U.S. RECORD SETTING SWING-WING ROCKET / GLIDER...

GROUND HOG 16

SPARROW ROCKET/GLIDER

By Jon Robbins

The Groundhog 16 is a variable-geometry (swing-wing) glider, specifically designed for the new Rocket Glider event. In designing the bird for this event, various other configurations were examined and subsequently discarded. Basically there were two methods which were considered. The first was a shift of the center of gravity position. This was discarded as the CG shift did not present any advantage over current B/G technology – there was no reduction in drag during the boost phase, hence lower altitude and duration would result. The second method is a shift in the center of pressure (moveable wings). Here you have two basic possibilities, the first being the flop-wing (see MRm, August and September 1970). This method provides an improvement in boost phase drag, but still wasn't what I was after. Besides, someone else thought of it first!

The method utilized with the Ground Hog 16 is the "swing-wing" concept, where the wings pivot parallel to the fuselage during boost and swing out upon reaching apogee. Previously only in the larger classes of gliders was any thought given to the swing-wing design due to the misgiven idea that swing-wings had to be *heavy*. The Ground Hog 16 weighs in at a little over 30 grams in glide configuration. This includes 10 grams for an expended engine. The 20 gram net weight for a glider of this wing area (54 square inches) should dispell this overweight theory.

The reduction in frontal area during boost (wing cross-section less than ½ square inch) allows maximum altitude to be realized, and hence gives a longer glide duration.

As of this writing, the Ground Hog Rocket/Glider concept has been entered in one Area meet (Buckeye II), two Regionals (PRANG-II and MMRR-71), and two Record Trials (NART-II and PACT-I). Events have ranged from Hornet to Condor, and the Ground Hog design *has yet to be beaten* by the competition.

If the Ground Hog is to be your first glider, *don't build it!!!* Instead, build, trim, and fly a dozen or more of the gliders sold in kit form or those published in **Model Rocketry**. The Ground Hog is a winning Rocket/Glider, but should only be attempted by the experienced rocketeer due to its complexity.

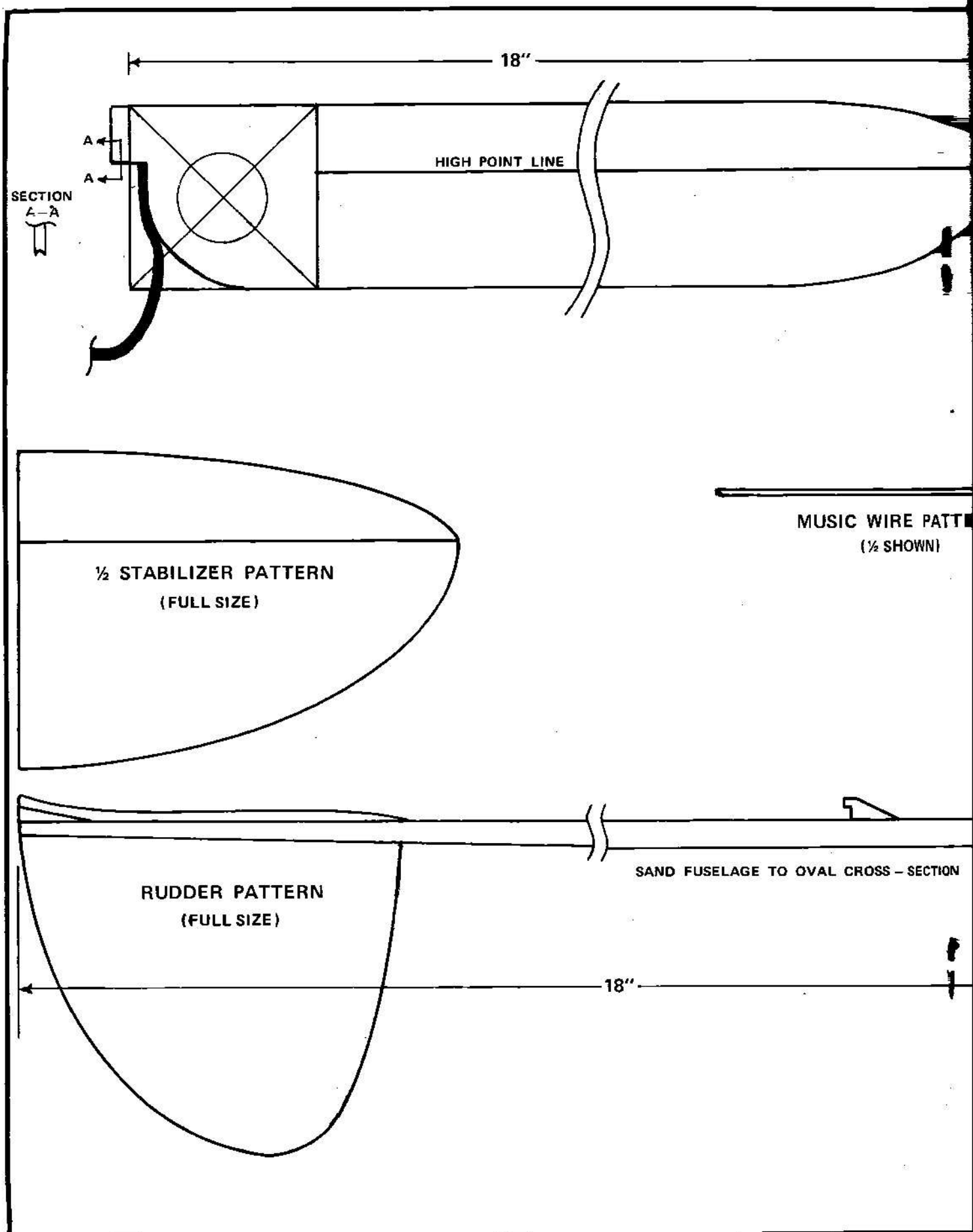
Construction

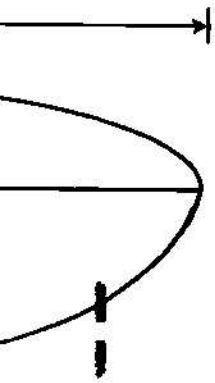
Before you start polluting the air with balsa dust, let's make sure you have the right grade of materials to work with. The wings are made from medium-weight (8 to 10 pound stock) balsa. Select as straight and warp-free a piece of 3/32" thick balsa as you can find. One sheet, 3" wide by 36" long should give you enough for two sets of wings unless you are as much of a balsa butcher as I am. The stabilizer is cut from 1/16" light-weight (4 to 6 pound) stock, and the rudder from 1/32" medium-weight balsa. The fuselage is cut from 1/8" by 3/4" spruce. Do not make any substitutions, especially the spruce fuselage – balsa just will not take the stress.

The pod is constructed from a Centuri No. 7 body tube with a CMR NC-74 lightweight plastic nose cone up front. The piston, used to actuate the wing opening, is an Estes JT-20C paper tube coupler. The difference between the ID of the Centuri No. 7 body tube and the OD of the Estes JT-20C paper tube coupler ensures effortless movement of the piston. The wing pivots are Estes EB-20B engine blocks. The elastic cord, used to actuate the wings, can be purchased in the millinery department of any five and dime store (at 35¢ for 8 yards). It also makes great shock cord for your other birds. A piece of 1/16" diameter music wire is used to hold the wings back during boost.

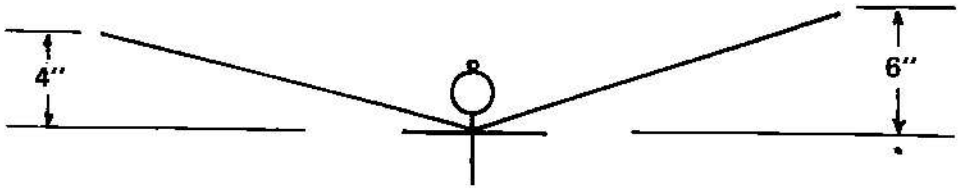
Now that you have the correct materials, start making balsa dust. Cut the 3" by 36" sheet of 3/32" balsa lengthwise down its center. This will give you two 3/32" by 1½" sheets, each 36" long. Set one aside for your next Ground Hog 16. On the remaining sheet draw in the elliptical wing tips at each end. Locate the exact center of the sheet and draw a line across its width. Two more lines should be drawn one on each side of the center line at a distance of 1½ inches. This will give you two boxes, side by side, each being 1½" square. Draw diagonals in each box to locate its center.

Jon Robbins preps his record setting Ground Hog 16 rocket glider. During boost the wings swing back to lower the frontal area drag. At apex the wings open to a 36" span, giving the Ground Hog 16 a 50 square inch wing area. Note the "U-shaped" wire bracket just forward of the wings. It serves to hold the wings closed during boost. At ejection the wire moves forward, allowing the wings to open.


18"
A
A
SECTION
A–A
HIGH POINT LINE
½ STABILIZER PATTERN
(FULL SIZE)
MUSIC WIRE PATTE
(½ SHOWN)
SAND FUSELAGE TO OVAL CROSS – SECTION
RUDDER PATTERN
(FULL SIZE)
18"

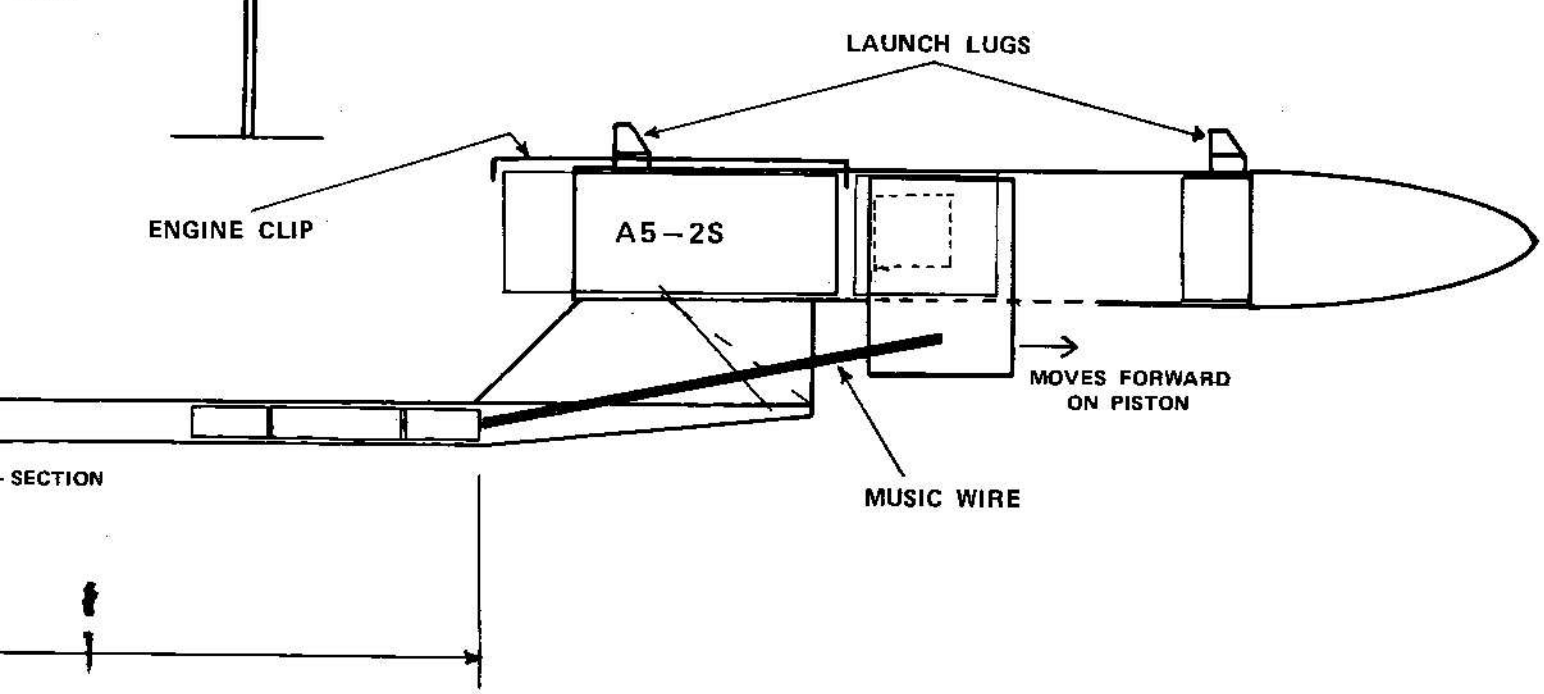


FRONT VIEW



DIHEDRAL PLAN

RE PATTERN
HOWN)



- SECTION

Ground Hog 16

Designed and Drawn by
Jon Robbins NAR 16092

6-15-71 FULL SIZE

The Ground Hog 16 is one of a series of rocket gliders and boost gliders which were developed by Jon Robbins. U.S. records are currently pending for Ground Hog flights in Condor R/G, Hornet R/G, and Sparrow B/G, as well as Sparrow R/G.

Center one of the Estes engine blocks on the intersection of each set of diagonals and trace around the engine block. Draw the pivot line (the curved portion of the wings) as shown in the plans. Mark the airfoil high-point line ½" back from the leading edge. Now the cutting begins.

Cut the sheet in half along the center line. Cut the elliptical wing tips, the pivot hole, and pivot line. Rough sand the airfoil using 220 grit sandpaper on a sanding block. Be careful not to sand either of 1½" square pivot areas. Finish sanding the airfoil with 400 grit paper. The pivot areas should be given two coats of clear dope and covered with Jap tissue to strengthen them. (See the October, 1970 issue of MRm for tissue covering details). Give each finished wing two coats of thinned clear dope (its lighter than colored dope), sanding each coat with fine sandpaper. This will weatherproof your wings and give them a smoother finish.

Epoxy each end of a 5" length of elastic cord to the wing pivot ends as shown in the drawing. The wing pivot plate assembly is next. Cut four 1½" by 2" rectangles from 1/32" medium weight balsa stock. Locate the center of each plate using the diagonal method. Double glue one engine block to the exact center of each of two pivot plates.

The engine blocks are 1/8" high, and the wings 3/32" thick, so you must carefully sand the engine blocks until their height matches the wing thickness. Place one wing on the pivot plate — pivot sub-assembly — and double glue the top pivot plate onto the top of the engine block. Repeat procedure for the second wing. Be careful not to get any glue on the wings or you will have a non-swinging swing-wing glider.

Carefully sand one end of the pivot-wing assemblies to provide a dihedral angle. A dihedral of 6" under the right wing and 4" under the left wing should give you about 75 foot circles during glide.

The fuselage can now be cut out as shown in the plans. Round all sharp corners except where the rudder, stab, wings, and pod are to be attached. An oval cross-section fuselage is used to provide maximum strength with minimum weight.

The rudder is sanded symmetrical and the stab airfoiled with a high-point line 1/3 back from the leading edge. Decalage is built in by gluing a small piece of balsa (see plan) between the stab and fuselage, and fillet all joints for strength.

Now that the glider portion is completed, construction of the pod can begin. Cut the Centuri No. 7 body tube to a length of 4" as shown in the plans. A CMR body tube cutter comes in handy here. Four lines should be drawn along the length of the tube. Three lines should be spaced 120° apart, and the last line should be midway between two of the previously drawn lines. This fourth line is the line on which the launch lug should be attached. The line on the opposite side of the body tube is to be slit along two inches of its length (starting at one end). This slit should be enlarged to a 1/8" width starting ½" from the end where the slit begins and running 1½" down the length of the tube. The remaining two lines are to be used as centering lines for the two 3/8" square exhaust portholes which are cut as shown in the plans.

Glue a shorty engine retaining wire to the pod as shown. Remember, in Rocket/Glider everything that goes up must come down — *gliding!* Ejected engines do not glide well, so use that engine hook.

The piston is made as follows. Cut a 1/8" slot lengthwise in the wall of the JT-20C paper tube coupler. Glue a 1" length of 1/8" by 3/4" spruce in the slot in the coupler. Glue a disk of 1/16" thick balsa into one end of the coupler. Apply a coating of epoxy to the disk to prevent the ejection charge from burning the piston. Drill a 1/16" diameter hole in the spruce piston tongue as shown in the plans. Coat the inside of the body tube with Estes flameproof paint. When the inside of the tube is dry, insert the piston in the tube. (Be sure the epoxied end of the piston is facing the engine.) Glue the slit closed, and epoxy a CMR 74 nose cone in place.

Cut the pylon from 1/8" by 3/4" spruce and glue to the body tube. Double glue the pylon to the fuselage at the location shown in the plans. Form a piece of 1/16" diameter music wire to the shape in the plans and epoxy into the hole drilled in the piston tongue. Glue a small piece of spruce to each wing end (as shown in the drawing) and sand until the correct 90° wing position is obtained. This spruce section serves as a wing stop when the wings are opened.

Cut a small slot in each of these spruce pieces. It is in these slots that the ends of the music wire are seated to hold the wings against the fuselage during boost. If this wire doesn't quite hold the wings back, bend the wire until the correct wing position is achieved.

With the wings in the open position, move the elastic cord back on the fuselage until it stretches. Mark this position on the fuselage. Shape a scrap piece of spruce to serve as a hook for the elastic as shown in the drawing and glue it to this position. Set the bird aside to dry overnight to make sure all glue joints are thoroughly dry. A Ground Hog shredding on the way up is not a pleasant sight to see.

Trimming the Ground Hog

As CG locations vary from bird to bird, you might find your Ground Hog needs trimming. The easiest way is to apply clay as required. This, however, adds weight. The correct trimming procedure is to cut off the pod and reglue it at another position. This might be time and energy consuming, but remember that on a contest bird you want every extra second you can get.

A properly constructed Ground Hog 16 should turn in consistent times in the 90 second range in the Sparrow competition when flown with an A5-2S engine.

Anyone building or experimenting with the Ground Hog concept is invited to write me in care of MRm. A stamped, self-addressed envelope will assure your questions being answered. *Good Flying!*