



Larger "Shrike" (left) and smaller "Mini-Delta", both ducted fans.

DUCTED FAN DUO { SHRIKE AND MINI-DELTA

P. E. Norman's last major efforts with impeller-propelled free flying model aircraft were in the perfection of these two remarkably stable, surprisingly simple, sturdy fan-enclosed fighter-like whiz wagons. And—no broken props!

BY BILL DEAN with P. E. NORMAN

For more than a decade, Percival Edward ("P. E.") Norman of Banstead, England, successfully built and flew F/F and R/C scale and semi-scale ducted-fan models. The story of his extensive D/F experiments (March '62 AM) and the feature on his "Rapier" D/F R/C (June '62 AM) attracted so much reader interest, we sent "P.E." samples of the little Cox .010 and .020 engines and asked him to develop simple all-sheet-balsa designs for readers who wanted to try out D/F flying for the first time.

Finally, after various delays due to sickness, poor model flying weather on

both sides of the Atlantic and shipping damage to the original models P.E. sent over to America for our testing, here are the .020 "Shrike" of 21" span and the .010 "Mini-Delta" of 16" span, two of the best D/F designs yet flown. Both are semi-scale in appearance and feature rugged, light airframes, with knock-off flying surfaces.

Since building methods are similar, we'll concentrate on the Shrike construction in detail and give only brief notes on the .010 Mini-Delta. Use epoxy-resin glue throughout and unless otherwise specified select only fairly light-weight balsa.

WING TONGUE PLATFORM/ENGINE MOUNT. Glue together pieces of 1/32" and 1/16" plywood, with grain running lengthwise, to form wing tongue platform (use 1/16" plywood alone for .010 model). Cut out 1/16" plywood engine mount, using back of engine tank as a pattern. Drill bolt holes in mount and in 1/4" wide thin tin strip and solder nuts to latter, which is then glued behind mount.

Mark center line on wing tongue platform and glue to engine mount after notching former to take engine mounting nuts. Cut engine fairing cone from balsa block (or laminations of 3/16" sheet), leaving square section initially. Sawcut 3/32" wide slot in fairing, shape front to match engine mount and taper to conical shape. Now glue to wing tongue platform and engine mount, checking alignment in top and side views.

Cut a 2-25/32" dia. disc from 1/16" plywood (2-7/32" dia. for .010 model) and carefully drill to fit engine shaft. Make fan-ring from 1/2" wide strip of 1/32" plywood (use 7/16" width for .010 model), soaking in warm water and wrapping around circumference of disc as tightly as possible (allowing 2" surplus and marking this overlap in pencil). Chamfer overlapping ends of plywood strip and glue ends together to form fan-ring, with plywood disc inside to hold true, and using several rubber bands around circumference until dry. Take off fan-ring and clean with sandpaper and then replace on disc.

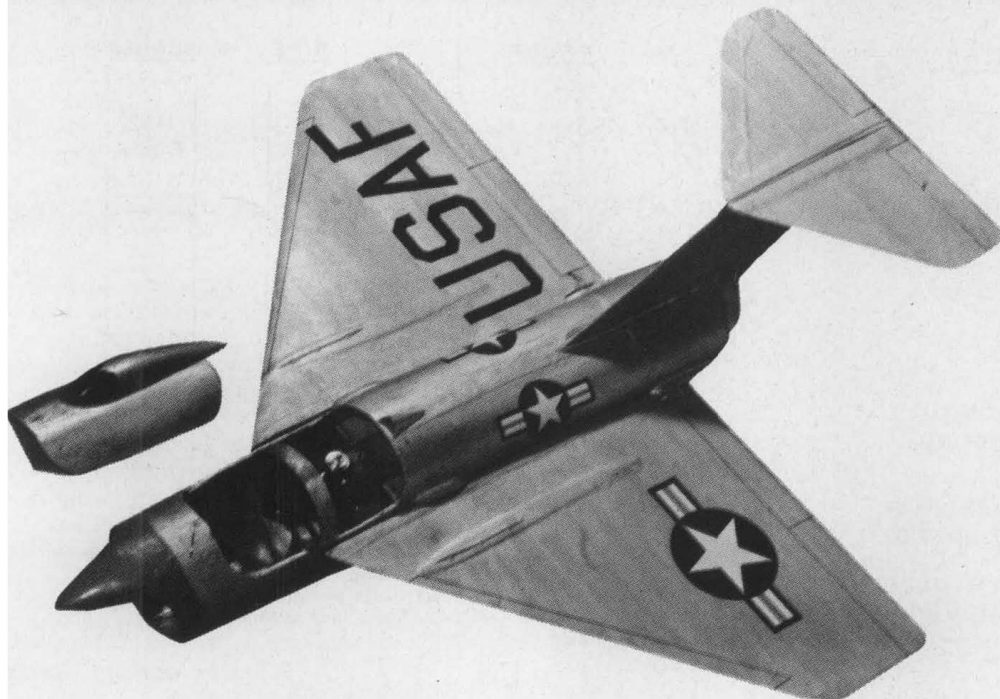
Streamline front and rear edges of that portion of wing tongue platform located inside fuselage, on either side of engine fairing cone. Bolt engine to mount and cover all openings with masking tape, for sawdust protection.

FAN. See drawings for details of this item, which must be made accurately and then carefully balanced. Cut the six blades from a long strip of 9/16" wide 1/32" thick fiber (1/2" width for .010 model). Cutting the fan blade slots in the hub at the correct pitch angle is simplified if a small jig is made, such as the type described and illustrated in "Rapier" D/F feature in June '62 AM.

FUSELAGE. Using 3" wide sheet that bends easily across its width, cut four fuselage shell pieces to the patterns shown. Join each pair edge-to-edge (flat on building board) along straight edges (center line) and when dry, reinforce joint with 3/8" wide strips of medium-weight brown wrapping paper, cemented or doped in place. Pencil in center line on both sides of each of the two sheet assemblies, and also mark fan-ring location on inner faces. Cut a 2 3/4" dia. front inlet template (2-9/32" dia. for .010 model) and rear outlet template to pattern given, from 3/16" sheet.

Take sheet assembly for lower shell and run hot water over both sides, until soft and pliable. Shake off surplus water and place fan-ring (with plywood disc inside) in position. Hold sheet to curve of fan-ring with rubber bands and loop more bands at intervals along the sheet, aft of fan-ring.

Next, soak top sheet assembly; place over fan-ring, overlapping lower shell



World's leading authority on D/F flying at the time of his death last July was the modest chap thousands of aeromodelers called "P.E." Mr. Norman was stricken while flying his well known Comper Swift gas plane on Epsom Downs. Our sympathy is extended to his family and many friends.

and again holding with rubber bands, around both shells. Cement short lengths of $\frac{1}{8}$ " dia. dowel (for handling) through inlet and outlet template centers. Insert templates in front and rear fuselage openings and hold sheet firmly against templates with several rubber bands. Put on one side (in warm area) and allow the shells to dry, then separate and cement or dope 3" long brown paper reinforcements inside and outside, at front and rear of fuselage. Cover entire inner surfaces with light tissue, doped in place, and remark fan-ring location in pencil.

Bolt plywood disc to engine (packing with washers to prevent wobbling) and replace fan-ring on disc. Align wing tongue platform/engine mount assembly in lower shell slots and check alignment, before glueing the assembly and fan-ring in place. Fill in gaps in shell, above wing tongues, with strips of $\frac{1}{16}$ " sheet.

Pin and temporarily cement rear outlet template in place and chamfer the facing overlapping edges of top and lower shell sides. Check fit of top shell on rear outlet template and fan-ring and mark "saddle-shaped" engine hatch outline in pencil. Before glueing top shell to lower shell, place a scrap of greaseproof paper on top of fan-ring, so that latter will not stick to top shell. Glue on top shell, pinning to outlet template and holding shells together with plenty of rubber bands (and pins, along overlapping joints).

Cut out upper and lower shallow "V" portions from nose, as indicated on pattern drawings. Now pin and temporarily cement front inlet template in place; pull shells together to close "V" gaps and provide slight nose taper (no taper on .010 model). Again reinforce the center line joints at nose with $\frac{3}{8}$ " wide strips of brown paper.

Lightly sand shell exterior and dope $\frac{3}{8}$ " wide tissue strips (two layers) over the overlapping side joints. Wrap and dope on a length of $\frac{1}{4}$ " wide nylon ribbon around nose (see plan). Using a

sharp knife or razor blade, cut engine hatch free and then dope narrow strips of tissue around hatch and hatch opening edges. Remove fan-ring plywood disc, inlet and outlet templates. Shape the inlet and outlet to the shapes shown on fuselage side view drawings. Round off inlet and outlet edges and reinforce with tissue strips.

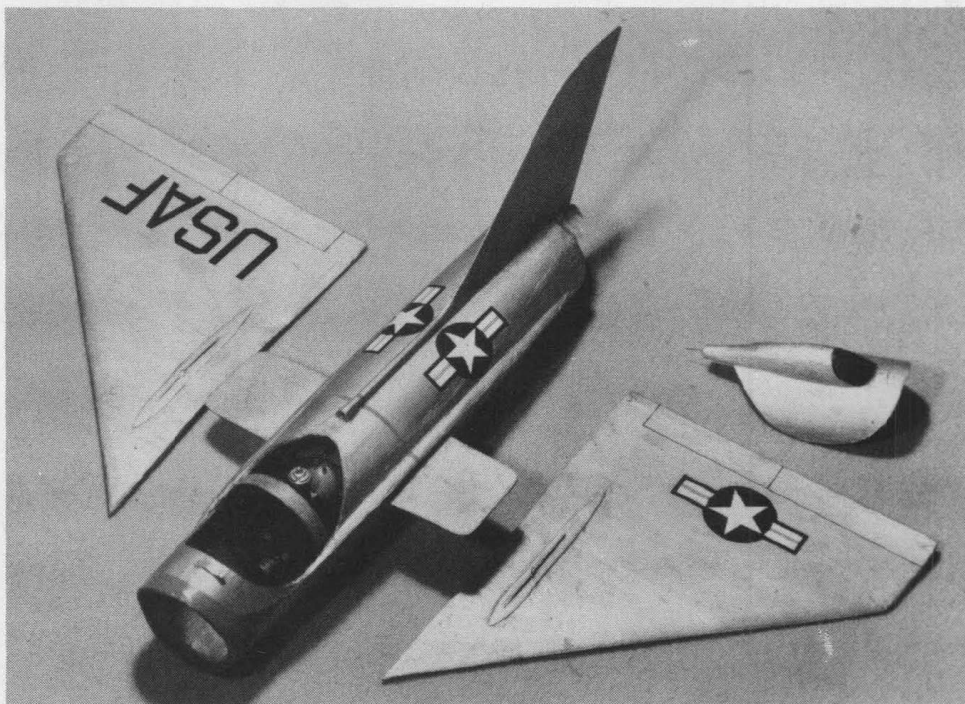
Cut and sand balsa canopy to shape and glue to hatch. Install rear aluminum and front wire canopy fittings. Soak a piece of $\frac{1}{32}$ " plywood in water and wrap around a glass jar (holding with rubber bands), to match the inside nose section curve. When dry, trim this plywood and glue to top inside shell at nose (see plan). Carve and sand the balsa nose, and glue to front and inner faces of inlet at top.

Carefully trim off any small imperfections, especially at intake, outlet and engine mount areas, and give two or

three coats of clear fuelproof dope. Add $\frac{3}{32}$ dia. engine anti-vibration screw, drilling through underside of fuselage shell, fairing cone and wing platform. Glue $\frac{1}{32}$ " plywood washer to fuselage at bolt hole and glue securing nut to cone top. Slight vertical adjustments, to obtain correctly centered fan, may be made by means of the anti-vibration screw. Use thin tin strips between engine and mount, to eliminate any side, down or up-thrust.

FIN. Join two pieces of 3" wide $\frac{3}{32}$ " sheet edge-to-edge and cut out fin so that the grain is parallel to trailing edge. Taper leading edge (to $\frac{1}{4}$ " back) and trailing edge (to $\frac{5}{8}$ " forward), then reinforce tapered areas with brown paper strips cemented or doped in place, and cover completely with lightweight tissue doped on.

Using the pencil center line for reference, carefully cut a $\frac{3}{32}$ " wide slot



Mini-Delta (above) differs from Shrike (top) in that it has no horizontal tail.

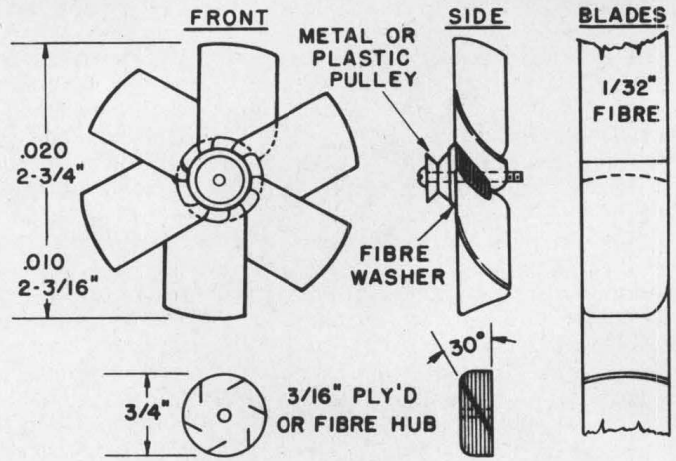
CUT SLOT
FOR SNUG FIT

**NOTCH FOR
MOUNTING NUTS**

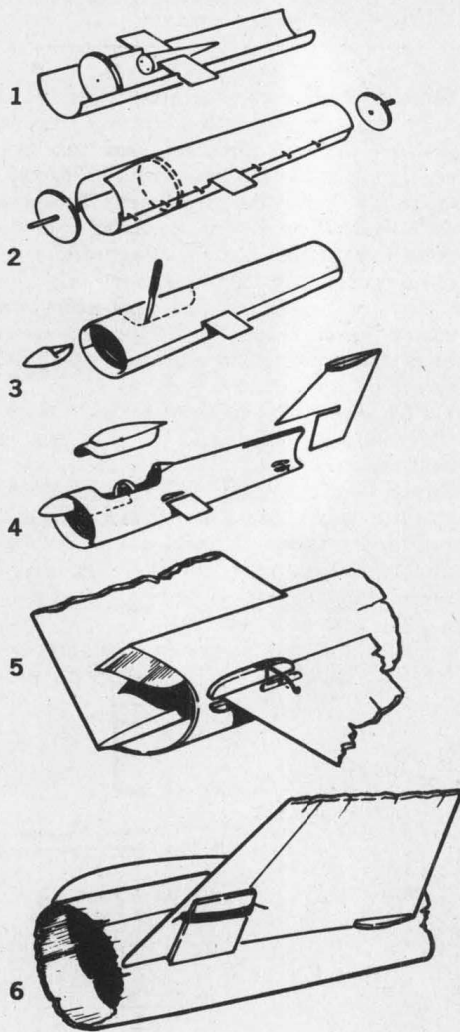
CARVE AND SAND ROUND

1/16" & 1/32" PLYWOOD LAMINATED

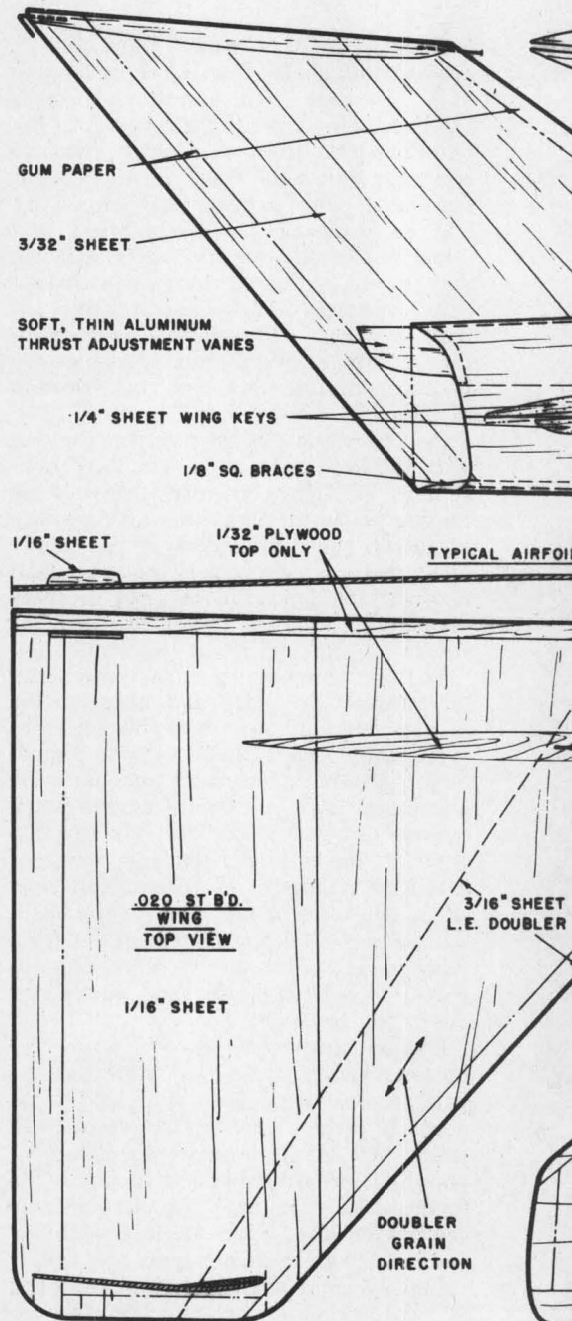
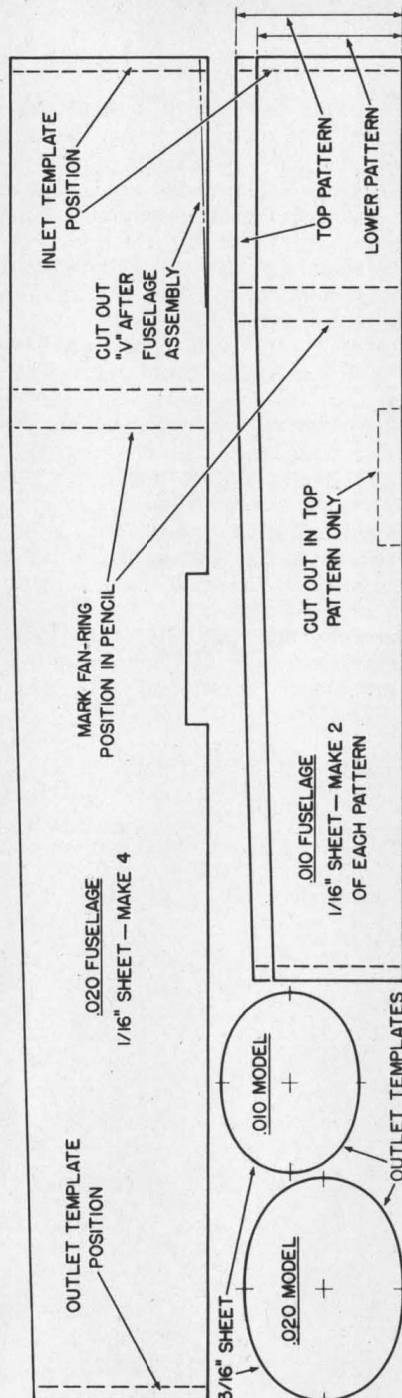
1/16" PLYWOOD ENGINE MOUNT - SOLDER NUTS
TO TIN STRIP & GLUE TO REAR OF MOUNT.



Make fan blades in one long strip. Dampen and curve similar to fuselage shells. Use heat to dry and retain the camber. Cut blades slightly oversize to start. Glue to hub with epoxy. Trim off blades and balance carefully. Apply fuel proofing.



"Shrike" (.020 power) Construction Details:
 (1) Wing tongue/engine mount fits slots in lower fuselage; plywood disc—inside fan ring—serves as center template. (2) Top shell overlaps lower shell; balsa templates are inserted at fuselage ends to form correct shape inlet and outlet openings. (3) Saddle-shaped engine access hatch is cut out of shell top. (4) Solid canopy is glued to hatch and fin notches into shell slots. (5) Top view of wing keys and clip at trailing edge of wing panel. (6) Underneath view showing wing fastening with bands stretched between wing hooks, holding wing panels against tongues.



in the fuselage shell top at rear. After checking that the fin top matches angle shown on plan and lines up in rear and top views, cement fin in slot, and add lower $\frac{1}{8}$ " sq. braces. Attach shaped $\frac{1}{4}$ " sheet stab platform pieces to fin sides at top.

STABILIZER. Join two pieces of 3" wide $\frac{1}{16}$ " sheet edge-to-edge and after tapering leading and trailing edges (as with fin), glue $\frac{7}{8}$ " wide strips of $\frac{1}{32}$ " sheet to both surfaces at center. Sand edges of these strips so that they blend into stabilizer, and cut notches at front and rear for rubber band locations. Reinforce leading and trailing edges with brown paper strips and cover with lightweight tissue, pinning down flat until dry, to prevent warps.

WING PANELS. Join three pieces of 4" wide $\frac{1}{16}$ " sheet edge-to-edge for each panel, then after cutting to shape,

sand down the rear edges of the $\frac{3}{16}$ " sheet leading edge doublers and glue in place. When dry, sand upper and lower leading edges to obtain root and tip sections shown on plan.

Carefully bend in correct camber, dope both panels and hold together with rubber bands stretched front to rear, with a 9" long tapered $\frac{3}{16}$ " sheet spar ($\frac{5}{8}$ " at root and $\frac{1}{4}$ " at tip) inserted to maintain the camber. Cut out $\frac{1}{32}$ " plywood root and outboard reinforcing strips, bend them to follow camber and glue to top of wing panels.

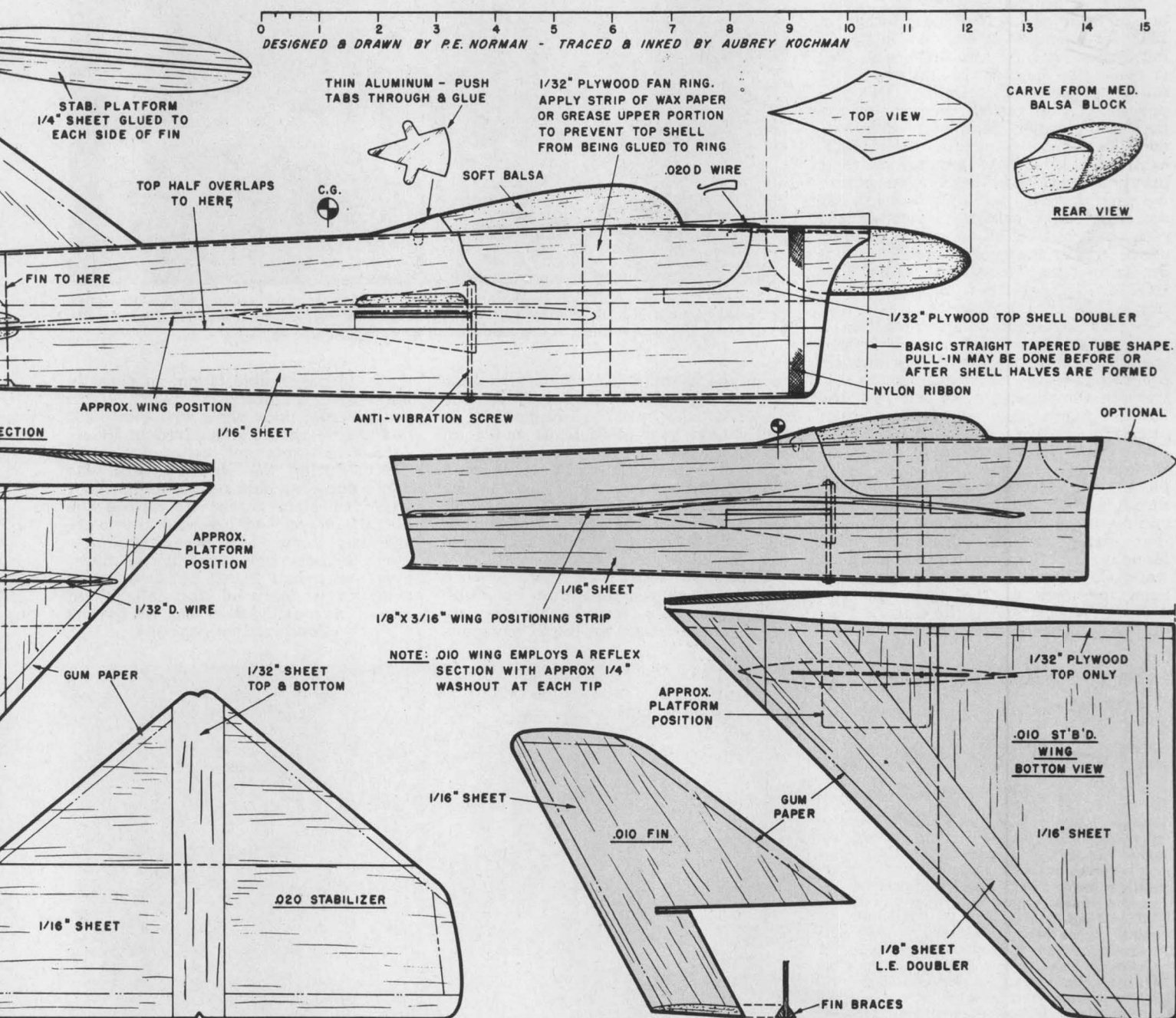
When dry, separate panels and glue brown paper strips (same width as plywood strips) underneath panels at roots. Also reinforce both sides of trailing edges and tips with brown paper strips. Cover panels entirely with lightweight tissue and again hold together with bands and insert the camber holding

tapered spar (follow a similar procedure with .010 model wing panels, which have slightly reflexed trailing edges, giving a shallow "S" section).

FINAL DETAILS. Glue the aluminum downthrust adjustment vanes to fin and inner lip of rear fuselage shell (although not shown on plans, it's also advisable to fit smaller versions of vanes to .010 model). Add $\frac{1}{32}$ " dia. rear and front hooks to fin/stab platform.

Bolt engine and fan in place, secure stab to platform with several $2\frac{1}{2}$ " rubber bands and tape the wing panels to wing tongues. Push a pin into the fuselage top at CG position and shift panels fore and aft until the model hangs level when suspended by pin.

Glue $\frac{1}{4}$ " sheet wing keys above tongues and at fuselage rear, so that wings fit snugly (see sketch for details of rear wing clip). Pierce. (See pg. 85)



Ducted Fan

holes in the outboard 1/32" plywood reinforcing strips, on either side of tongue positions, and push 3½" lengths of 1/32" dia. wire through the holes. Secure these wire pieces by sewing to plywood with strong thread. Stretch several rubber bands between protruding lower ends of each wire, to hold wings securely to tongues (see sketch).

For best performance, finish model with clear dope alone, unless after clear doping, all-up weight is less than 7-oz. (or 3½-oz. for .010 model). The original models were given two thin coats of silver dope, with red trim and USAF decal markings added.

FLYING. Check that CG is right and that flying surfaces are correctly aligned and free from warps. Glide test into wind over long grass, holding with left hand under fuselage and right hand near top of fin, correcting any diving or stalling tendencies by placing small slivers of packing between stab platform and stab trailing or leading edges. Bend wingtip trailing edges to achieve a gentle turn to right, to counteract too sharp a left power turn (bend wingtips alone for trim on .010 model). Trim with downthrust vanes only if model shows stalling tendencies under power.

Before trying any power flights, bench mount the engine and get used to starting with a length of string wrapped around the fan pulley. Quick, easy starts will save a lot of wear and tear once the engine is installed. For handling convenience, you may wish to solder an extension to the needle valve.

When it comes to flying, you'll find that the Shrike lives up to its name ("predacious bird with a strong bill") and can absorb an amazing amount of rough treatment without sustaining major damage. And with the engine tucked well away inside the fuselage, it's rare to experience fan damage.

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1 ST	OPEN CONTROL LINE B SPEED TORPEDO .29R "Series 64" 161.23 mph John Newton, Baldwin Park, Calif.
1 ST	SR. CONTROL LINE PROTO SPEED TORPEDO .29R "Series 64" 130.86 mph* Dubby Jett, Seagoville, Texas
1 ST	OPEN R/C RUDDER ONLY TORPEDO .35 Tom Williams, Oklahoma City, Okla.
1 ST	JR. FREE FLIGHT B GAS TORPEDO .23 Mike Taibi, Lakewood, Calif.
1 ST	SR. FREE FLIGHT B GAS TORPEDO .201 Mike Fedor, Grand Prairie, Texas
2 ND	OPEN CONTROL LINE B SPEED TORPEDO .29R "Series 64" 160.22 mph Phillip Bussell, Dallas, Texas
2 ND	OPEN CONTROL LINE A SPEED TORPEDO .15R "Series 64" 148.95 mph Jim Nightingale, Phoenix, Ariz.
2 ND	OPEN CONTROL LINE PROTO SPD. TORPEDO .29R "Series 64" 133.87 mph James Delaney, Chicago, Illinois
2 ND	R/C Intermediate—JR.-SR. OPEN TORPEDO .45RC Donald Crow, San Clemente, Calif.
2 ND	R/C PYLON—JR.-SR. OPEN TORPEDO .15R "Series 61" 1:00.0 min. Austin Leftwich, New Cumberland, Pa.
2 ND	FLYING SCALE TORPEDO .35 Ralph Burnstein, Oxford, Ohio
3 RD	OPEN CONTROL LINE PROTO SPD. TORPEDO .29R "Series 64" 133.87 mph John Newton, Baldwin Park, Calif.
3 RD	R/C PYLON—JR.-SR. OPEN TORPEDO .15R "Series 64" 1:00.5 min. Zell Ritchie, Westminster, Calif.

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