engine that deserves to be considered by more modelers, and I feel that exploded views and adjustment instructions would broaden its appeal considerably.

I made a test stand for the Wankle and mounted a two ounce tank for break-in. It should be mentioned right here that the Wankle must be started with an electric starter. The starter will fire it up immediately the first time and every time. For the break-in period, I mounted the engine with the muffler low and on the left side, facing the engine, as per the instructions. I ran it slobbering rich for two minutes at a time for a total of 30 minutes at, or near, full throttle, and then another 30 minutes at varying throttle settings. We've used K & B 100 for break-in and Tower's 10% nitro for flying, which provides all the power we need. This is a .30 size engine that spins out nearly 1.3 horsepower at 18,000 rpms. Check those figures against a hot .40 sometime and you'll be pleasantly surprised.

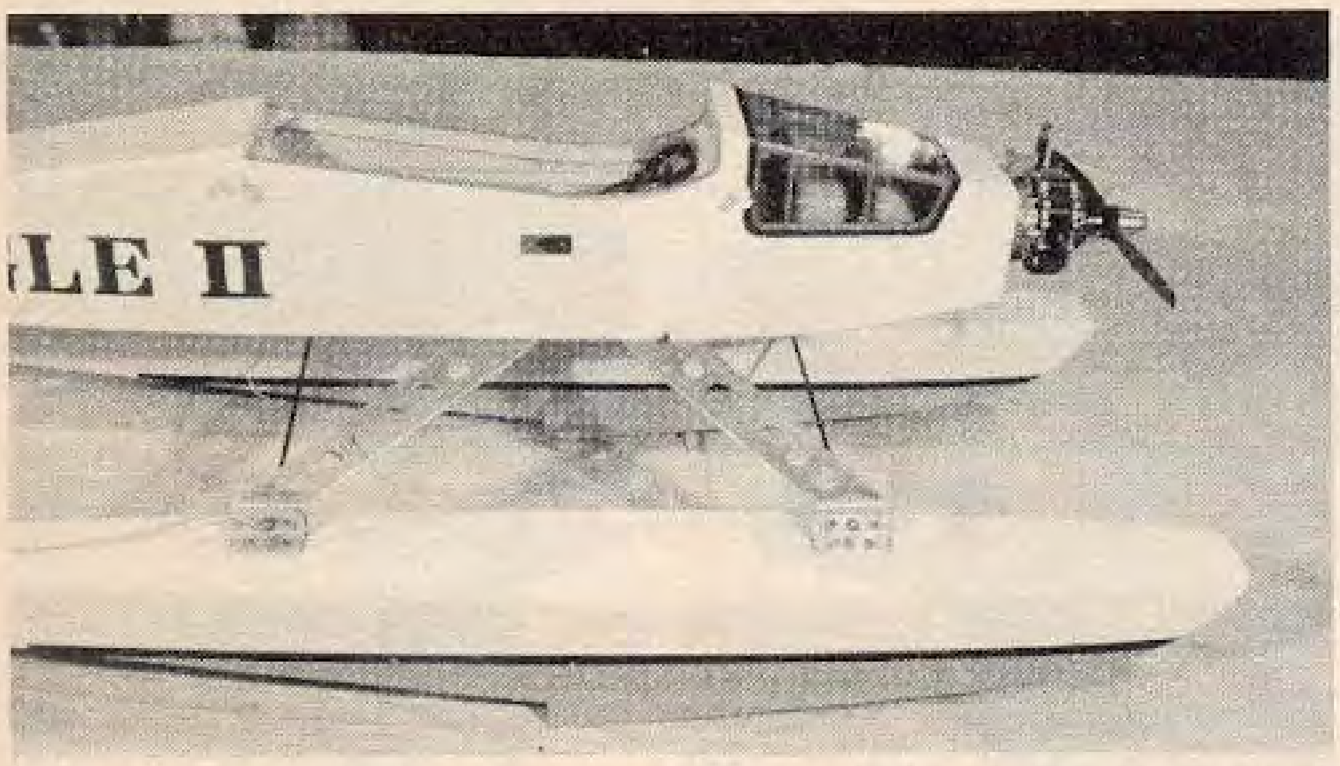
There are certain characteristics of the Wankle that should be addressed to make you feel more comfortable with it. First of all, it likes to run hot and needs adequate cooling. O.S. recommends very little cowling and the use of a very small spinner, if any, to accomplish this and I agree. I've

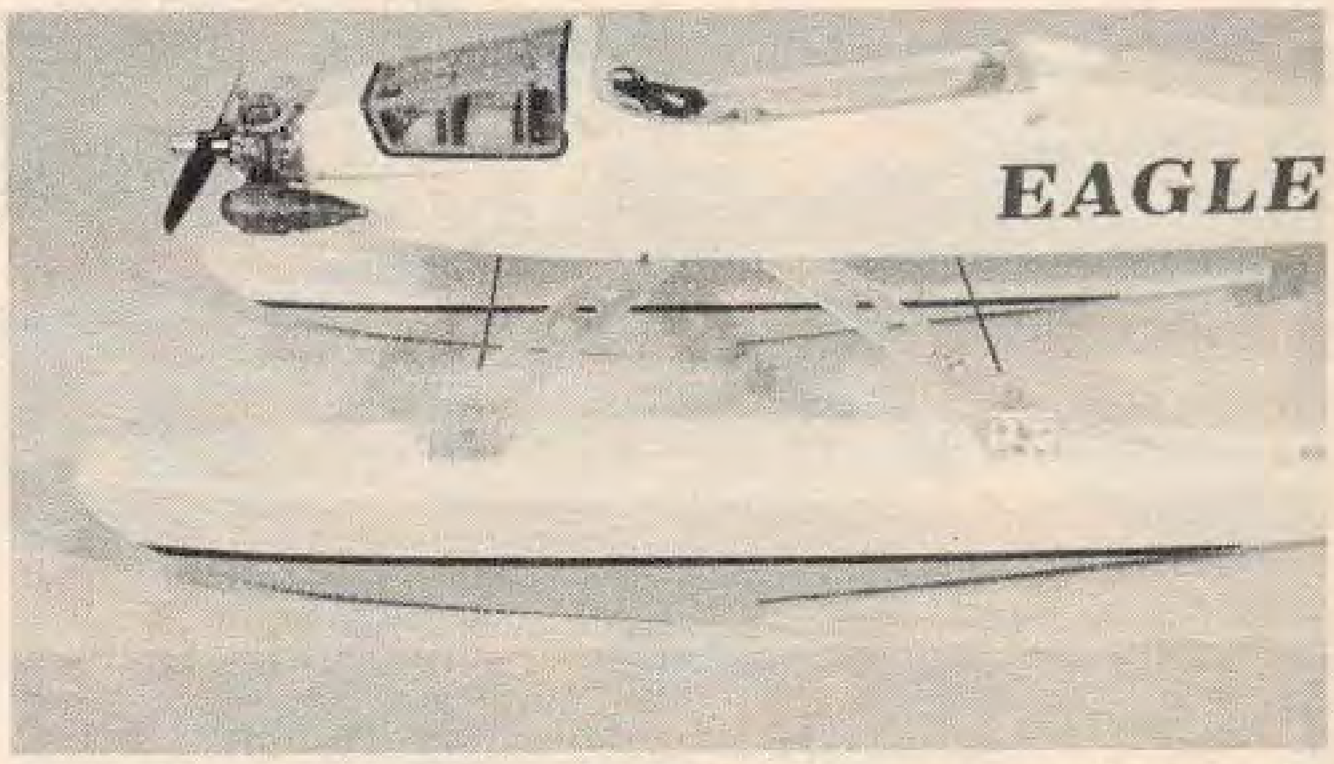


Nose group showing Wankle, throttle exit and tank. Silicone saddle seal a must for float flying. Use four No. 64 bands each side for wing hold-down.

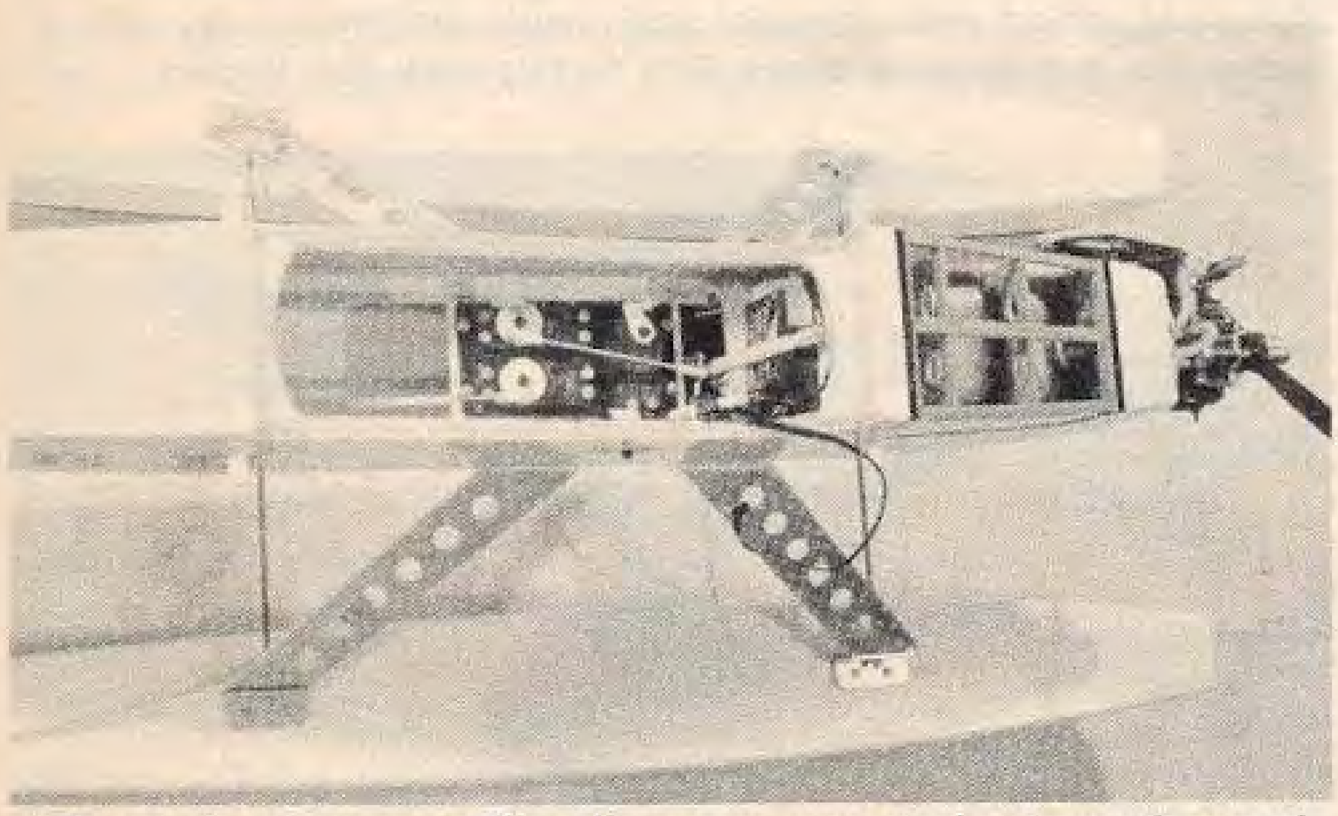


Fuel tank access is from bottom. Foam wedge at left holds tank against formers. Felt tape isolation is adequate for low vibration Wankle.

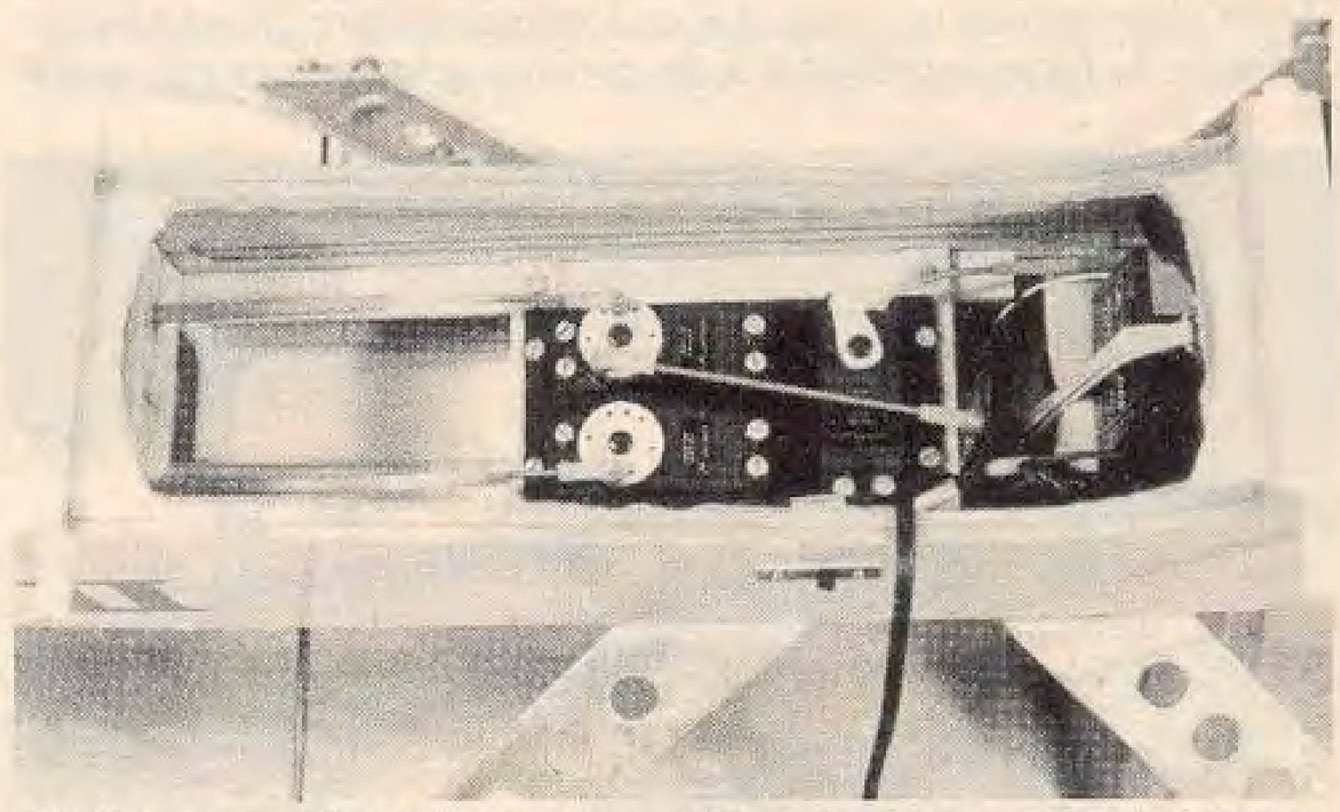




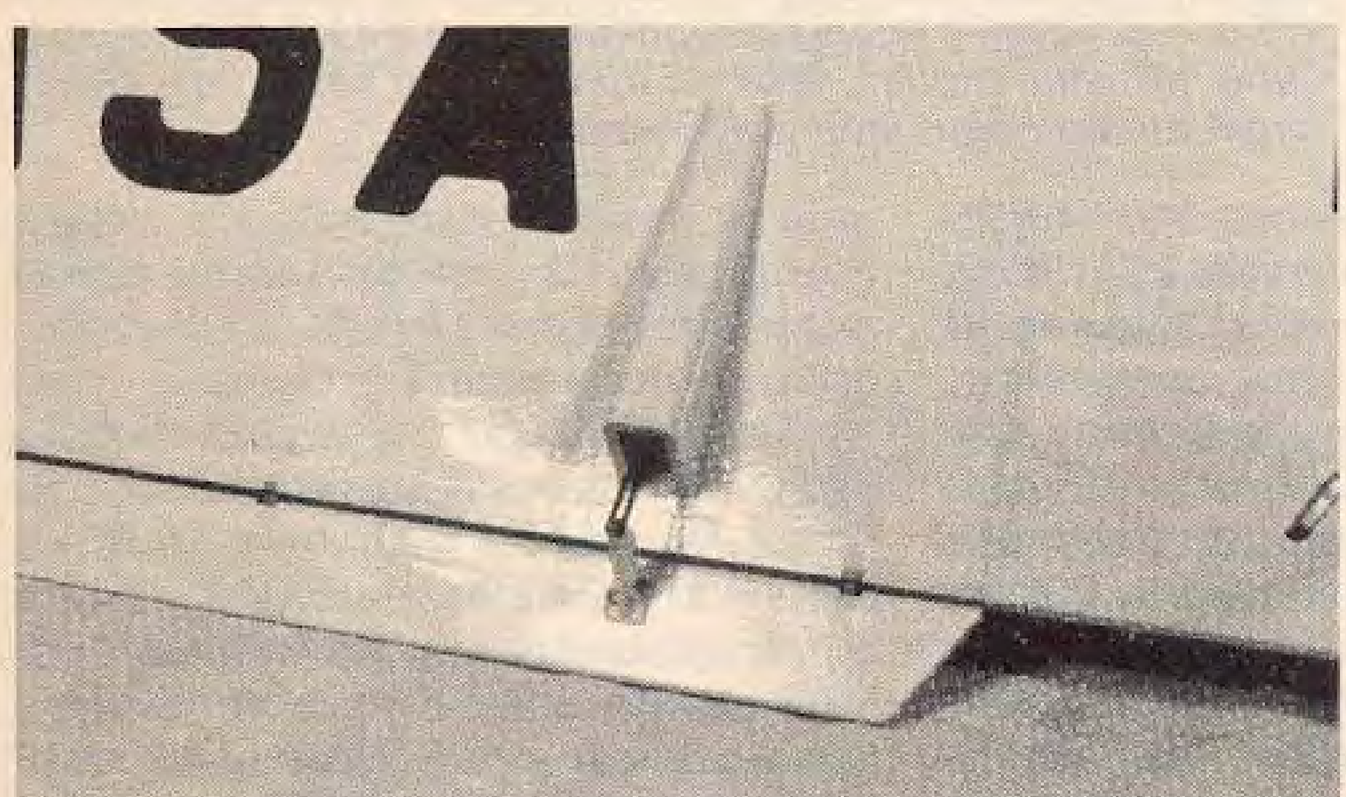
Fuselage side views show recommended orientation for mounting Wankle. Note that muffler and on/off switch are opposite from the norm. Clean lines of Eagle II along with zero dihedral wing make for simple and fast building. Use the time saved to make the floats.



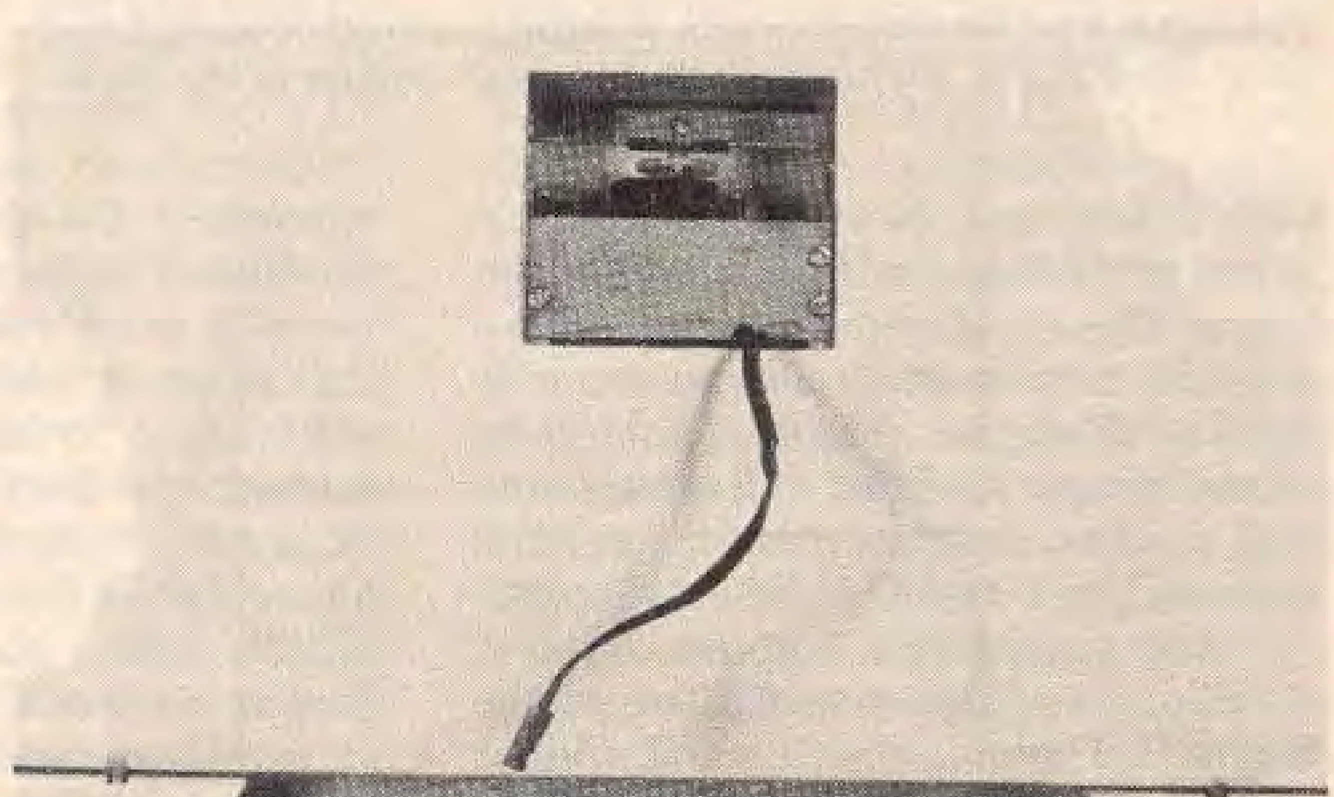
"The chain of command" radio group mounted extreme forward. Build the tail light. Plane balanced without lead. Note bulkhead gussets fore and aft.



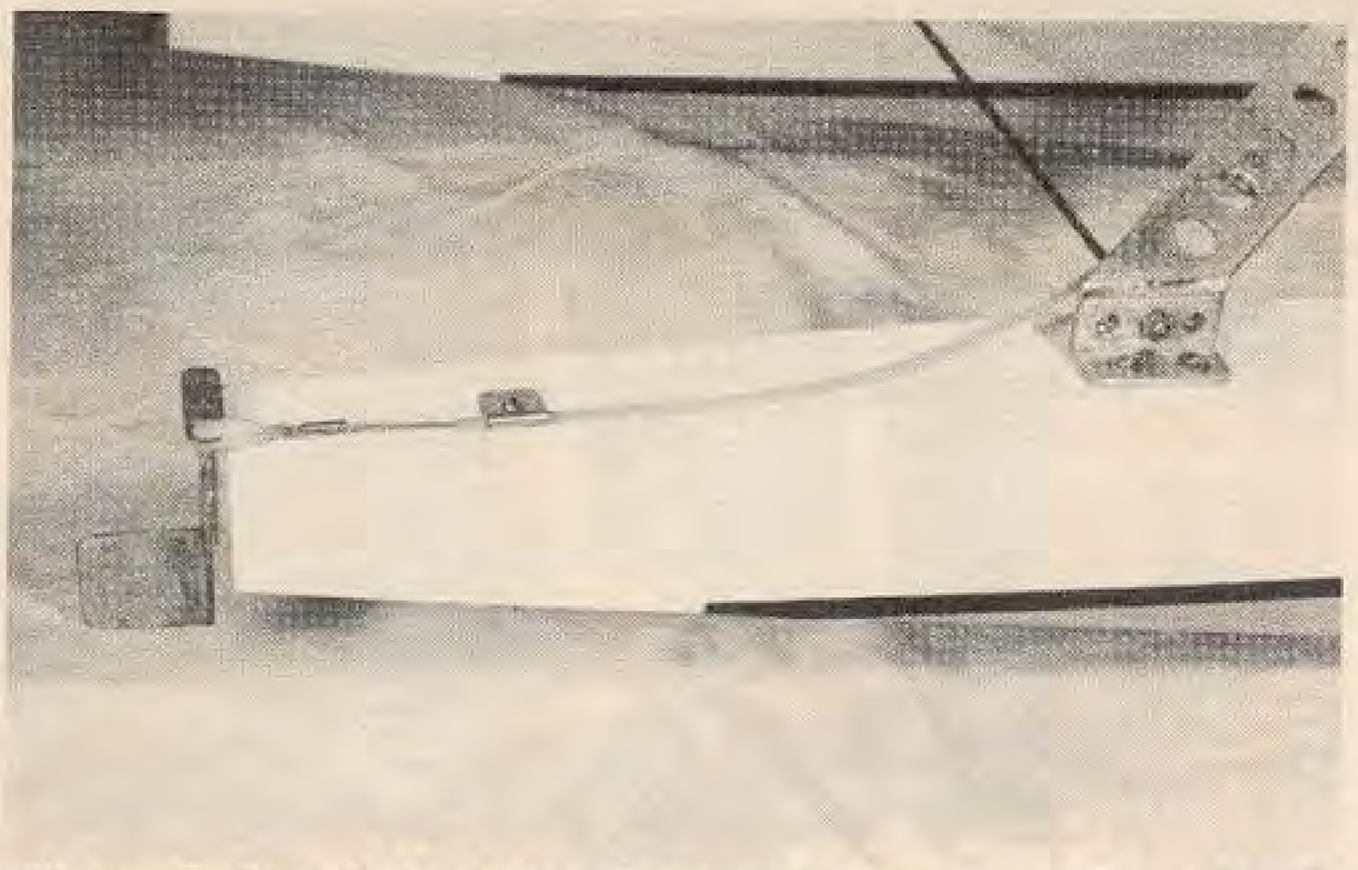
Radio compartment close-up. Airtronics' gear. Note receiver hold-down at front bulkhead. Antenna routes through straw tube on fuse floor and exits at tail group. Note water rudder tiller.



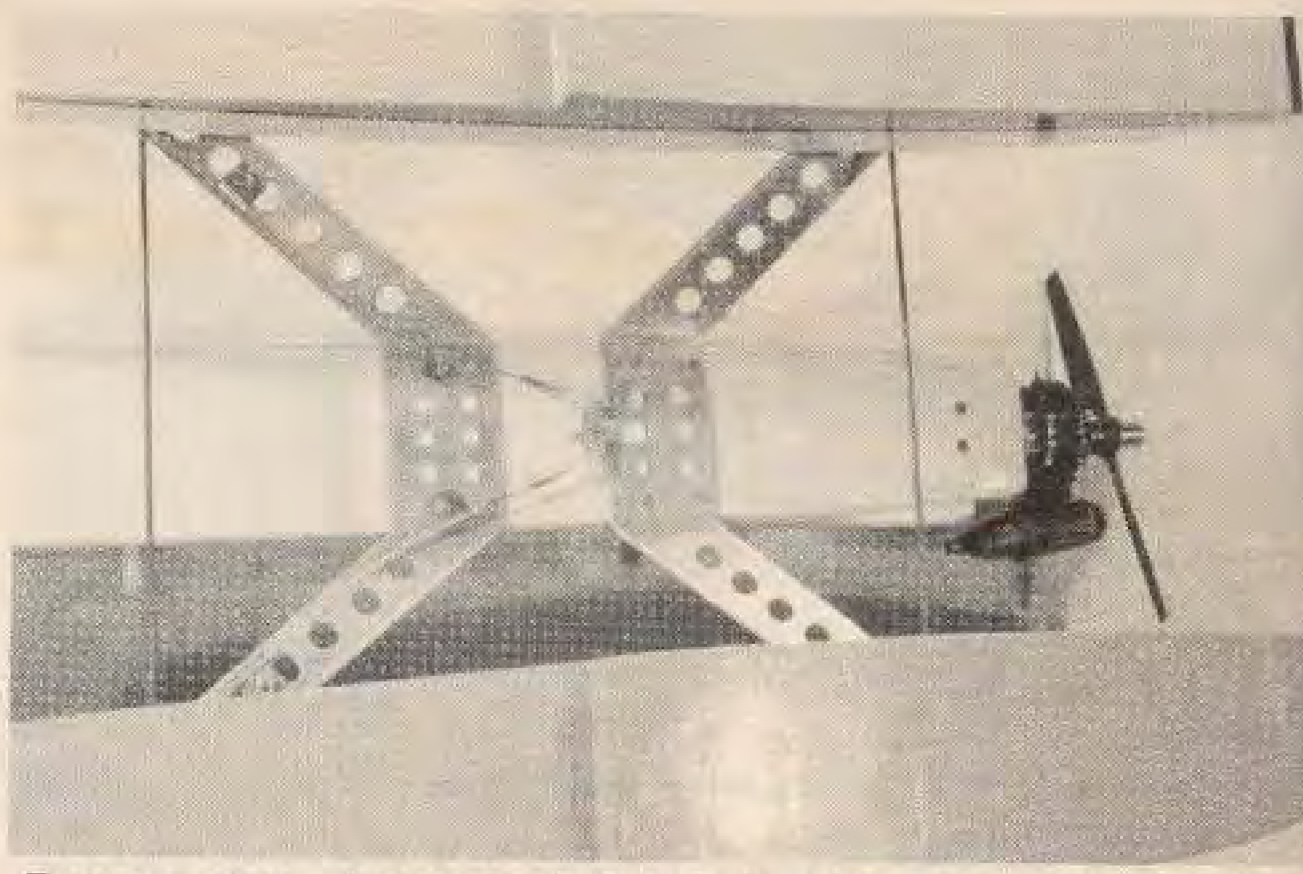
Close-up of aileron pushrod housing. Use metal clevis at aileron for ease of adjustment, and bind nylon clevis inside for non-rotation at bellcrank.



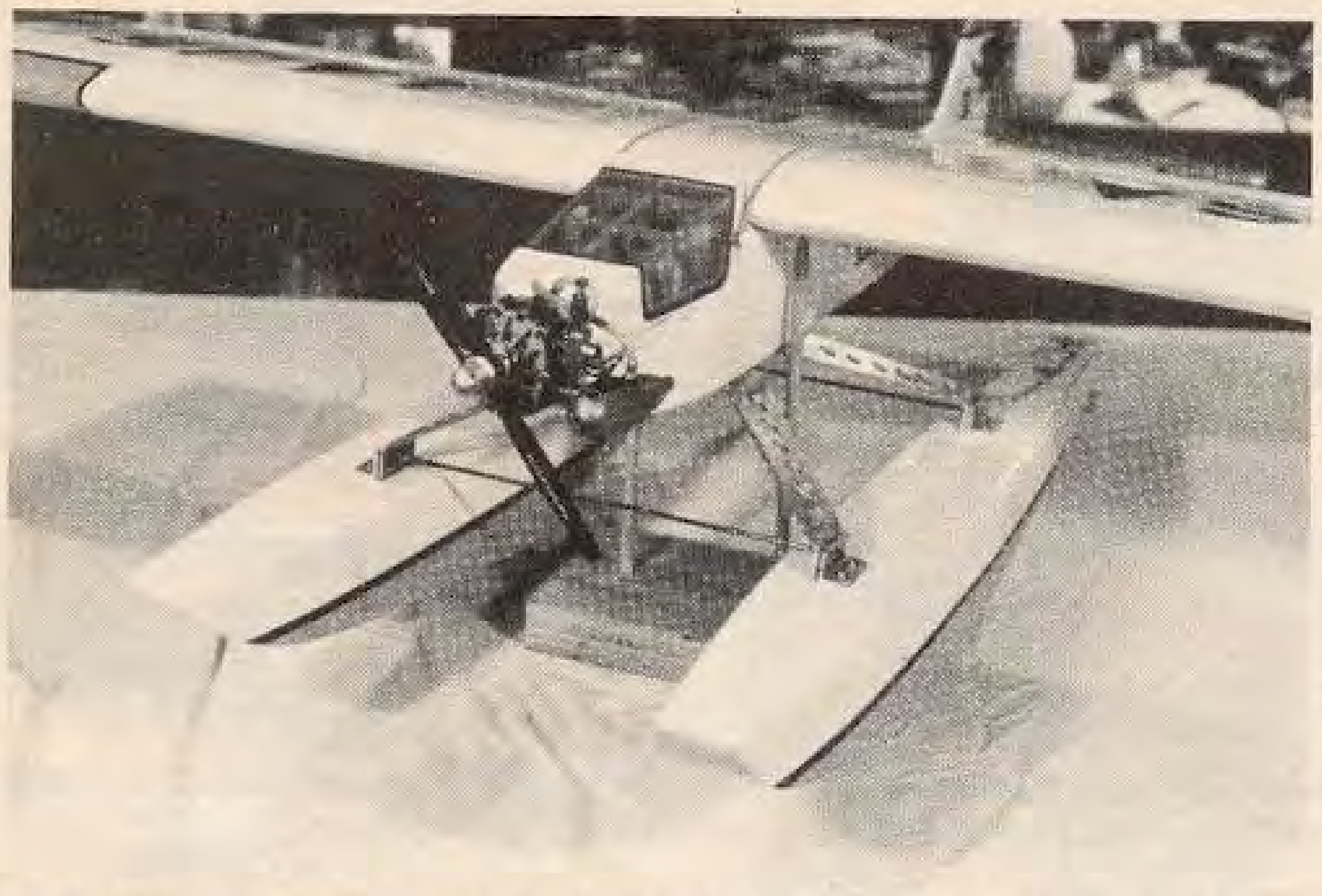
Aileron servo mounts inside wing. No damage in event of severe shift. Aileron rods mount to single post. No differential required.



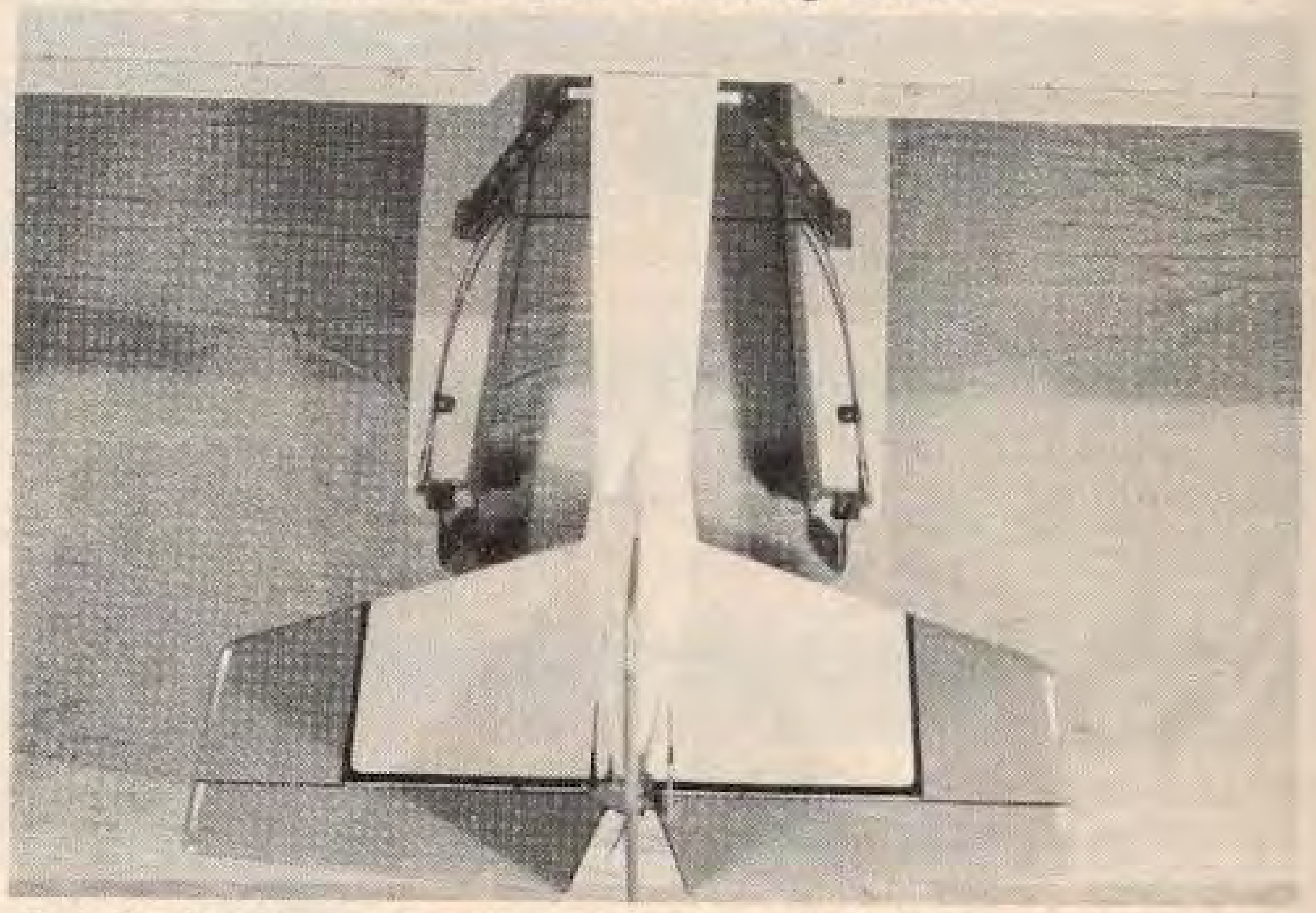
Water rudder linkage is simple and very positive. Stock 1/8" x 3/4" aluminum angle used for float mount. Sullivan gold cable used.



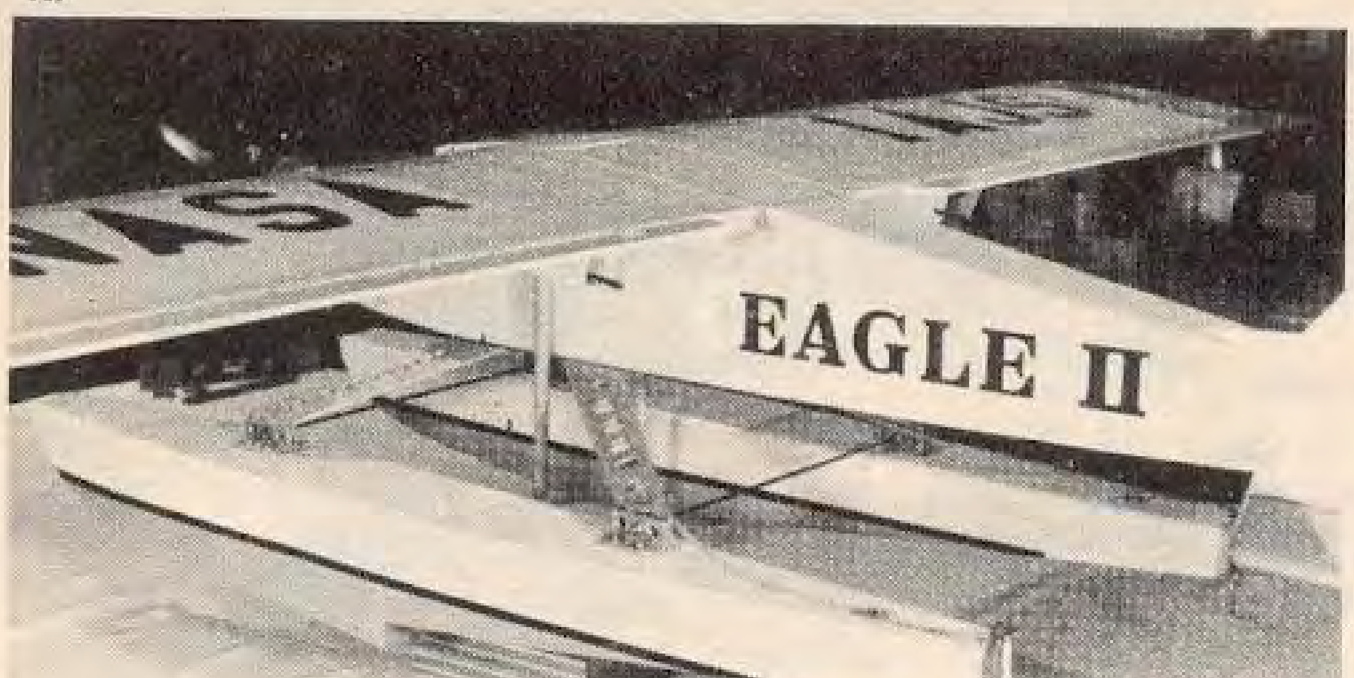
Bottom view shows tank hatch in place and water rudder connection. "S" bend in cable reduces slop to a minimum. Two cable hold-downs share gear mounting screws.



Front view on balance rods. A shoulder mount zero dihedral wing appears to have anhedral. Looks good — goes where you point it.



Relatively short rear moment and ample tail group give lots of authority, but smooth. Make first flights with low throws.



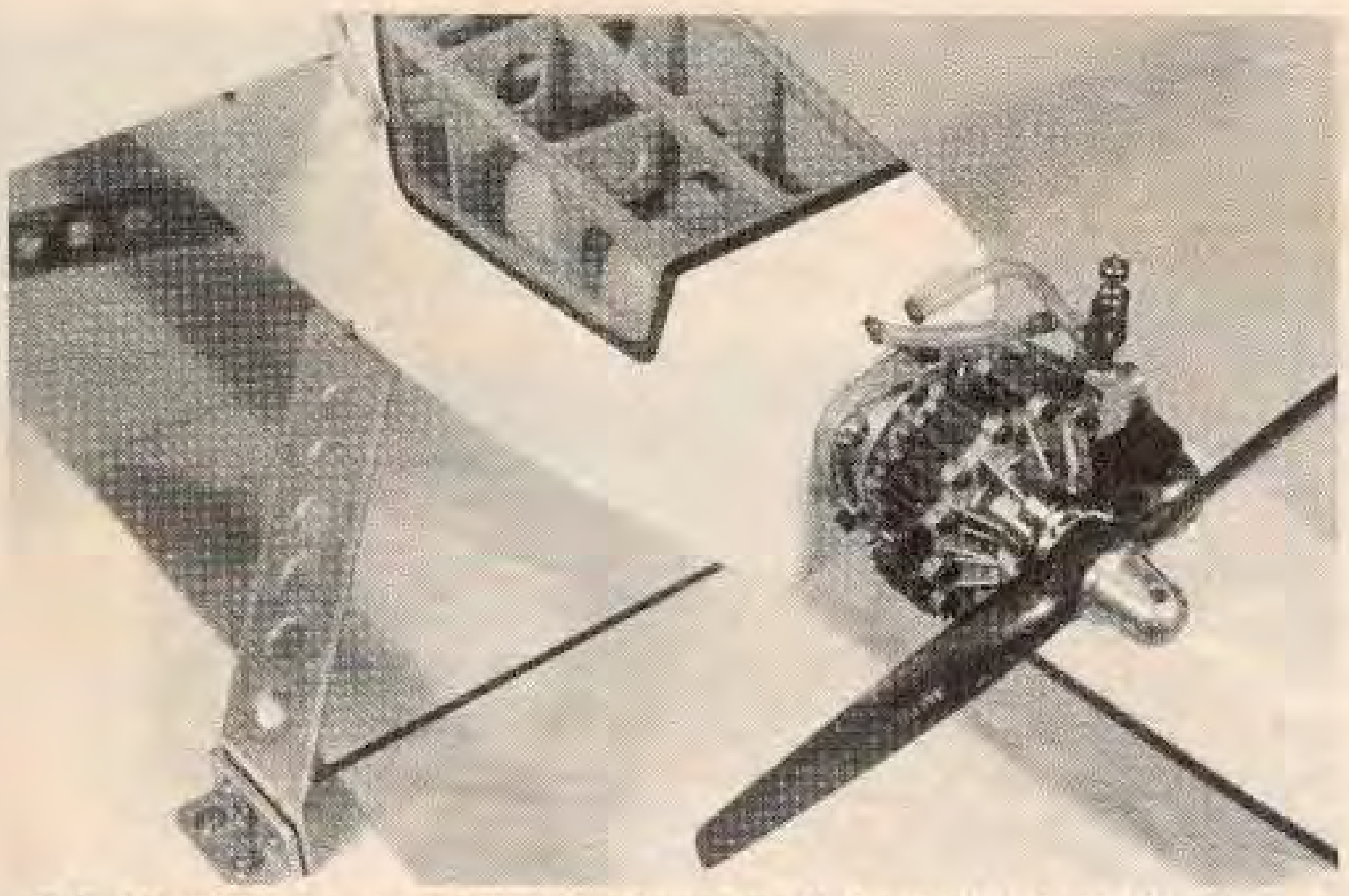
The Eagle II on the balance rods. Aileron pushrod housings keep wing interior dry. Lightning holes in gear whistle in the wind.

Tail group Eagle II template requires sharp #11 X-Acto blade. Spray tail with Windex, float on trim, slice at hinge line. Don't forget to seal edges with polyurethane.

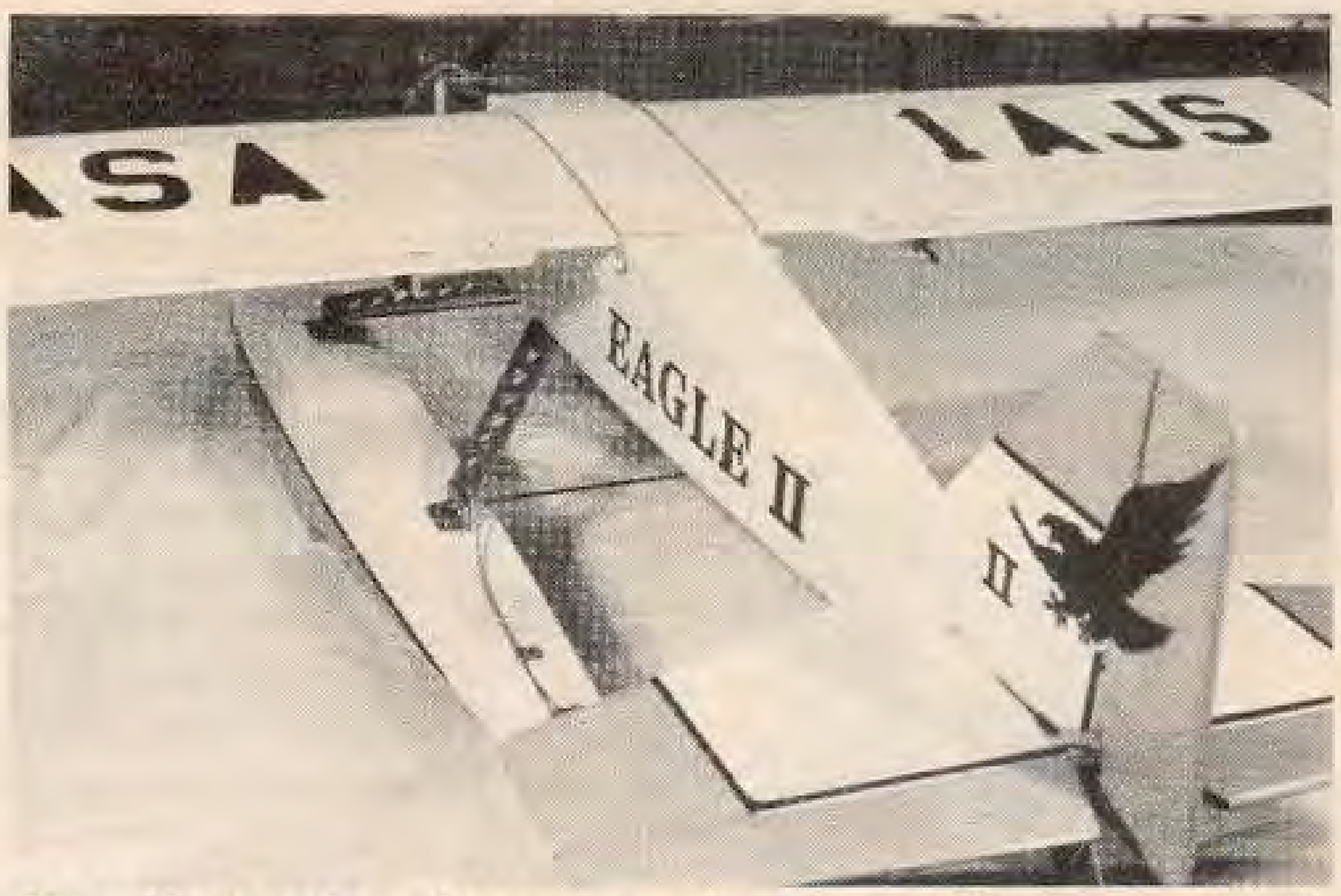
rich. I next put the vent line over a pressure fitting we had installed on the muffler. Again, the engine ran rich. In retrospect, we have come to realize that the Wankle is, among other things, a highly efficient pump and doesn't need a pressurized fuel system. I just wish O.S. had told me so.

I won't give you a blow by blow description of the construction of the Eagle II. The plane is easy to build for anyone who has constructed a few kits and perhaps gotten into a little modification of same. We feel the success of the plane can be directly attributed to its relatively light wing loading. Wood selection and lightening holes are important, especially on an aircraft with the added burden of floats. At the beginning of every project, I buy two balsa planks from Balsa USA. It costs a little extra, but I specify that both planks have a 'C' grain & one plank is medium weight & the other, light weight. I use the medium weight plank for all the internal framing, bracing, ribs, etc., and the lightweight plank for sheeting. This method, coupled with the exclusive use of cyanoacrylates, gives me a light, strong airframe every time.

The choice of an airfoil for the Eagle II was adventurous to say the least. We started with the top half of a NACA 2412 (which is a semi-symmetrical airfoil) and flipped the profile upside down to create a symmetrical airfoil. We then flattened the rear underside to facilitate ease of building and changed the profile in general to match the set of French

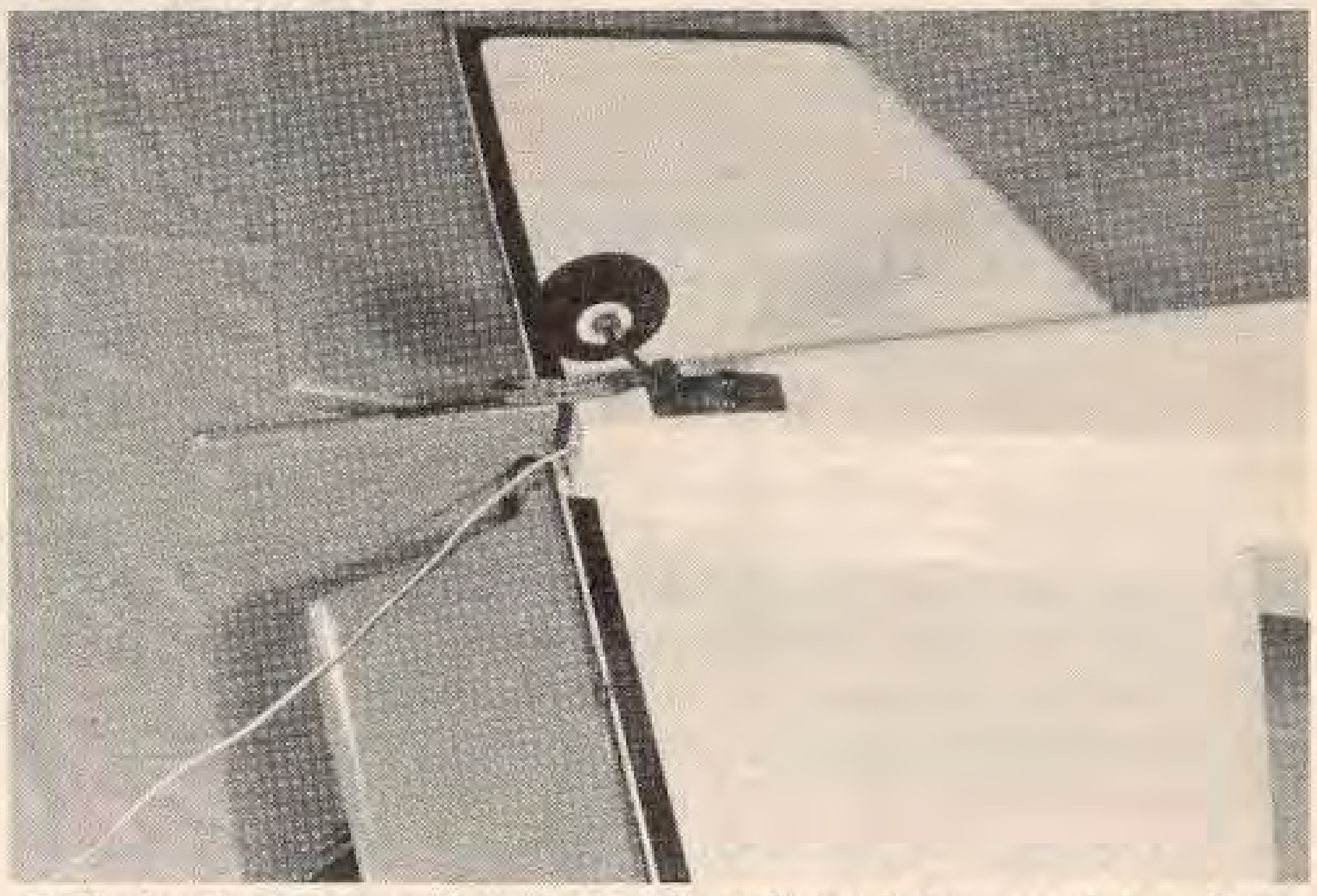


O.S. Wankle comes with aluminum radial mount. 1½° aluminum wedge gives needed right thrust. Note music wire spreader and soldered nut keepers on float gear.



MonoKote color changes occur over solid areas except numerals and letters. Grey and white used. How about silver and black with white trim?

Goldberg control horn and Robart steel pin hinges used. Dorsal fins add nice touch to the tail group. Black MonoKote trim used.



Tail wheel may never be used --- float flying is too much fun. Note antenna exit and rudder to wheel shock connection.

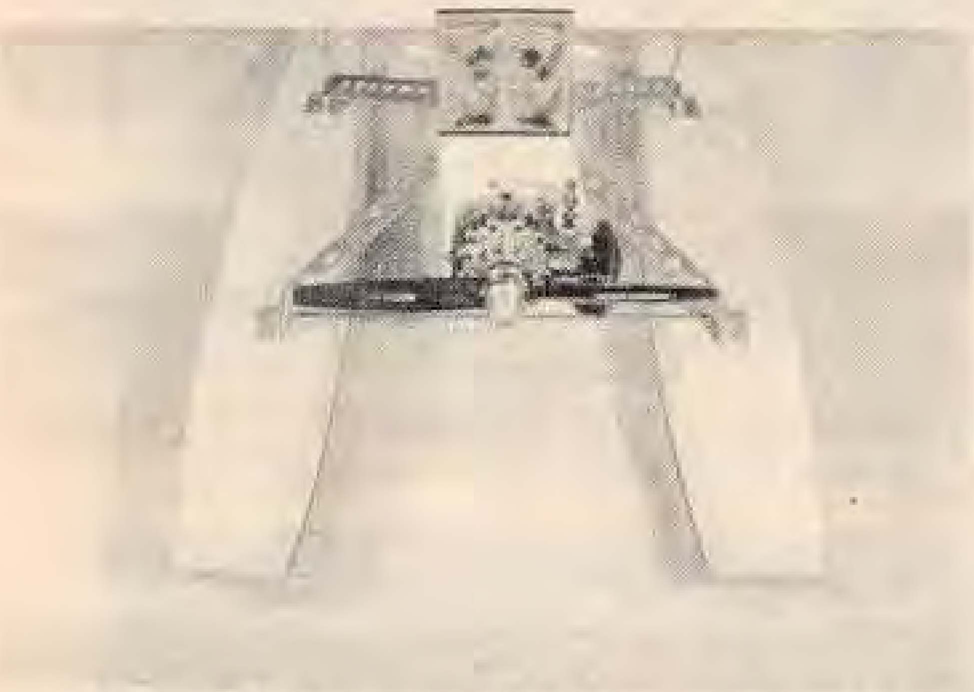
curves we have. This is a step up from the "Florsheim shoe" approach. The resulting airfoil has a 17% chord thickness, penetrates very well, and performs beautifully throughout the entire speed range of the plane. I've seen many models with thinner sections that lumber through the sky while the engine screams out of proportion to the speed at which the plane is traveling. I would have to admit that the performance of the Eagle II owes much to our good luck, but, nonetheless, the results have been very gratifying.

The wing is of standard "D" tube construction and has no dihedral. We pinned the trailing edge to the building board and then added the spars, leading edge, shear webbing, plywood braces, top sheeting, and capstrips in that order. At this point the wing is rigid enough to remove from the building board and add the bottom sheeting, capstrips, ailerons, servo tray and wing tips. You will notice that we used redwood for the main spars. Spruce or hard balsa could be substituted, but we have built three planes as of this writing with redwood spars and the material has served us admirably. It's light, stiff, accepts cyanoacrylates happily, and is inexpensive. The wing is completed by installing the aileron hardware and the aileron pushrod housings on the bottom. The housings prevent water from getting inside the wing on high speed runs and landings.

The empennage is built by first pinning soft balsa sheeting over the plans. Be sure to draw extension lines off the perimeter of the components so you know where to place the internal framing. The framing is then glued to the bottom sheeting, the hinges are let in, and the top sheeting glued down to complete the sandwich. The lightening holes are marked and are cut with a fresh #11 blade after the stab and fin are removed from the board. The resulting empennage is light, strong, and will not warp.

The fuselage is a straightforward four sided affair. The sides are 1/8" light ply forward of the wing trailing edge station and 1/16" light balsa sheeting over stick framing aft of that point. I made up the two sides complete with servo rails and bulkhead station lines, cut out the bottom plywood sheeting, gear doublers, etc., and then assembled the parts over a sheet of paper with a centerline down the middle for alignment. The aft and forward sections of the fuselage are then drawn together over the centerline, the appropriate bracing and forward bulkheads fitted in place and then glued. I prefer to install the empennage and top sheeting to the fuselage while it's on the building board as checking for alignment is easy at this point. I also prefer cutting the lightening holes in the plywood fuselage sides before assembly, but, as with the empennage, I cut the holes in the balsa sheeting after the assembly is complete. At this point the fuselage is removed from the building board and the bottom sheeting and forward bottom hatch are constructed to complete the assembly. Vibration from the Wankle is negligible, and the 6 ounce tank is held in place with foam strips glued to the hatch cover.

The wing, empennage and engine horizontal thrust lines are all set at 0-0. After flying the Eagle II, we found it necessary to add 1½° right thrust to the engine to counteract torque, and the plane now flies without trim compensation. One final note on the fuselage: My intentions were to fly the Eagle II as a taildragger in a land plane configuration and, with this in mind, added the tail wheel which you see in the pictures. However, after



"All dolled up and rarin' to go!" Bench fly till 10 p.m., get a good nights rest and fly in the morning. Planes on floats add a whole new dimension to R/C.

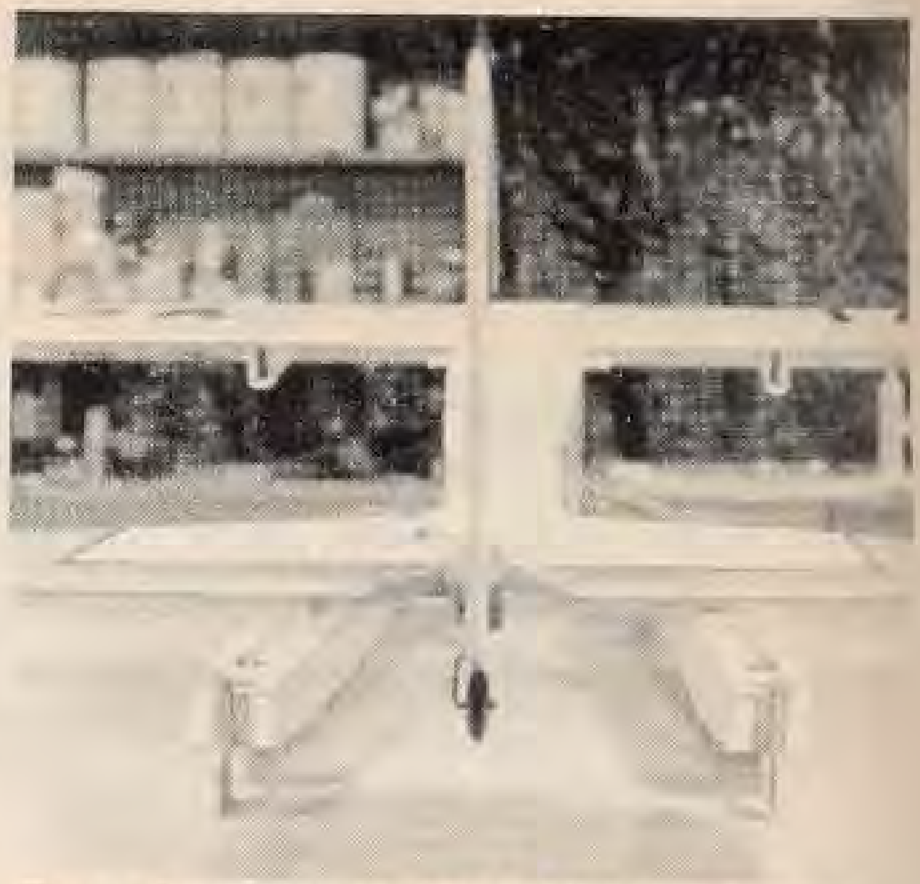
first flying the plane on floats, I've decided that the substitution of wheels would be an aesthetic disservice. If you do decide to fly the Eagle II as a land plane, I have indicated a suggested landing gear position on the plans.

Our club, "The Napa Valley Miniature Aircraft Society," has accumulated a considerable amount of float plane experience despite its small size. The floats for the Eagle II are a product of that experience along with much input from Chuck Cunningham, Gordon Whitehead, Ken Willard and others. The floats are built upside down beginning with a 1/8" light ply top. The tips, bulkheads, longerons, stiffeners and screwblocks are then added and the bottoms are sheeted. I used 3/32" balsa spanwise for the first bottom layer and the same thickness lengthwise for the second. The floats are then removed from the board, the side framing sanded fair, and the lengthwise 3/32" balsa sheeting applied. The floats are then sealed with Balsarite and MonoKoted. The bottoms are lightly sanded and painted with two coats of clear polyurethane as are all the top seams.

This type of construction and finish is not the most durable available to the application (fiberglass comes to mind) but we have three sets of this type of floats in the club which have endured two years of occasional hard landings and runs up on the beach at speed. If we punch a hole in them, we patch and fly again. The gear is another matter entirely. Correct alignment and a rigid mounting system are essential to float flying. Hard landings, beachings and ground (water) loops put incredible strains on the gear from an unimaginable variety of directions. Positive and effective rudder control is also important in windy conditions. The Eagle II's gear and rudder system has proven to be a winner on both counts and I recommend them.

I found the aluminum gear fabrication to be a simple and enjoyable new experience when compared to wire and solder. I constructed a wooden jig with alignment lines drawn on it and 3/4" aluminum angle clips were cut and screwed down. I next cut a cardboard pattern for the gear, transferred the pattern to a 1/8" sheet of aluminum and cut the gear out on a bandsaw. The beauty of aluminum is that it can be rebent a few times without fatiguing, unlike piano wire. After the gear could be dropped on the jig and its fit was relaxed, I drilled lightening holes and sanded it smooth. The last operation was to drill through holes in the gear for the 1/8" spreader rods. The rods were then soldered in position with drilled out nuts as keepers, and the gear was removed from the jig and installed on the plane. The floats are at 0-0 to the thrust line and have no toe-in.

The rudder action is positive and smooth and always returns to neutral. In the past we've tried air rudders, air rudder extensions, closed loop cable systems, threaded pushrods off tiller bars, various types of fish line and eyes, etc., to no avail. I'll describe the Eagle II system starting at the rudder servo. I mounted a ball link on the opposite side of the servo wheel. This ball link is connected by threaded rod to an aileron ball link on an "L" shaped tiller rod which exits the bottom of the fuselage through a brass tube. The aileron ball link provides throw adjustment by moving it back and forth along the tiller bar. With the system through the fuselage bottom, I next fabricated three adjustable outside tillers by soldering wheel collars to sheet metal arms and then drilling the appropriately spaced holes. I substituted pan head machine screws for the Allen screws provided with the wheel collars. One of the tillers attaches to the rod under the fuselage and the other two hold the rudder posts captive in brass tubes affixed to the rear of each float. After much trial and error, we've found the Sullivan throttle cable system to be the best. It's the one that utilizes their ribbed, yellow pushrod as a sheath with a gold cable inside and comes in 36" lengths. Each cable run is attached twice to the gear trailing arms and once to the float top in a gentle "S." Done this way the cable action is smooth, slop-free and



Rear view of completed plane. Author's trusty range finder missed with dead center shot --- or maybe trusty author missed dead center shot with range finder.

imposes a negligible load on the rudder servo.

The final touches were applied to the Eagle II. All MonoKote and trim seams were sealed with polyurethane. The Airtronics gear was mounted as close to the leading edge bulkhead as it would comfortably go and the plane was put on the balance rods. I've never had this happen before, but this time the Eagle II balanced perfectly without the addition of a single gram of lead. We're ready to fly.

We couldn't have picked a much worse day for the test. Summer in California, that day, was heavily overcast, cold, with winds over 10 mph and a 4" chop on the lake. I was overjoyed to have Fred for a test pilot. Fred has the distinction of having been involved in modeling since the age of nine. He grew up in Southern California and his hobby shop proprietors were Addie and Tony Nacarato. We should all be so fortunate. O.S. recommends hooking up the glow plug and allowing the combustion chamber to warm before starting on a cold day, and after that short interlude the Wankle fired on the first spin and we put the Eagle II in the water.

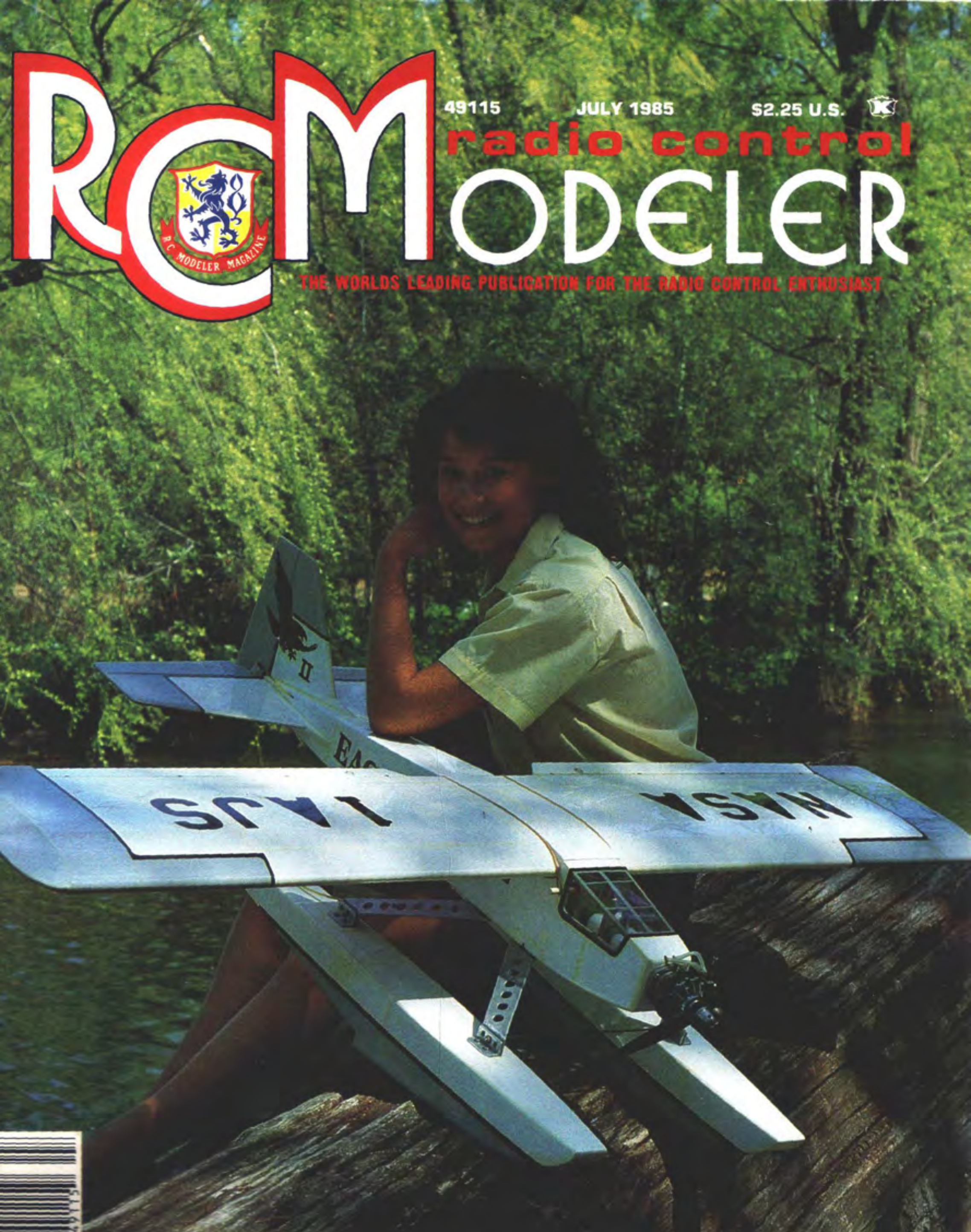
Our intent was to taxi the plane out into position and try a few high speed runs with a short lift-off and landing, but the chop was so high that every time we started a run, the plane would dip, the prop would eat water, and we would have to get in the boat and retrieve. After three attempts, we decided to cut the fancy stuff and go for it. The Wankle was flushed out, started, and the Eagle II was pointed into the wind a foot offshore. Fred gave the Wankle 3/4 throttle and the plane was airborne in 25 feet, hit the tops of two more waves on its trajectory and sped off in a gentle left turn. By the time Fred had flown out 200 feet and returned overhead, he had put in two clicks of right aileron and the Eagle II was flying hands off and rock steady. We confined our experiments to level flight at various throttle settings for the first tankful and found the Eagle II would fly upwind and easily hold altitude at just a touch over idle. Despite its total lack of dihedral, it would self-correct from a gentle turn at low speed and we feel this is a function of the float's pendulum effect. This characteristic disappeared as the throttle was advanced and the plane became a fast, predictable performer.

The first landing was dead stick as we had let the Wankle idle for almost three minutes and it loaded up. The combination of thick airfoil and float gear makes the Eagle II easy to land, and touchdown is only slightly more rigorous than setting the plane in the water with a shove.

The second flight was reserved for aerobatics and Fred flew every maneuver he wanted to. The rolls are not axial because of the floats and they also have a softening effect on other maneuvers which, for me, is a pleasure to behold. Vertical performance is short lived and, if you don't wait too long to feed in the next control, the plane will just fly off on its new heading. At one point, Fred had become so absorbed in the flight that we had to warn him of a fast approaching wall of trees. He simply went vertical, and with full throttle, flew away from the trees inverted. Pretty exciting stuff, but it was the third and final flight of the day that made my heart soar like an Eagle (II?).

It was time for Adam to fly his plane. Here was the culmination of weeks of work that **he** had participated in. He had taken his buddies out to the shop to show them the Wankle on the test stand and he had watched for precious hours with fascination as our pile of balsa, fittings, and MonoKote was transformed into the Northrop 1AJS (Adam Justin Sullivan). He even contributed hands-on to the project by learning to build and solder and MonoKote, and later by tracing and cutting out that beautiful bird on the rudder. So the Wankle was fired up for the third time, Fred got the plane airborne, the old man here tried a few cross wind manuevers and a loop, and then handed the transmitter to Adam.

I can't describe the elation and sense of satisfaction I felt as I watched Adam pilot his plane around the sky. He's a great kid, talented and easy to love, and I'm sure that in our lives there will be many rewarding times. But for now the pleasure of watching him circling the lake carefully and then tightening his turns and adding more elevator and then wagging the wings as he flew overhead before handing the transmitter to Fred, is enough for me. That's what this hobby is all about: passing it on to others. □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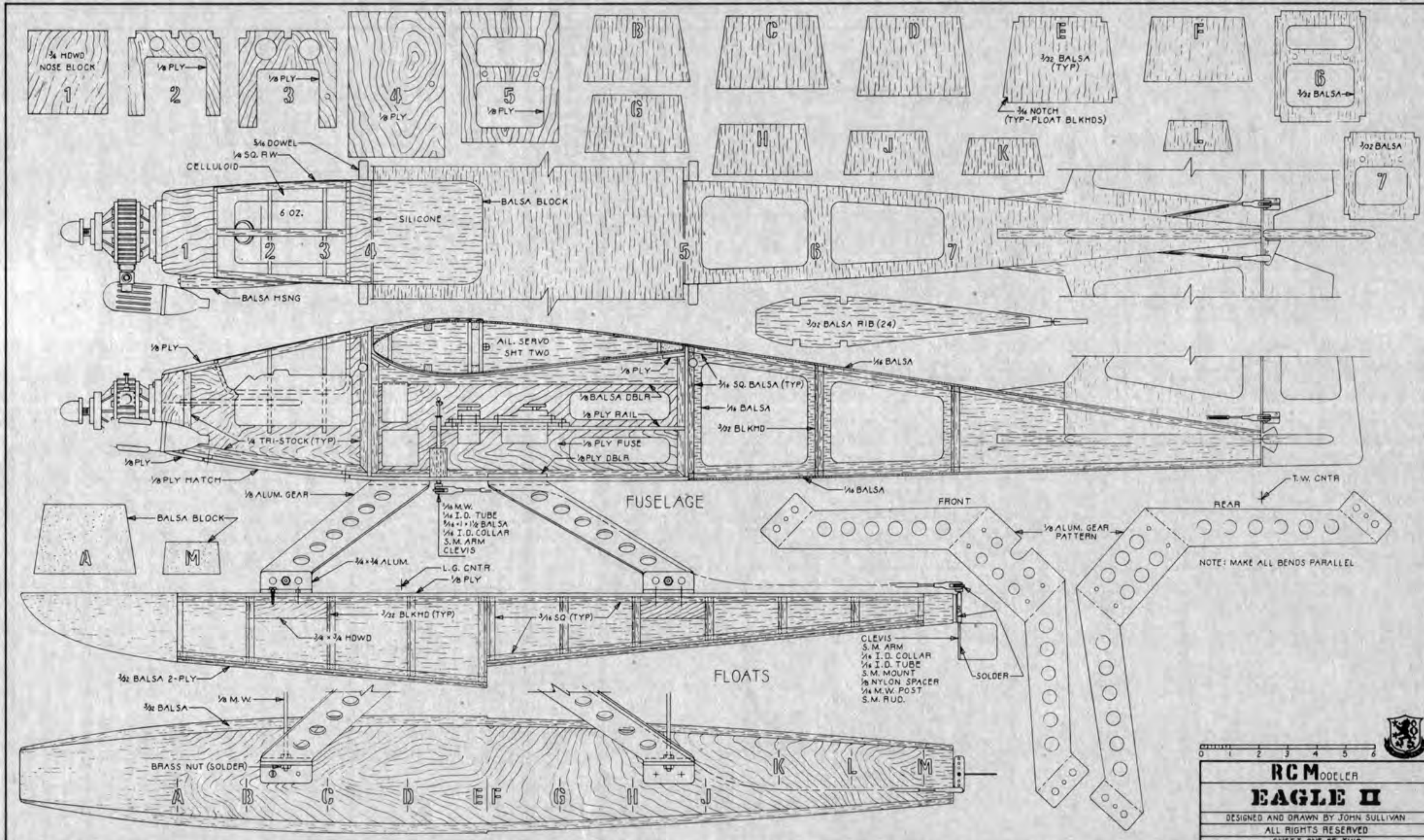

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