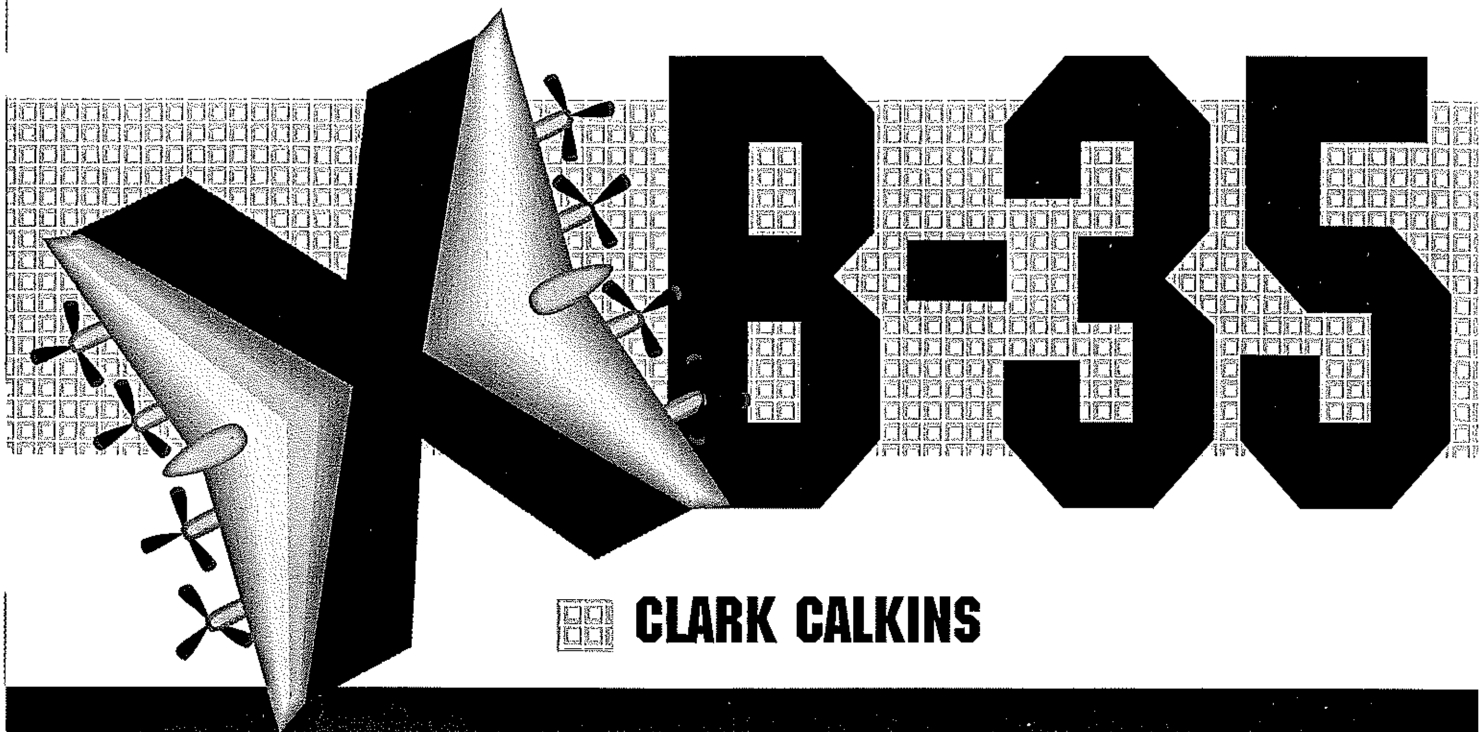
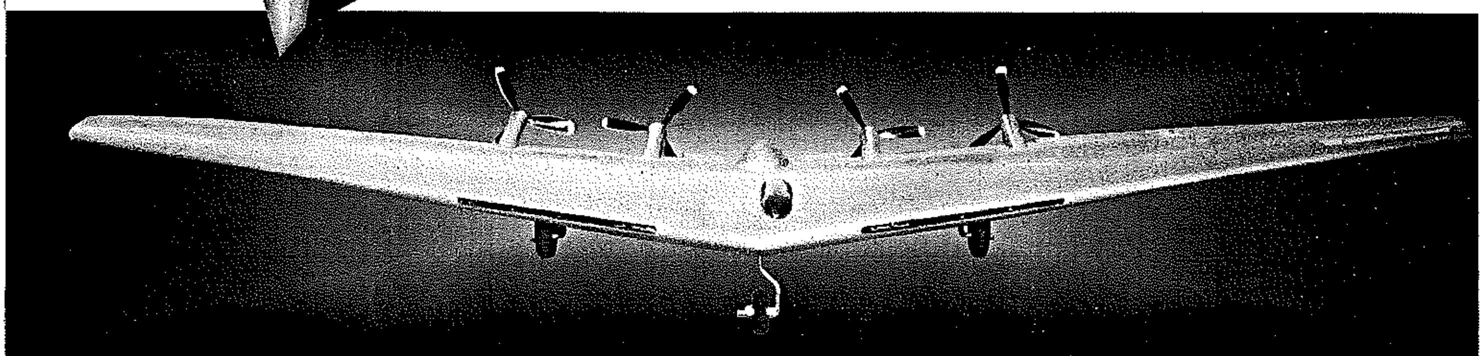
#814



XB-35

CLARK CALKINS

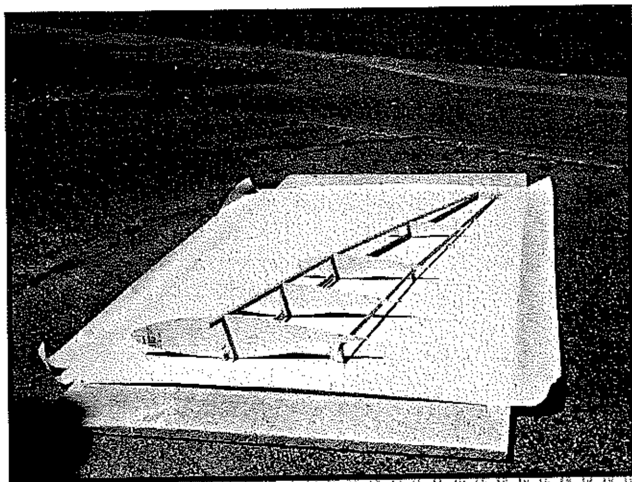


Flying-wing aircraft have fascinated me for a long time. When I was quite young I recall seeing a large flying-wing bomber on a TV news program. They were probably covering the cancellation of the Northrop XB-35/YB-49 project. This brief glimpse of such a graceful aircraft has stayed with me for more than 40 years.

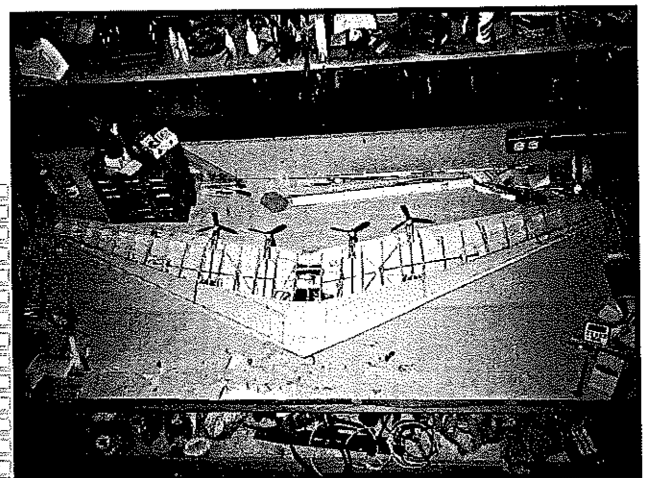
As a youngster I played with the usual assortment of airplanes: gliders, control-line airplanes, and simple RC models. Fond memories persist of my father and I walking into Tony and Addie Naccarato's Hobby Lobby in Burbank, California, and coming out with some kits and single-channel RC gear—for about $100. "Don't tell Mom how much we spent," I still recall my father saying. I enjoyed the hobby very much, even though my flying success was quite limited. The pursuit of education and earning a living stepped in and took me away from the hobby.

One day a few years ago I ran into a copy of the book *The Flying Wings of Northrop* in a used bookstore. Here were the details of the Northrop XB-35 (propeller) and YB-49 (jet) flying-wing bombers that I remembered. I was fascinated once again.

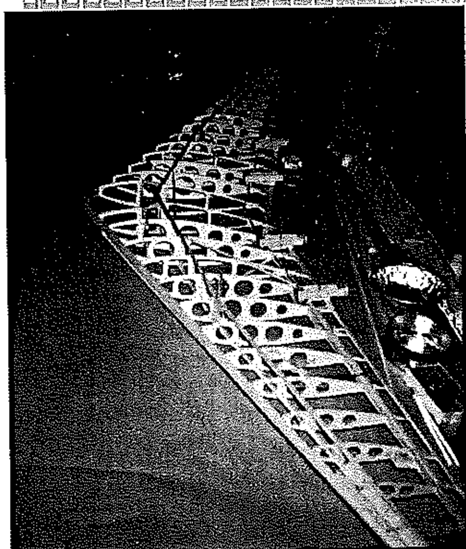
From the photographs and cutaway drawings in the book I sketched up some approximate dimensions, and toyed with the idea of building a model. Maybe even one that would fly! Looking through some current model airplane magazines, I



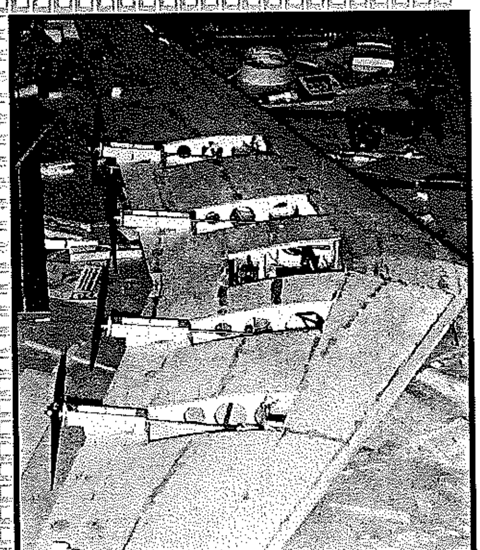
Ribs are trial-fit on spar jig before being trimmed to match leading and trailing edges. Lightening holes will be added.



With all of the bottom and part of the top sheeting in place, final checks are made before the "guts" are covered up.

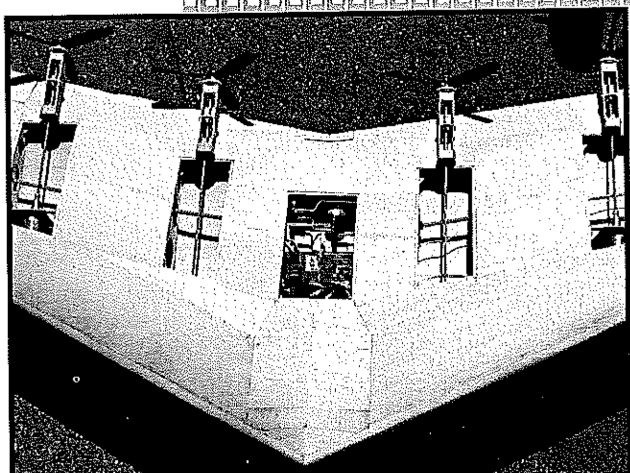


Internal structure of the XB-35. Light weight is paramount. Most strength will come from the top and bottom sheeting.

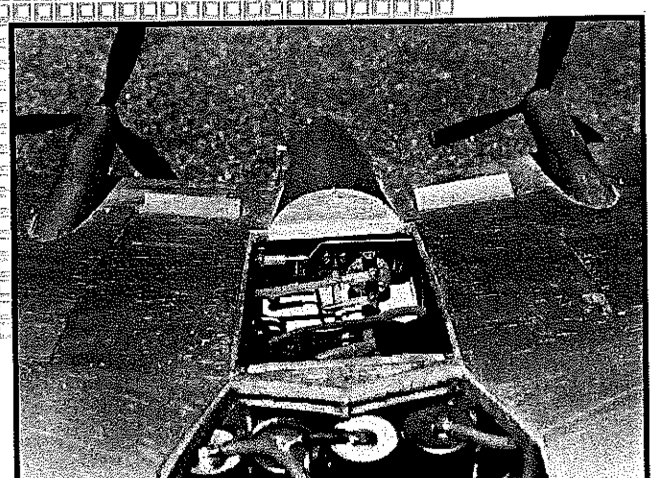


Top sheeting has been completed. Access is limited, but motors are mounted such that they can be removed for servicing.

Photos by the author. Graphic Design by Carla Kunz



The 46-ounce XB-35 is powered by four Silver Streak Electric motors, turning Cox 5 x 3.5 three-blade pusher props.



Servo installation. Rightmost servo has mixer attached. Upper link on left servo goes to steering bellcrank. Note vents.

was amazed at how advanced and affordable RC equipment had become.

I continued to look for literature on flying wings in general, and the XB-35 in particular. At times I felt that I was the only one who remembered these airplanes. With persistence I uncovered several excellent publications and was able to determine the basic geometry of the airplane, and make good estimates of some of the less-obvious parameters.

I determined that a 1/32-scale model would be the smallest practical size that would still have good flying characteristics. It could be powered with Electric motors, which I felt would be easier to control than gas engines. Batteries would provide three to five minutes of flight. Power for takeoffs would be adequate, if not outstanding.

I tried various motors, propellers, and batteries before deciding how to proceed. The design that I settled on included standard balsa-and-Lite Ply construction; four Silver Streak motors (from Peck-Polymers) turning Cox 5 x 3.5 three-blade pusher propellers; a Futaba four-channel radio system (with speed control and small servos); and a Du-Bro V-tail mixer.

The motors would be wired in parallel, and high-efficiency wire with Sermos connectors would be used. A six- or seven-cell 1,500-mAh battery pack would power everything. With a wingspan of slightly more than five feet, I set a target weight of 40 ounces and hoped to come in under this. I was slightly optimistic; final flying weight was 46 ounces.

CONSTRUCTION

The wing is built as two halves joined in the middle. The balsa sheeting is applied after the halves are joined and the motor mounts and propeller-shaft support structures are in place. This allows easy access during the alignment phase.

Because of the model's symmetrical airfoil, a jig is required to build the wing structure, as it cannot lie flat on the workbench. While each half of the wing is flat from root to tip, the main spar has an inflection at rib 7 which requires some extra care.

The spar support elevations for a flat work surface are shown in the table below. The elevation of the main spar at rib 7 compensates for the inflection.

The main spar is a "T" structure on the top and bottom surfaces of the wing. The center portion is made from 1/4 x 3/32 balsa; the outer portion is made from 1/4 x 1/16. Be sure that the spars are straight and flat. Pin one piece to the work surface, using a straightedge as a guide. The vertical piece is then centered and cyanoacrylate (CyA) glue is used to hold it in place, forming a T-shaped cross-section. Attach these spars to the work surface over the plans, supported at the elevations shown. Supports at several intermediate points will also help.

Spar Support Elevations

Location	Root	Rib 7	Tip
Main Spar	0.0	0.125	0.0
Rear Spar	1.125	0.75	0.1875

Cut all of the ribs from sheet balsa. For consistency, put the pattern on the *inboard* surface. It is worthwhile to mark "top," "bottom," "left," and "right" on the pieces to prevent confusion; they are almost—*but not quite*—symmetrical.

Cut the main spar notches first, then place the ribs in the jig to locate the rear spar location. Because of the

XB-35

Type: RC Sport
Wingspan: 64½ inches
Power: Four Silver Streak Electric motors
Battery: Seven-cell 1,500 mAh pack
Functions: Elevons, speed control
Flying Weight: 46 ounces
Construction: Built-up balsa and plywood
Covering: Balsa sheet

angles involved, it would be difficult to cut everything at once and maintain alignment. With the spar notches in place, remove the ribs from the form and trim off portions for the leading and trailing edges and cut the lightening holes.

Attach the ribs to the bottom spars. The ribs need to be inclined 3° off vertical to compensate for the dihedral angle of the bottom surface. Use a doubler at rib 7 to add strength where the inflection joint appears in the main spar. When all of the ribs are in place, the top spars can be added.

With the ribs attached to the spars, the leading and trailing edges can be added. The leading edge is made from 1/4 x 3/4 balsa. Trial-fit the pieces to make sure that all of the ribs make firm contact. Holding the piece in place, mark the top and bottom points where it contacts each rib. Remove the stock and draw a line from root to top at the contact points and use this as a guide to trim the excess material before it is glued in place.

The leading edge has a large slot to allow cooling air to reach the motors, batteries, and speed control. Cut this slot before the leading edge is attached. After it is glued in place, carefully trim the material. Remember that the structure is fairly fragile before it is covered.

The elevons are built from balsa in a similar procedure, using leftover pieces from the ribs. Use 1/16 plywood for the control horn. Line them up with the main wing and locate the hinge points. Glue the hinges to the elevons first (I used pin-point hinges from Carl Goldberg Models, but almost any available hinge would work just as well).

Cover the elevons with 1/32 balsa. Sand them to shape. Now the elevon hinges can be attached to the main wing (use thick CyA or epoxy; thin CyA can wick into the hinge joint). Elevon throw should be ±15°.

The wing slots are added next. I could not find any details on these, so I used straight pieces of 1/32 balsa sheet. These are glued between the ribs. These are included more for appearance than function. The full-scale XB-35 used these on takeoff and landings only. They were closed during normal flight. I do not know if they would even be effective on a model this size.

The motor mounts and propeller-shaft housings are built up from 1⁄16 plywood. I used ball bearings with custom propeller adapters as the final shaft supports, but plywood or nylon bearings would also work.

The motor mounts are constructed so the motors can be removed for servicing. Align the components as best you can *before* gluing them in place. Misalignment can cause excessive vibration, leading to a lack of power and eventual fatigue failures. Spend a little extra time here. The balsa webbing between the bottom of the propeller shaft supports and the trailing edge is used to absorb normal vibrations and is very important. Do not test-run the motors without this support in place.

The next step is to join the two wing halves. The main strength here is provided by a 1⁄16-plywood bulkhead at the main spar. Balsa blocks on the top and bottom are used to fill the gaps between the bulkhead and spars.

Verify the dihedral before gluing everything in place. Use slow-curing epoxy so you can adjust the components if necessary before the adhesive sets. The two leading edges are secured with a 1⁄8-plywood strengthener. The 1⁄16-plywood rear bulkhead also holds the servos. Check that the servos fit properly, and that the mixer works before gluing things in place. Now you can install the elevon controls and cables. Secure the cables to the ribs to reduce any "slop" and improve control.

Attach the main landing-gear support blocks. The steerable nose wheel support is made from 3⁄16 plywood with a 1⁄16 hole drilled through it. The control cable for this also needs to be supported in several places to improve ground handling.

To cover the model, build a simple jig to hold it firmly in the center and at the wingtips. Note that each wing has 5° of washout (from the front, the wingtips point down slightly) that must be built in before the covering is added. This is very important for good flight characteristics. Make sure that the correct amount of washout is present; once covered, it cannot be changed.

The covering material is 1/32 balsa sheet. Start with the leading edge; cover from the midpoint of the main spar forward to the leading edge. Use thin CyA to hold this in place. Use extra-wide pieces of balsa to cover the aft portion of the wing (you can glue two or three four-inch-wide pieces together with thin CyA). Note the access hatches which enable you to service the motors, bellcranks, etc. Do not cover these areas.

Before both sides are covered, install a dummy antenna wire. This will enable you to pull the actual antenna through when the receiver is installed. Some may find it easier to install and wire the motors before the wing is fully covered, although this can also be done afterward.

Once the covering is in place, remove the airplane from the jig—it should be very torsionally stiff. Be careful; you can easily poke a finger through the thin covering material. Cut two air-exhaust hatches in the top surface as shown on the plans.

Make hatch covers for each of the access openings out of 1/32 balsa. Secure them with small screws. Use 1/8-wide strips of 1/32 balsa to cover the propeller shaft housings. Light filler can be used if necessary.

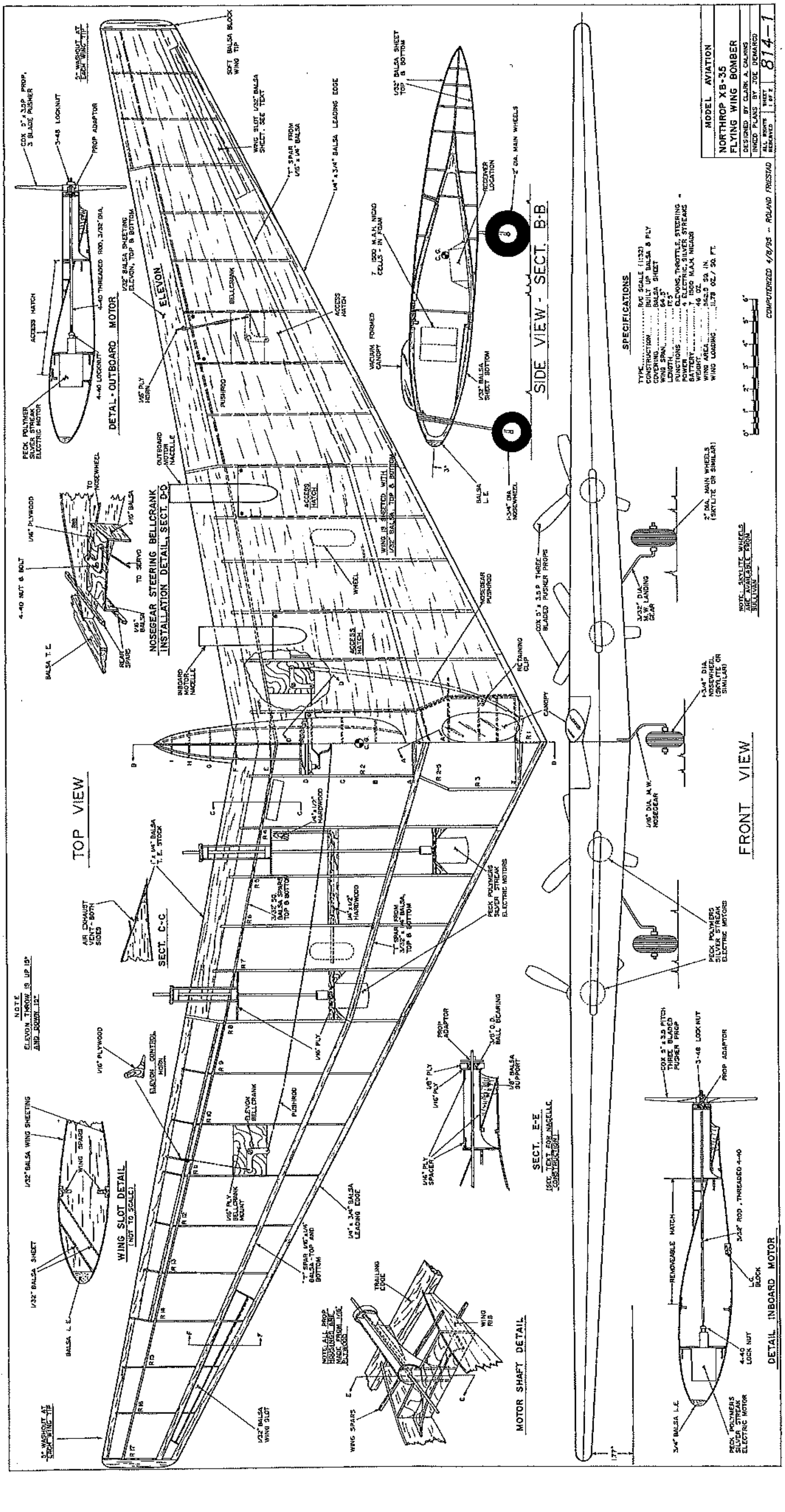
The main nacelle shape is now added to the wing surface. Use 1/16 balsa for the bulkheads and 1/16-square balsa runners. Cover with 1/32 sheet balsa.

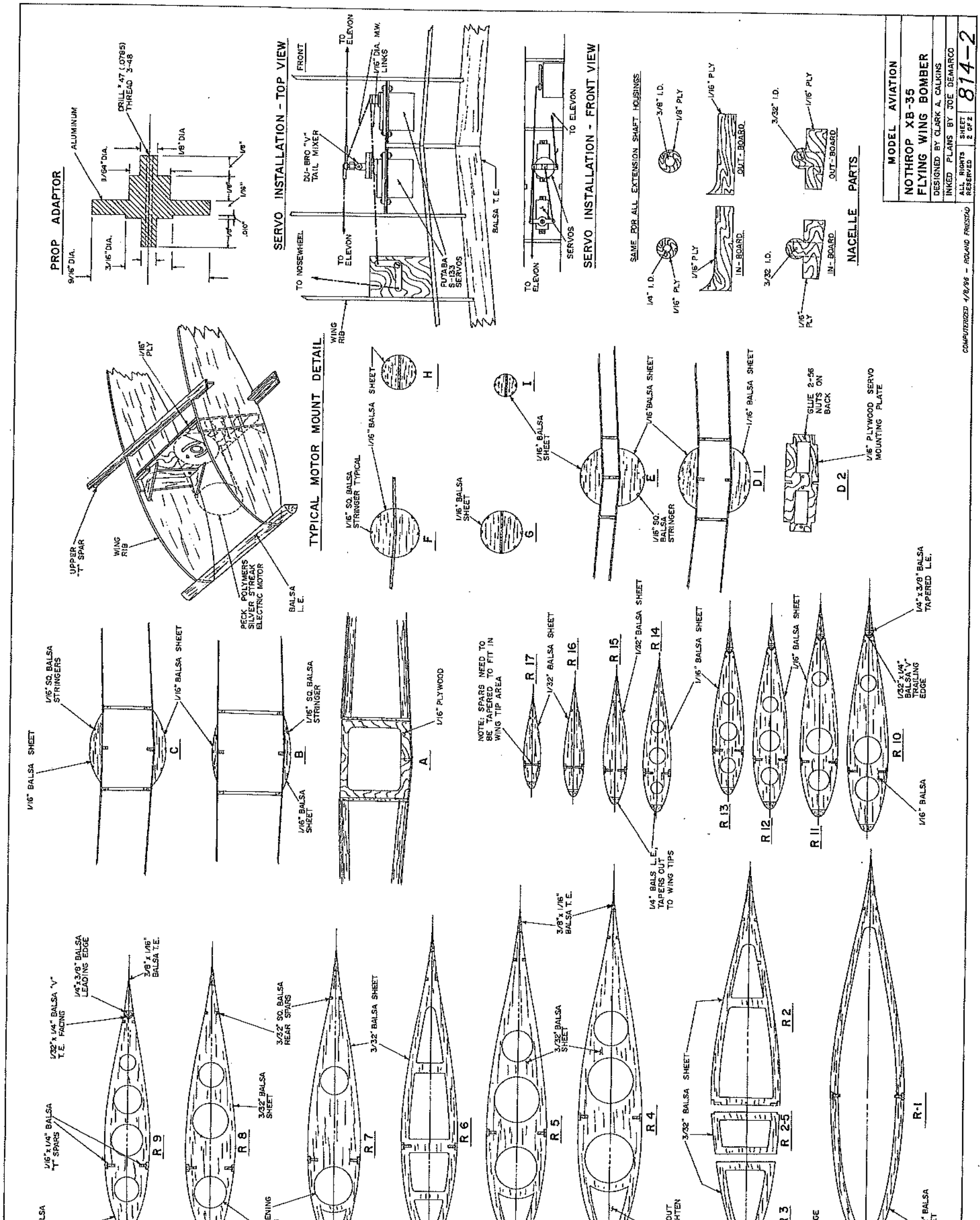
Sand everything smooth and paint the model with silver automotive trim paint. To keep the weight down, do not use too much paint.

The pilot's canopy is molded from plastic sheet, vacuum-formed over a wooden block that has been carved and sanded to shape. Painting the surface of the wing under the canopy black, and attach the canopy with plastic cement. A small pilot head can be added if desired.

The main landing gear is formed from 3/32 music wire. The nose gear is formed from 1/16 music wire. If you do not have a wire bender, use two door-hinge pins held securely

Full-Size Plans Available—see page 189




MODEL AVIATION
NOTHROP XB-35
FLYING WING BOMBER
DESIGNED BY CLARK A. CALKINS
INKED PLANS BY JOE DEMARCO
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SHEET 2 OF 2
814-2
COMPUTERIZED 4/8/96 - ROLAND FRIESTAD
PROP ADAPTOR
ALUMINUM
DRILL #47 (.0785) THREAD 3-48
SERVO INSTALLATION - TOP VIEW
SERVO INSTALLATION - FRONT VIEW
DU-BRO "V" TAIL MIXER
FUTABA S-133 SERVOS
BALSA T.E.
TO ELEVON
TO NOSEWHEEL
WING RIB
SAME FOR ALL EXTENSION SHAFT HOUSINGS
NACELLE PARTS
IN-BOARD
OUT-BOARD
TYPICAL MOTOR MOUNT DETAIL
UPPER "T" SPAR
PECK POLYMERS SILVER STREAK ELECTRIC MOTOR
BALSA L.E.
1/16" PLYWOOD SERVO MOUNTING PLATE
GLUE 2-56 NUTS ON BACK
1/16" BALSA SHEET
1/16" SQ. BALSA STRINGERS
1/16" PLYWOOD
NOTE: SPARS NEED TO BE TAPERED TO FIT IN WING TIP AREA
1/4" BALS L.E. TAPERS OUT TO WING TIPS
1/32" BALSA SHEET
3/32" BALSA SHEET
3/32" SQ. BALSA REAR SPARS
1/16" x 1/4" BALSA "T" SPARS
LIGHTENING HOLES
TRIM OUT TO LIGHTEN
1/4" BALSA LEADING EDGE
3/8" x 1/16" BALSA T.E.
1/4" x 3/8" BALSA TAPERED L.E.
1/32" x 1/4" BALSA "V" TRAILING EDGE
R-1
R 2
R 2-5
R 3
R 4
R 5
R 6
R 7
R 8
R 9
R 10
R 11
R 12
R 13
R 14
R 15
R 16
R 17
A
B
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D 1
D 2
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I

in a vise about ¼-inch apart. Sullivan SkyLite wheels are used.

When all of the components have been installed, check the center of gravity (CG). You'll want the CG to be very close to the location that the plans indicate. Start with the CG slightly ahead (not more than ¼ inch) of the location shown on the plans. Move the batteries around to adjust the CG location—don't add weight if you don't have to. The model's final weight should be 44-48 ounces.

Flying: The flying wing's characteristics will be similar to other more "normal" aircraft if the CG is properly located. The model's elevons have a very short moment arm, and can't correct for a CG that is off by very much. The directional stability provided by the swept wing and the propellers is more than adequate. Pitch stability is provided by a thrustline that is above the CG and elevon balancing forces. This, combined with a symmetrical airfoil with wing twist, makes for an easily controlled aircraft. I did not find any bad habits.

A smooth runway is important; it will help prevent the airplane from bouncing around, as the nose is quite light. If your runway is not so smooth, you can use "training wheels"— small wires trailing down from the wingtips—to help prevent the airplane from rotating too much, or tipping from one side to the other.

I made several taxi tests to get a feel for the steering. Slight misalignments in the main gear will make the model hard to control. You will find that if you taxi the airplane fairly fast, it may pop off the ground if you suddenly let off the throttle. This is because the propeller thrust exerts down force on the nose wheel. When you let up, the sudden drag causes the nose to lift! It's quite surprising the first time this happens.

When you prepare the model for its initial flight, make sure the batteries are fully charged (peak-charging is best), and trim the elevons up about 3°. For your first flight, close off the wing slots with clear plastic tape. While these are supposed to improve low-speed handling, they increase drag, making acceleration more difficult. You'll want to takeoff directly into the wind if possible.

When you apply full throttle the model should get up to speed in 100 feet or so. You might need to add a little "up" elevon to get it off the ground. If the CG is too far forward it might not get off at all, or if it does, it might not be able to climb.

Once the model is in the air, climb gradually as it builds up speed. While this battery, motor, and propeller combination is adequate, the airplane is definitely *not* overpowered.

Be careful with your turns until you get the feel of the model. Turn slowly at first. The symmetrical-airfoil wing with little dihedral will prevent the airplane from righting itself after a turn. You will have to turn the model back to straighten it out.

You should be able to cut the power back to conserve your batteries after 30 seconds or so. Keep the airplane close by—with this type of aircraft it is easy to lose orientation if it gets too far away. Because of light wing loading, wind gusts will be quite noticeable.

Landing is not much different from other airplanes, although with such a light wing loading it does tend to "float." You will find that it decelerates when the power is cut, due to the high propeller area. For this reason it is best to land under power.

The sight and sound of this model in the air is amazing. It sure brought back memories! ✈

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TWITT ("The Wing Is The Thing"), Tailless aircraft group: Box 20430, El Cajon CA 92021