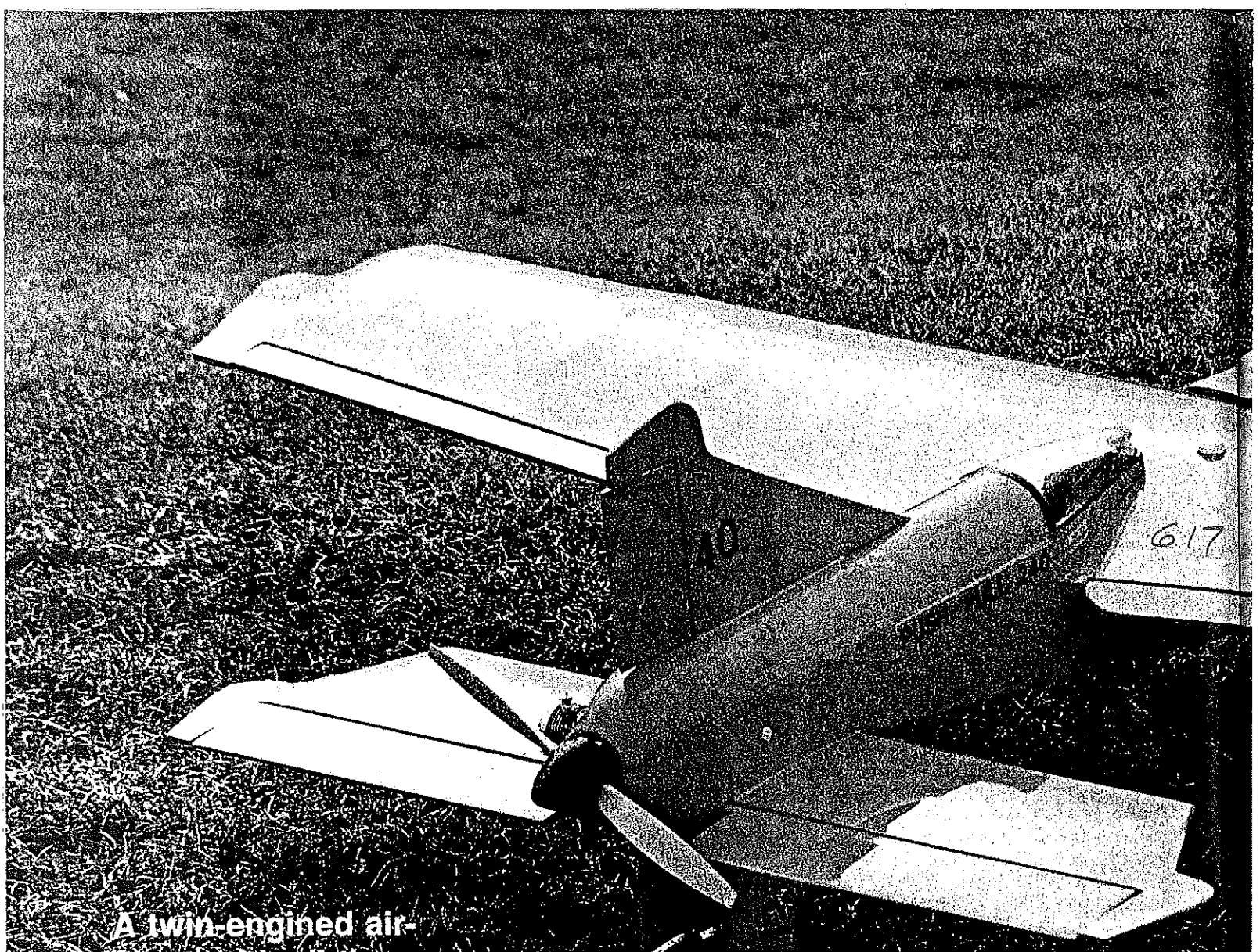


A twin-engined airplane with all the performance you'd expect, but without the nightmare of unruly flight when only one engine is operating. Sounds too good to be true? Its not, and here's the design to prove it!

■ Al Masters

PUSH-PULL

A DIRECT DESCENDANT of my original Scale Dornier-335 design, this sport twin engine model is much simpler to build than its predecessor. The 1962 rendition, scaled from factory drawings and photos received directly from Dornier, was powered with twin K&B .45 engines. A later version (photo in *Model Aviation*, October 1986) utilized two K&B .40s. As a "full-house" model, the Dornier is quite complex. In contrast, the Push-Pull 240 goes together easily and was designed with basic construction methods in mind.

Since using two engines of equal size was my prime objective, achieving the correct weight and balance became the major challenge. Doing so would allow the plane to stay airborne with either engine playing dead, while the push-pull configuration

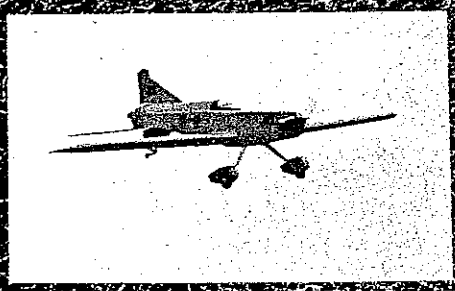
L240

would eliminate the asymmetrical thrust problems of the conventional twin engine design.

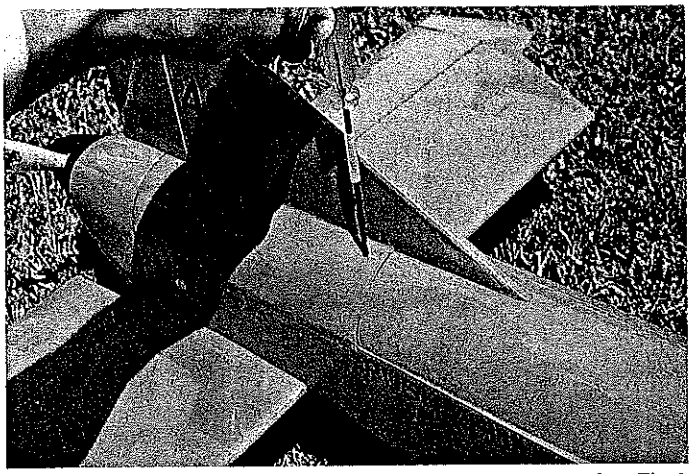
With any new and original conceptualization, determining when to freeze the design can be tricky. The PP-240 was no exception. Originating as a low-wing, it ended up a shoulder-wing—giving a weight savings of 24 oz. over the first prototype. The design requires a 12-oz. fuel tank up front and 6 oz. of fuel aft for balance control. The only extra weight, for purposes of achieving an accurate center-of-gravity, is the 2-oz. Higley Heavy Hub hidden under the nose spinner.

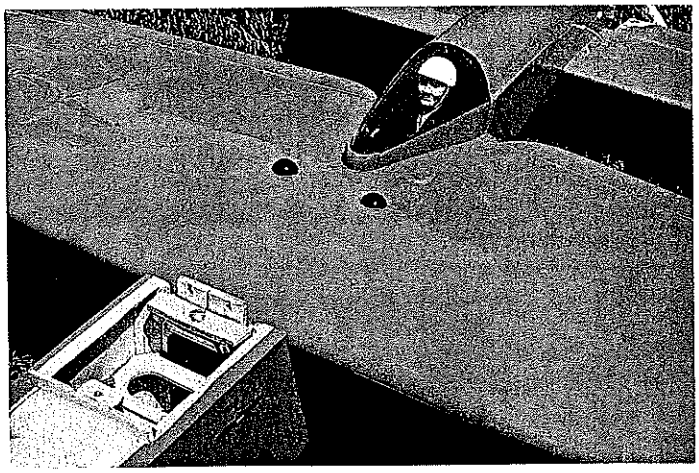
Three prototypes have been flown as of this writing. I wanted an aerobatic sport flier capable of doing spins, and a model that wouldn't stray into bad habits with either engine out. Although I haven't attempted it, smaller than .40 size engines would most likely fly the model but at the expense of reasonable single-engine performance.

If I have sparked your interest and you enjoy scratch-building from plans, give this twin engine a shot. You may have a duo of .40 engines on hand, but it's a good bet you'll have to purchase your first 10-6 pusher prop!

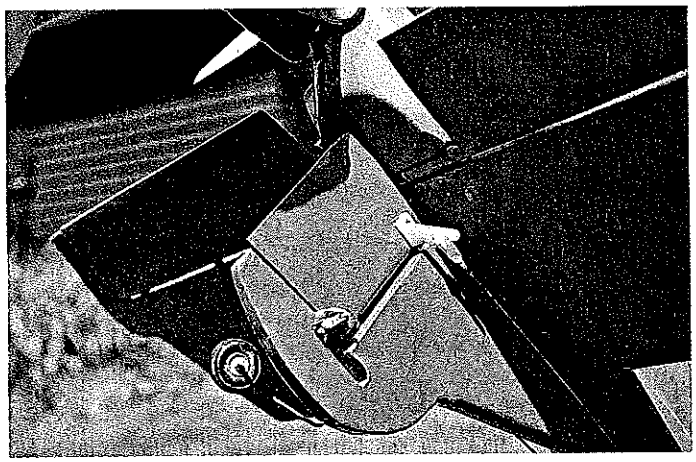


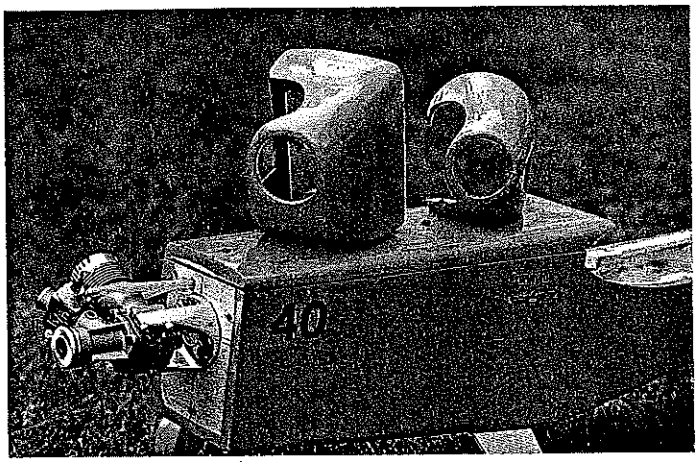
Big picture: With two .40-size engines working together, this 66-in.-span model is no slouch! Two engines don't always have to mean three times the trouble. This model performs well with either engine stopped. Above: At full bore, the author attempted to fly the No. 2 low-wing prototype model through the woods adjacent to the flying field. The pilot survived the crash and now sits in the No. 3 model presented here. Below: Our author with his unique twin-engined sport RC model.





Left: The aft hatch hides the 6-oz. fuel tank for the rear engine. The hatch/fin unit is retained with a trapped 8-32 socket-head bolt and two 8-32 nylon screws. Right: Removing the front hatch reveals the plywood keeper holding the two wing dowels in place. Under the Sig canopy, the Williams Bros. pilot is ready to go. The wing bolt covers are made from aluminum cigar wrappers that have been painted to match.





Left: the simple offset tail wheel tiller lessens servo shock during ground operations. Right: Fiberglass cowls are a nice addition to any model and are not all that difficult to make. The 4-oz. weight of the nose cowl helps with the balance. The aft cowl may be omitted if desired.

Fuselage. Use a piece of ⅛-in. Lite Ply, 12 in. wide and 48 in. long. Determine whether you want a separate fiberglass nose cowl or a built-up front engine compartment. If you opt for the built-up style, add 4 in. to the part labeled FS in front of FW on the plan.

Placing the Lite Ply under the fuselage side view, locate the end points of straight lines with a pin pressed into the ply. Connect the points using a ball-point pen. Having the basic lines straight makes easy work of drawing the sides. The only curved section is the wing saddle, which can be traced with a few pieces of carbon paper slipped between the plan and plywood.

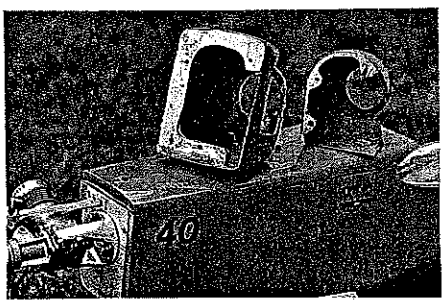
Cut out FS, and sand down to the lines shown on the plan. Trace the second side from the first, cutting and sanding it to the outline. Clamp the two sides together—or hold them together with small pieces of masking tape—while you block sand them to identical size (errors in tracing are inevitable). Make sure all edges are square. A 6 x 12-in. piece of 1/16 birch ply is used for the nose doublers (F4). Use FS as a template. Make a cutout section for the gear mount (F3). Apply a very thin coat of 30-minute epoxy to the doubler (F4) and position it on FS, making sure you allow for the firewall (FW). Use weights or clamps until the epoxy sets.

Make a right and a left fuselage side, assembling each with its respective birch nose doubler. Make the two aft doublers (F11), and attach them with a thin layer of epoxy. Allow the correct spacing for the aft firewall (FR). The two small doublers at F6 can also be attached using white glue. It is suggested that the sides be resanded to ensure that the upper and lower edges are true and identical.

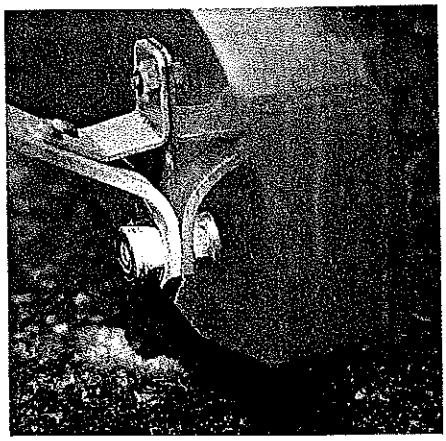
With the sides placed so that the inside surface faces up, carefully draw locations for F1, F2, F5, F6, and F7.

Make the firewall (FW) by laminating ¼-in. birch ply. Cut FR from 3/16-in. birch ply. Draw horizontal and vertical thrust lines on both sides of each firewall.

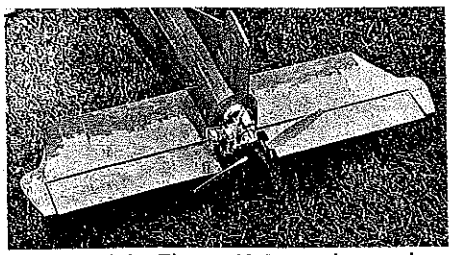
If you will be using engines of different makes, pick the heaviest for the tractor (front) unit. With the engine, including muf-



The socket-head bolts for attaching the cowls can be reached with a hex ball-driver.



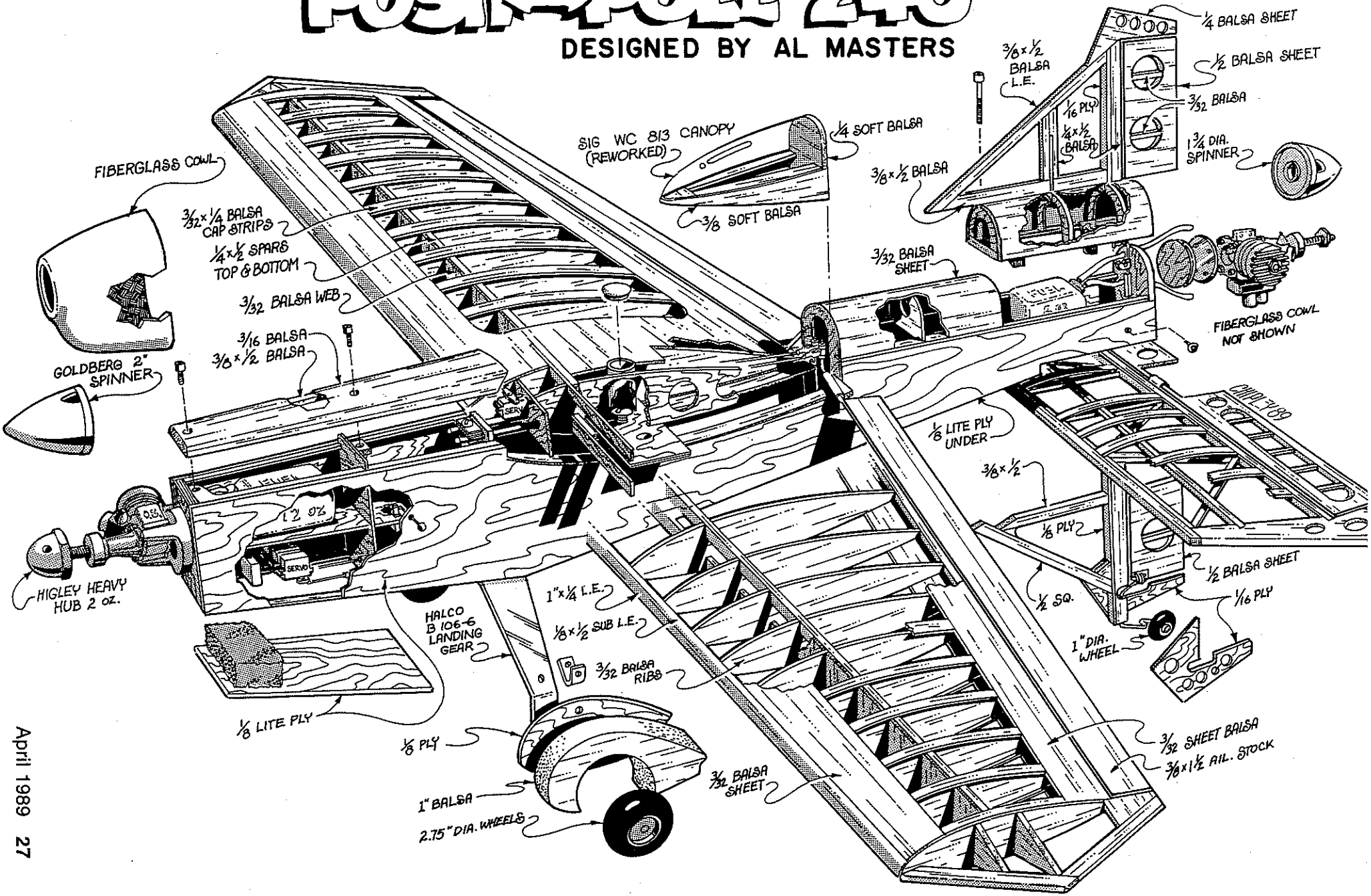
The Halco B106-6 strut, Du-Bro axle, and the K&S .062 aluminum clip hold the rugged plywood-reinforced wheel pants in place.

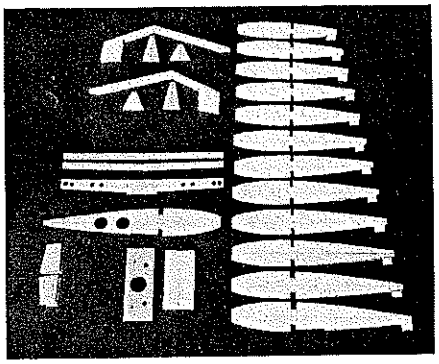


A lightweight Zinger 10-6 wooden pusher prop and the O.S. .40FP make a fine combination for the aft engine setup. The generous horizontal tail is 28% of the wing area.

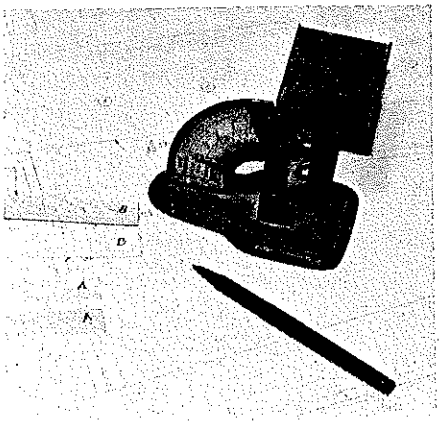
PUSH-PULL 240

DESIGNED BY AL MASTERS





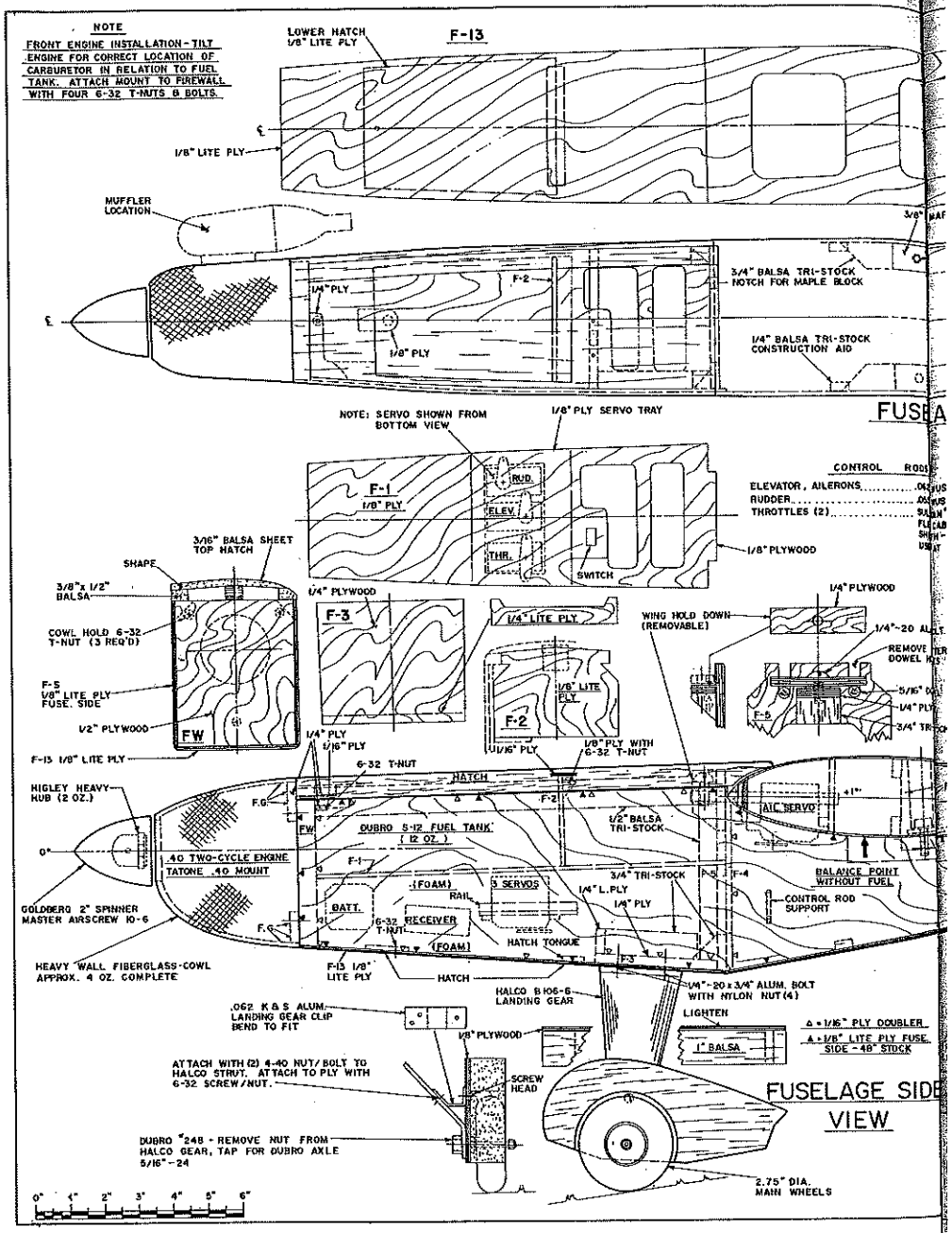
The wing ribs are first cut out with construction tabs left on to provide an easy method of building in the necessary wing washout.



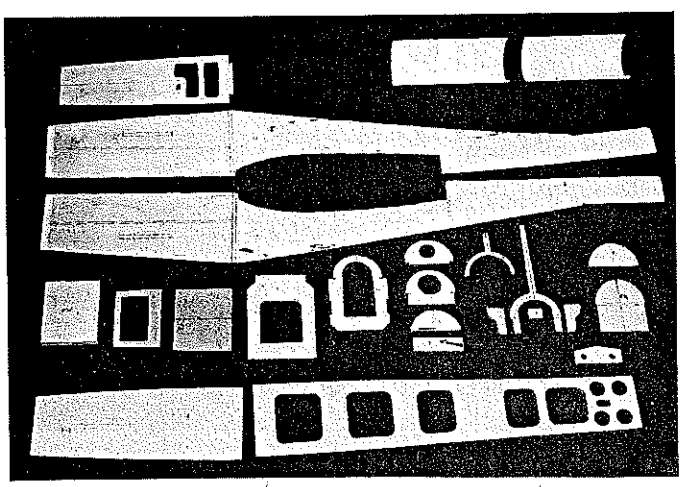
Weigh the wing spars to determine which two are the heaviest. Place one of the heavy spars in the right panel and the other one in the left.

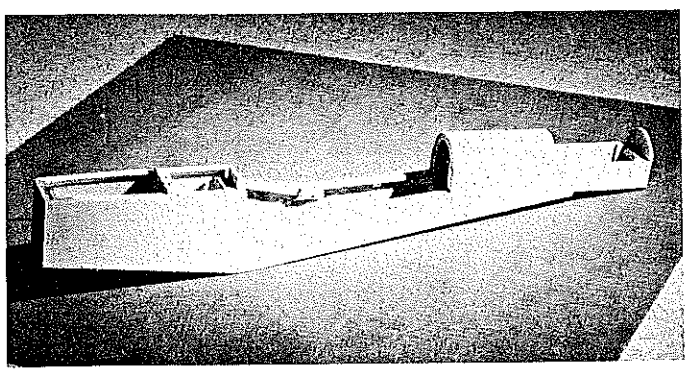
fler, attached to its mount, position it on the firewall, canting it counterclockwise (see front view). Hold the thrust line indicated, and allow for muffler clearance and proper carburetor location with respect to the fuel tank. Mark and drill the firewall, then install four 6-32 blind nuts (or three, if you intend to use a fiberglass cowl) on the back side.

The aft engine is side mounted with the exhaust down. While a standard mount such as a Dave Brown 4045 can be used, a lightweight variety is shown on the plans. The engine should be placed as close to FR as possible while still allowing clearance for the Tatone EM 40ss manifold. Lite Ply spacers can be used between FR and the mount, and if the mount arms are longer than necessary they should be cropped off to save weight. Use three 4-40 blind nuts with bolts to install the mount. Remove the mounts before continuing with the fuselage construction.

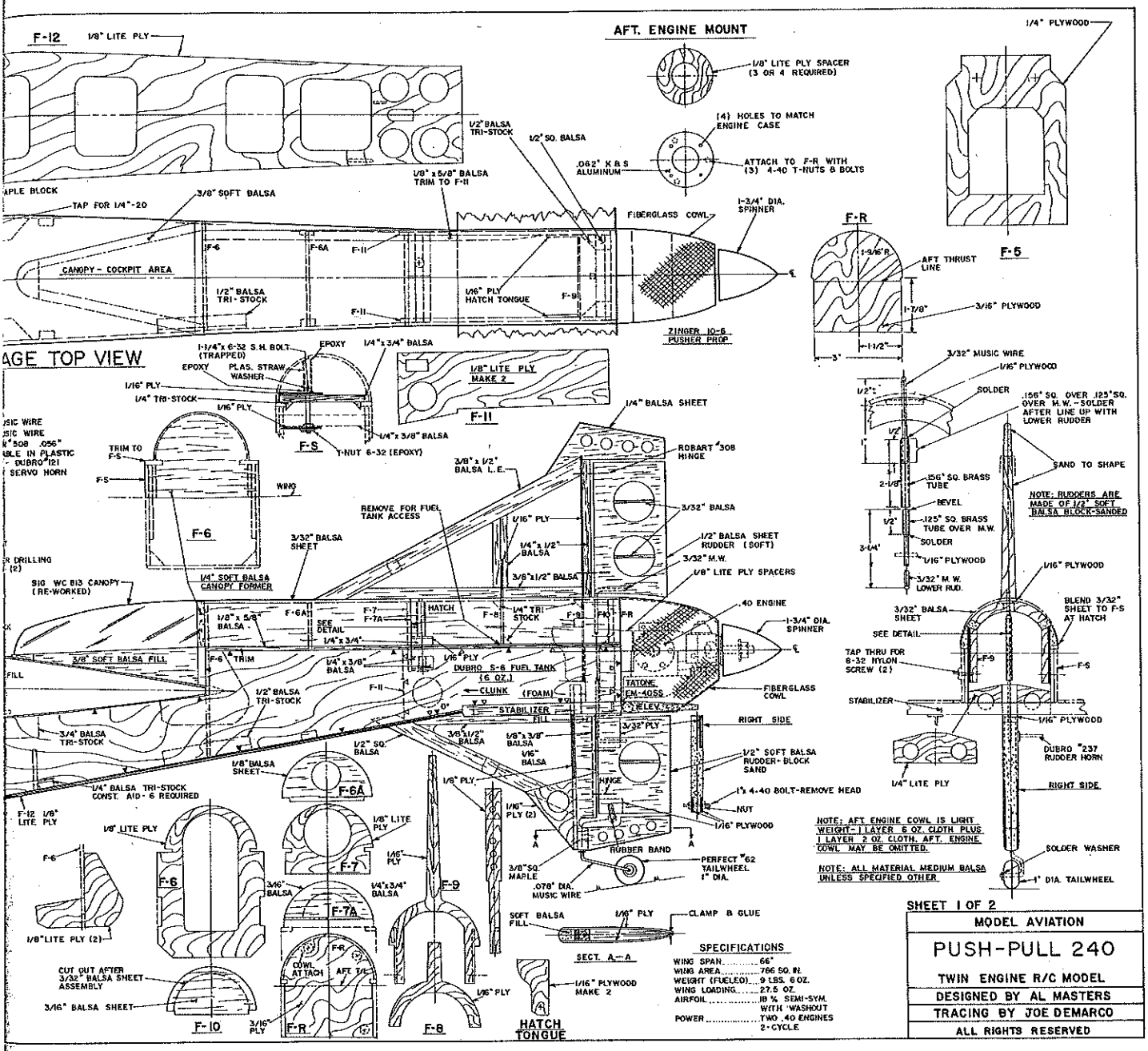


Cut the remaining fuselage components from the materials specified. Note that F1 is ⅛-in. birch ply and includes a switch cutout. F12 and F13 are shown actual length on the plan and can be traced as one piece,



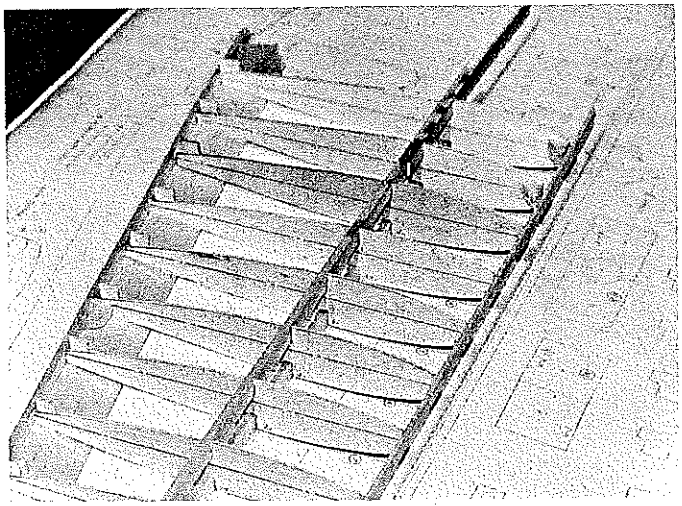


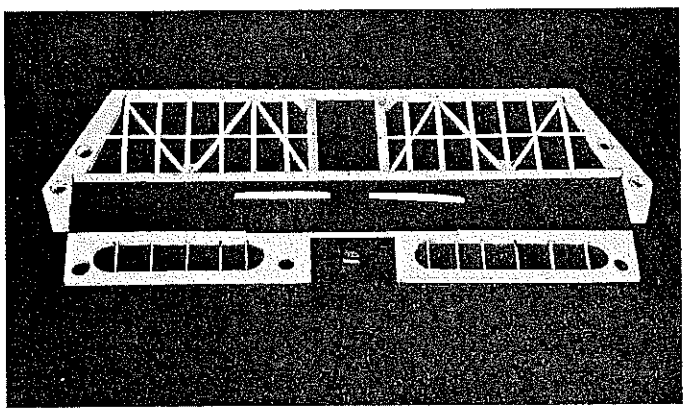
Left: Fuselage parts. Lite Ply sides and bottom, in conjunction with birch ply and balsa, keep the weight distribution under control. Notice the two pre-formed balsa skin pieces. The fuselage side doublers have already been glued into place. Above: Completed basic fuselage. The straight lines of this design signify an easy layout.



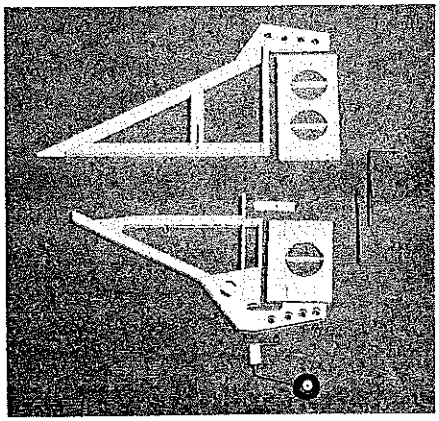
sanded to the correct outline, then cut apart. The finished components should include drawn centerlines to aid in lineup during assembly. Cut the lightening holes in F12 after separating it from F13. Glue the six construction aids to F12.

Make the preformed 3/32 balsa skin for the aft fuselage section. You will need some household ammonia and a cardboard tube of approximately three-inch diameter. A core tube from Christmas wrapping paper works fine.

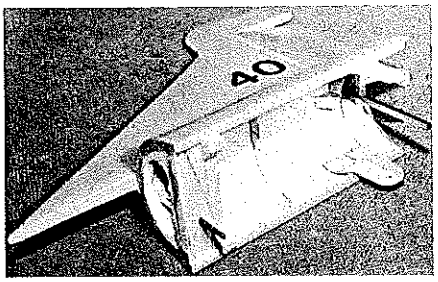




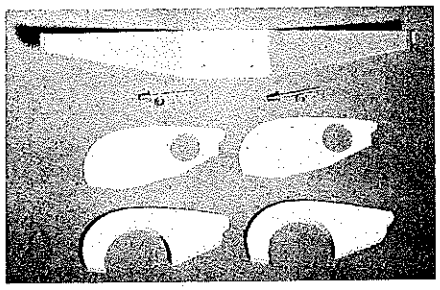
Left: The wing panel begins to take shape. It has been turned over here to show the construction tabs. Above: The bare bones of the horizontal tail show the lightweight structure. Because of engine vibration, it must be more rugged than those of a conventional model.



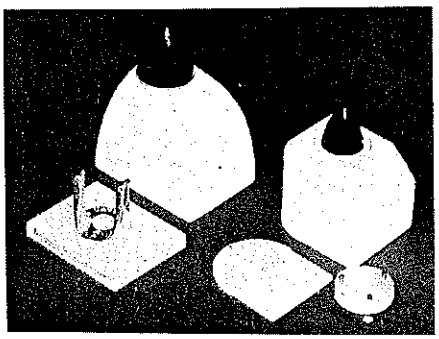
Due to the heavy side loads and the engine weight, it is necessary to use birch ply and hardwood for the lower tail post system. Note the soldered upper and lower torque rods.



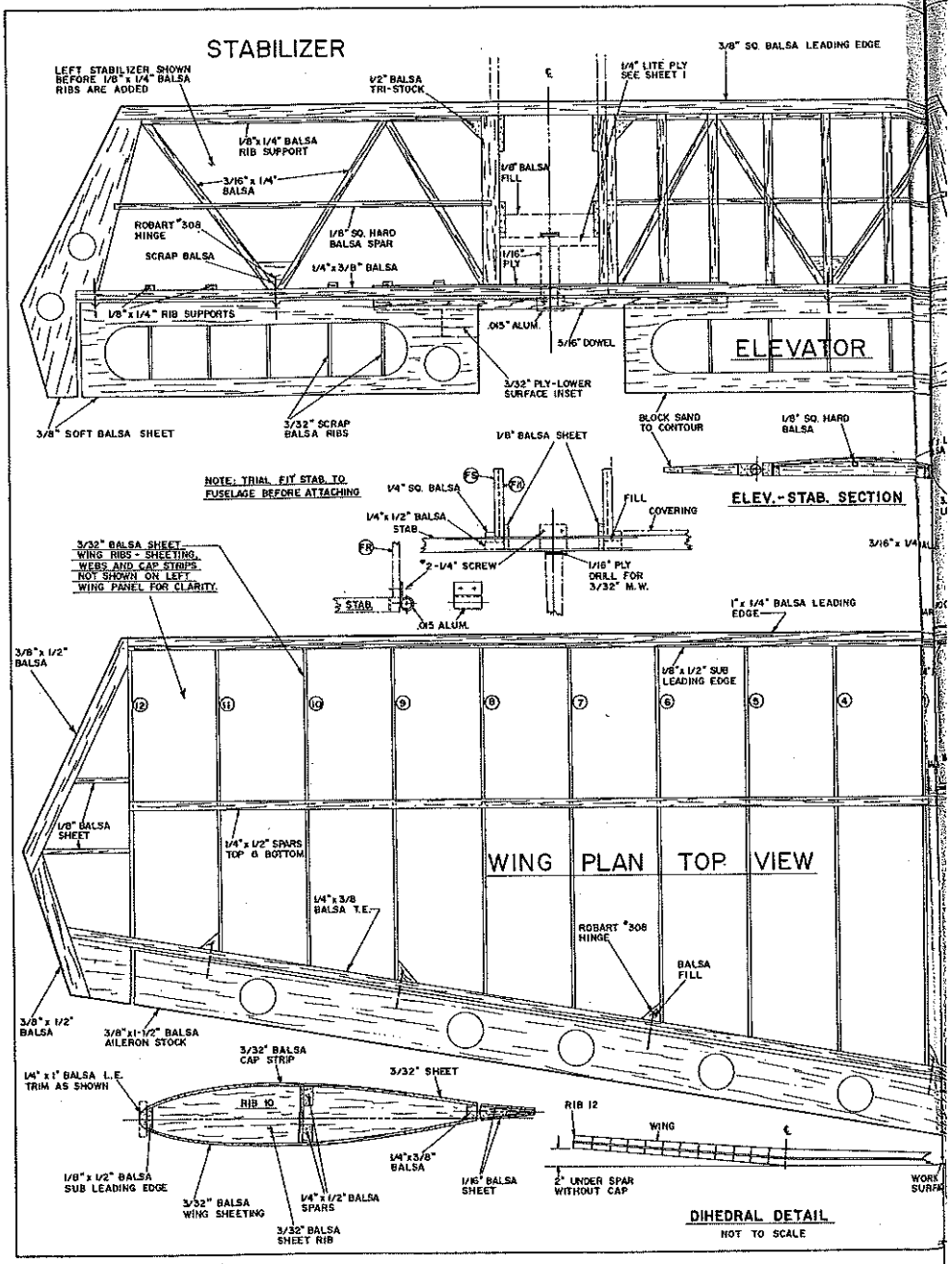
The upper rudder is fitted with a square brass tube that assembles with the lower rudder and tail wheel. The hatch offers easy access to the fuel tank supplying the aft engine.



Wheel pants are cut from 1-in. balsa block and reinforced with ⅛-in. birch ply. Do not carve to a nice streamline shape, as the extra drag helps slow the model down during landing. This model is a twin but, it only has the frontal drag of a single-engine model.



The finished nose cowl foam plug and roughed-out aft cowl plug. The aft cowl can be omitted, but the front cowl adds 4 oz. of much needed nose weight. A lightweight aft engine mount is used to help get the right CG.



Select two 7½-in. lengths of 3/32 sheet from 6-in.-wide stock. Trim the balsa to a 5-in. width, and soak it in the ammonia for at least five minutes. Blot the wood with a paper towel and wrap it around the tube, using masking tape to hold it in place. Set the balsa skin aside, and allow it to air dry thoroughly. Save the ammonia for another project.

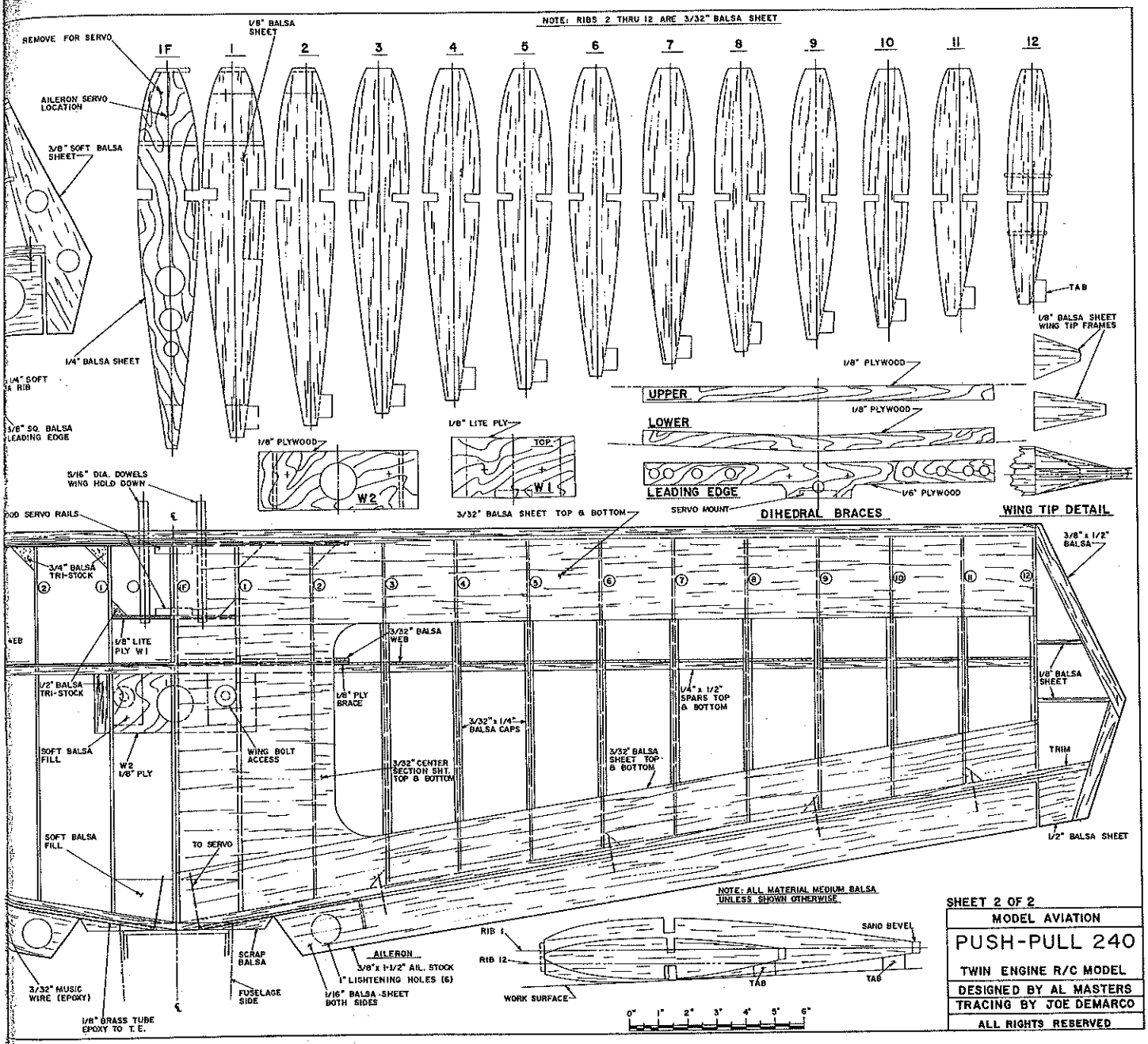
Begin assembling the fuselage over the top view of the plan. Support the sides upright, and glue the firewall in place using F5 as a spacer. Use white glue since it will allow more time for lining everything up. Place a weight such as an ordinary brick on the top front edges of the fuselage sides, and clamp FW in place. Do not pull the aft fuselage section together at this time. The lower fuselage line forward of F5 is straight, so the weight will keep the setup square on the work surface until the glue sets.

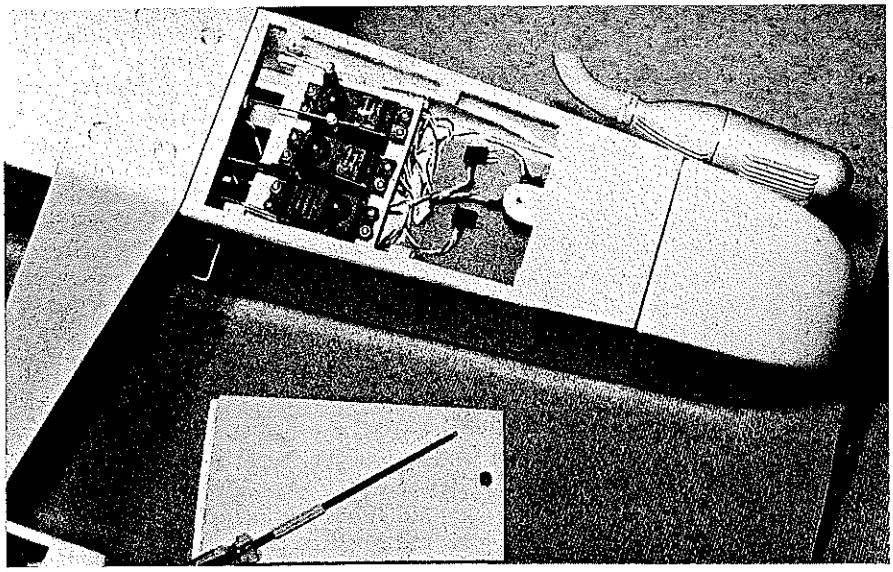
Attach FR using white glue or 10-minute epoxy with the aid of a clamp. Hold the sides together, and attach F6 with cyanoacrylate (CyA). Add the two ¼ x ⅜-in. crosspieces that fit into F11. Check the position of F5, and tack with CyA.

Make relief notches in F1 to clear the blind nuts on the back side of FW. Force F1 into position, where it will aid in correcting any misalignment of the front firewall and F5, and attach with CyA. Install 3/16 x ¼-in. hardwood servo rails, and make a servo tray from ⅛-in. ply to fit. After gluing F3 into place, set the fuselage aside—you'll be completing it later—and proceed to the wing.

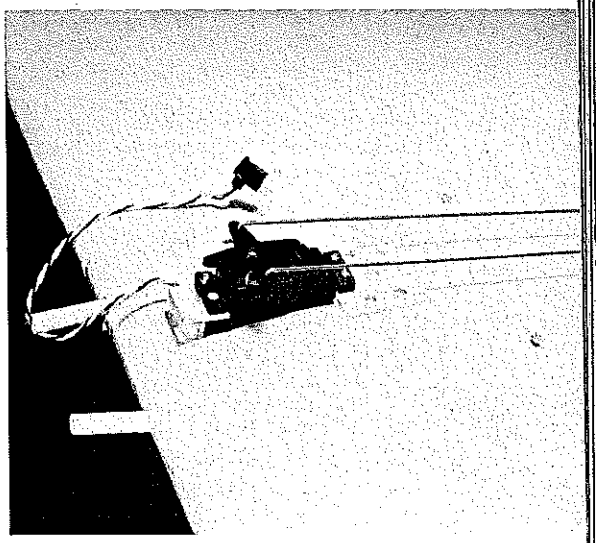
Wing. Trace and cut one set of ribs, using them as a pattern to make a second set. Finish sand the ribs in pairs, and draw the chord lines shown on both sides of each rib. Cut the dihedral braces, and draw the two centerlines indicated on both sides of the leading edge brace. Cover the wing plan with wax paper or plastic film before proceeding.

Cut four straight ¼ x ½-in. balsa spars to length. At this point I weigh the four pieces and distribute the spars to avoid using the

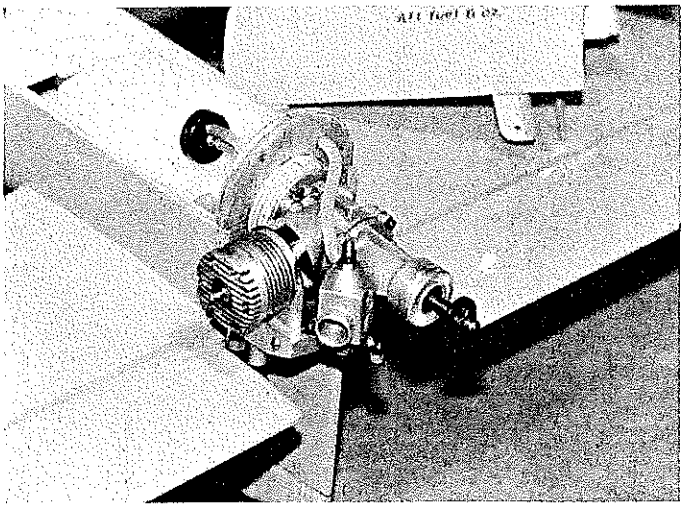


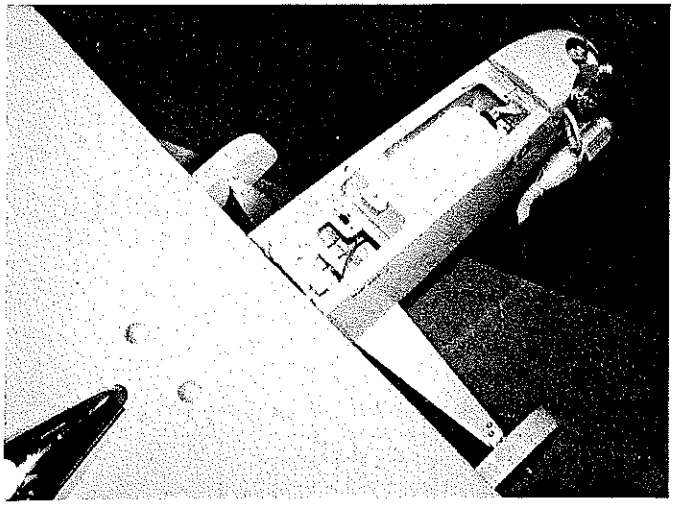


The receiver battery pack and three servos are nestled in the lower nose section below the 12-oz. front fuel tank. With dual take-offs, an S-28 servo controls the throttles on both engines.

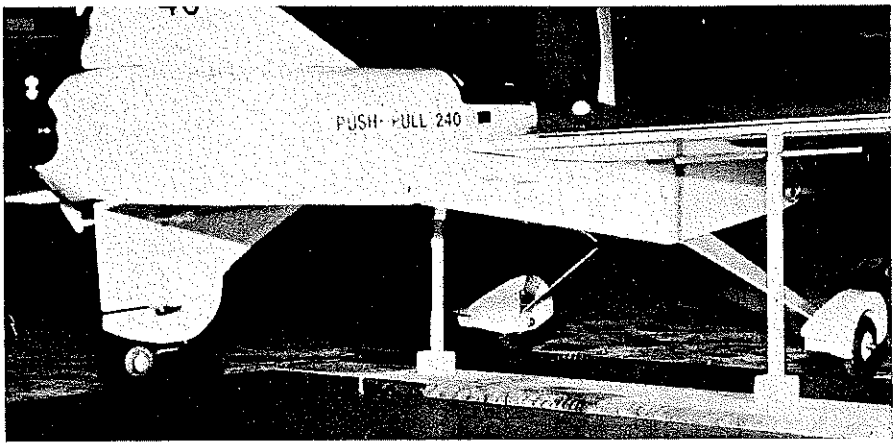


The aileron servo is carried well forward in the wing. Z-bends in the 1/16-in. music wire push-rods are used to connect to the servo arm.





Left: Both the K&B .40 and the O.S. .40FP have been used for the aft engine with equal success. The Lite Ply spacers on the firewall provide clearance for the Tatone manifold. Right: The fuel tank nose compartment is sealed to keep the fuel from leaking into the electronics below.



The finished model resting on the author's balancing rack. Location of the correct CG should always be determined on every model before making that first trip out to the flying field.

two heaviest on the same wing panel. A postal scale and a coding are used.

Glue the lower ply dihedral brace to one of the spar halves, and position the spar over the plan, securing it with pins or weights. Position ribs 1 through 12 on the spar, making sure the construction tabs are resting on the work surface. The ¼ x ⅜-in. trailing edge and the ⅛ x ½-in. leading edge are pinned in place on the ribs to aid in the lineup. The space between ribs 1 and 2 provides for the leading edge brace, which will be slipped in later.

After making sure that all ribs are perpendicular to the work surface, CyA the ribs to the spar, leading edge, and trailing edge. Fit the upper spar, and glue it in place. Block sand the upper surface of the trailing edge slightly to follow the rib contours.

Select four sheets of 3/32 balsa (2-in. stock) for the upper and lower trailing edge skins. Check their weights, using the two heaviest on opposite panels. Hold a metal yardstick edgewise across the ribs at the inboard sheet edge to be certain that the sheet line will be straight when attached to the ribs. A high rib can be carefully sanded down, but don't worry about a low rib at this point.

Turn the wing over. Using a piece of wood such as a ruler, press the wing downward to contact the 3/32 sheet as you bond the ribs with CyA. Work about three ribs at a time, starting at rib 1 and skipping any low ribs. Maintaining a straight sheet line without waves is more important than gluing every rib, and a chip of ¼-in. triangle stock can be used to support the skin at a low rib. The cap strips added later will hide a multitude of construction errors!

Build the wing tip, and attach it to rib 12. Center the tip on the rib chord line at the leading edge and on the ¼ x ⅜-in. trailing edge. The balsa filler at the trailing edge tip will allow for block sanding to fit the contours of the 3/32 sheet and aileron. Attach the tip webs, which will be final sanded after the rib caps are in place. Add the four hinge supports and the vertical-grain 3/32 spar webs between ribs 3 and 12.

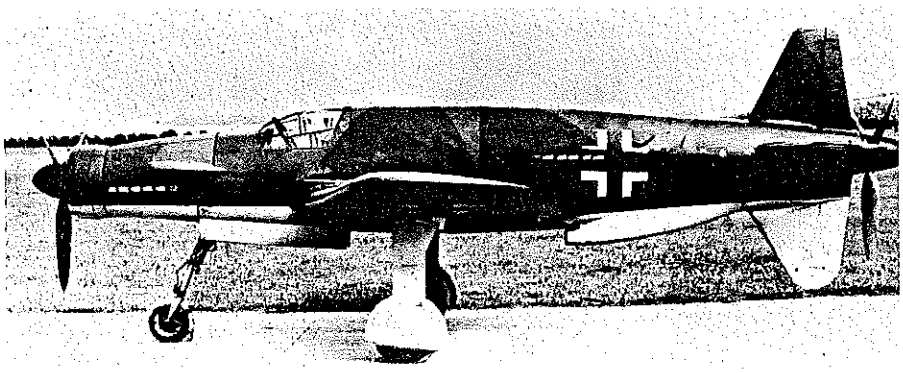
Fit rib 1F into place. With the panel one inch off the work surface at rib 12, set 1F perpendicular to the work surface; glue it to the trailing edge and the spar notch while tack gluing it to the leading edge. Note that 1F is shown at actual length on the plan and that it reaches the leading edge strip. Allow space in the spar notches in which to fit the dihedral brace and the mating spars later. Set the panel aside, and construct the opposite panel in a similar manner.

With the completed second panel on the work surface, fit the two panels together. Elevate the first panel 2 in. as per the drawing, and push the lower spars together until they butt. Slightly bevel the spar end to obtain a good fit. The upper dihedral brace is slipped in alongside the upper spars and clamped, using at least two clamps on each side of the wing centerline. Make sure the ⅛-in. dihedral brace fits flush with or slightly below the spars, as sanding down later will be difficult.

Add the leading edge ply brace, clamping it in the same manner. Rib 1F will have to be razor sawed ⅛ in. shorter. Make sure the horizontal centerline of the leading edge dihedral brace is located correctly on ribs 1 and 2 on both panels.

The bottom edge of the servo mount sec-

Continued on page 34



The idea for the RC Push-Pull 240 came from the WW II Dornier-335. Reported as the world's fastest propeller-driven aircraft of its time, the war ended before it could be made operational.

tion should be parallel with the work surface when the wing is level. With the upper spar and the leading edge clamped, and the rear section of the wing panels butted at the trailing edge, make a final check that the spars run straight from tip to tip. Hit the areas with CyA.

Carefully turn the wing over, and clamp the lower dihedral brace with two clamps and CyA. Add the four ¾-in. triangle braces at ribs 1 and 2. Complete the center section shear webbing, and cut off the construction tabs. Add the balsa filler blocks at the trailing edge bays between ribs 1 and 1F. Carve the notch on the bottom of 1F to accept W2. Install the latter, gluing it flush with the bottom of rib 1. Remove a section of 1F to accommodate the aileron servo. The location of W1 can be shifted if necessary to allow space for the aileron servo. Install W1, and add ½-in. triangles to support it and W2.

The upper and lower leading edge sheets are attached with a 1/16 overhang at the leading edges. Wetting the outside surface of the sheets will make forming easier. The sheet edges will be block sanded until they are even with the leading edge to provide a flat gluing surface for the ¼ x 1-in. leading edge cap.

Fasten a ¼-in.-thick scrap spacer along the leading edge with masking tape. Place the wing on the fuselage, and check the saddle area for fit. Remove the wing, and epoxy the hardwood hold-down blocks in place. A temporary ¼ x ½-in. cross brace is glued near the blocks for fuselage side support.

When the epoxy has cured, align the wing on the fuselage, and hold it in place with masking tape. Drill through W2 and the hardwood blocks with a 3/16 bit held perpendicular to W2. Remove the wing, and redrill W2 with a ¼-in. bit.

Tap the blocks for the ¼-20 wing bolts. Bolt the wing in place, and drill two 5/16 holes through F5, the leading edge, and W1. Trial fit two 5/16 dowels as shown on the plan. Use soft balsa or foam as filler around the the wing bolt holes, sanding down for the center section top sheeting.

Remove the dowls, and complete the wing sheeting, rib caps, and leading edge cap. Drill through the leading edge cap with the 5/16 bit. The two dowels are epoxied in after the wing has been covered.

Ailerons. Cut the two aileron cores from ⅜ x 1½-in aileron stock. After making the lightening holes, cover the ailerons with 1/16 sheet balsa. Drill the four holes for the hinge pins with a ⅛-in. bit, and drill the 3/32 hole for the torque rod. Transfer the hinge locations to the wing, and drill. Trial fit the ailerons with hinge pins and with the 3/32 torque rod assemblies. When the alignment is correct, epoxy the brass tubes onto the wing trailing edge. Remove the ailerons for final sanding and covering.

Fuselage-wing assembly and final fuselage construction. Razor saw the two slots

at the top of F5, and sand them to accept the wing dowels. Do not make the 5/16 drilled holes oversized. With the dowels inserted, bolt the wing in place.

Lay a small piece of wood across the top of the dowels, and trace its lower edge line location on F5. Move down 1/16 in. below the line just made, fit a piece of 1/4-in. ply between the dowel holes, and epoxy to F5. Epoxy a 3/4-in. triangle brace under the ply. Drill a 3/16 hole on center through the ply, and tap for a 1/4-20 bolt. Treat the hole with CyA. The 1/4-in. ply wing hold-down has a 1/4-in. drilled hole (see the drawing detail).

Cut two fuselage trim pieces 1/8 x 5/8 x 15 in. long from medium-hard balsa. Glue these to the top of FS so that they extend beyond FR about 3/4 in., but don't glue them beyond F7. Make a 3/16 notch in each trim piece to allow them to be pulled together slightly behind FR and secured with a rubberband or tape. Slip a piece of wax paper between FR and F10, and clamp F10 to FR. Glue F10 to the trim pieces, being careful not to bond the latter to FS.

Cut a piece of 1/4 x 3/4-in. balsa the width of F7A. Add 1/16 ply to the top, and drill a .140 hole (#27 bit) where shown. Glue the 1/4 x 3/4-in. piece to the top of the trim pieces, but not to F7. Glue F7A on top of the crosspiece after fitting it over the 1/16 ply. Install a 1 1/4-in.-long 6-32 socket-head bolt with washer through the .140 hole. Use a small piece of tape to keep the bolt from falling out.

Trim a section of preformed 3/32 skin to fit between F7 and FR, overlapping both slightly. Sand the bottom edges so that they're in alignment with the top of the trim pieces and to mate with F7A and F10. CyA the skin to the trim pieces only.

Aft hatch. Razor saw to remove the aft extensions from the trim pieces; cut through at F7. Remove the hatch section, and complete the application of CyA to F7A and F10. A piece of plastic soda straw epoxied in place will keep the 6-32 bolt trapped.

Sand the 3/32 skin flush with F7A. Install F8 and F9 through slots cut in the formed skin. Small pieces of triangle stock add the final rigidity to the unit.

Complete the hatch front hold-down by placing a piece of 1/16 ply with a 6-32 blind nut under the two 1/4 x 3/8-in. fuselage crosspieces. Line up the hatch, and snug up the 6-32 bolt. (Use a Du-Bro ball wrench inserted through a small hole in the skin.) CyA the ply in place, remove the hatch, and epoxy the ply to the cross members.

The two 1/16 ply aft hold-down tongues are installed as follows. Shave off the excess material on the inside of the hatch trim pieces. With the 6-32 bolt and masking tape at the rear holding the hatch in place, work through the opening at the fuselage bottom. Position the ply tongues, and tack them with CyA to F9 and the 3/32 sheet. Do not bond them to FS. Remove the hatch, and epoxy the tongues.

Again bolt the hatch, and secure it with

Continued on page 136

duke's mixture

Freebees available at this time are our new color catalog, new price sheets, and parts sheets for 1988 and 1989 model motors. We would appreciate receiving a self-addressed envelope with two stamps, however.

Effective January 1, 1989, all Fox motors (except the Combat) are supplied with mufflers.

For some time I have been using the "soft sell" approach in these columns. Many of our customers are more direct. Here are some excerpts from letters we have received.

Eric Larson, Pine Grove, CA — "Dear Fox Mfg., Yesterday I bought a Fox 40BB Delux. It was the first Fox engine I have owned. It was with some apprehension that I bought anything other than an O.S. engine, as I have been burned before buying off brand engines. Today, I am converted. The Fox 40 and my O.S. 40SF are similar in that they both start and idle magnificently and I can't tell any difference in their power. But that's where the similarities end. The Fox 40 vibrates less, is easier to adjust, is lighter, comes with a great spinner, costs half as much, and is American made. I have now made sure that everyone in my flying club knows what a great buy Fox engines are. THANK YOU FOR A QUALITY PRODUCT."

Eric Branham, Paris, IL — "After purchasing 40 Delux this year I am impressed. It performs exceptional (a lot better than O.S.). Are you planning to replace the Eagle III with an update 60 size? If so, you will be assured that I will be first in line to purchase."

Jon Armitage, Indiana, PA — "I wanted to send you a letter of praise about your motors. Your motors were all I used when I flew C/L and FF. When I started in RC about one year ago, I decided to try a Super Tiger 25, OS 4 Stroke 40, and they were good, but I came back to Fox. The power, quality, and handling all at a decent price. Your engines are the most popular at our field."

Will Sgarlat, Cape Cod, MA — "Just a note of thanks for all you've done for this wonderful hobby of ours — your fine engines, Duke's Mixture column, and the terrific service you offer to those of us who accidentally smash up Fox engines beyond what they'd care to tackle in repair."

Westley A. Keller, Gouster, OH — "Sir, I have been meaning to drop you a line for some time. The 40 motor I had trouble with that you replaced put the icing on the cake. I will never run anything on my planes unless it says Fox on the side. The performance and service says it all. On the subject of the Decals; at the present time I am running 8 Fox engines, so I am requesting Decals accordingly. Also, I am looking forward to the coming of the Eagle 4. Keep going with the best engines in the world."

Barry Doughty, Absecon, NJ — "I replaced an old OS Max 60 in my Clipped Wing Cub by Top Flite with your new Fox 50BB. WOW — what an engine, no vibration, started right out of the box with no adjustments. Idled good, acceleration from idle to full and back was terrific. Weight was the big factor purchasing the 50BBRC, which is lighter than OS, SuperTigre, Como, etc. Also must add, replacement parts are more economical than foreign imports. Coming in for landing the motor idled down beautifully and settled in for great landing. Again, this engine is something else, loads of power and very easy on fuel for a 50 size engine."

John Holder, O.D., Steverson, AL — "This engine was obviously defective. Why else would it have pulled the wings off of my Aerostar 40? Seriously, I was very pleased with this, my first Fox engine."

Vaughn Kempf, Modern Hobbies, Miles City, MI — "Just wanted to take a few minutes and send a few words of praise your way. I talked three of my customers into buying the Fox 40BB Delux motors. We are all quite impressed with these motors, and have a couple of observations to pass along. First, we have found that your performance figures seem to be a little conservative (modest)? We are measuring 14,000 plus with Master Airscrew 10 x 6 props, using a Royal Pro Tach for the readings. Idle is lower than any other 40 I've ever run, and realiable, even during spins, snaps, and inverted idling."

Kenneth Wilson, Schenectady, NY — "Want you to know that I am a loyal and satisfied Fox engine user, as over the years I've owned the U/C 36, many Fox R/C engines, such as the Fox 25, early Fox 40 and Eagle III. I currently own 2 Eagle IIIs. I must compliment you on the quality and value you've designed and built into Fox engines."

Corey Wills, Perryville, MO — "I wish to compliment you on having the finest engines made. Several of my friends and I have been flying Fox for the past three or four years, and I wouldn't give them up for any other engine. Even with the somewhat higher prices lately, they still can't be beat for affordability, reliability and performance."

Doc Matthews, Wichita, KS — "I just had to drop a note to express my pleasure over your engine (Fox 45). Excellent mid-range, easy to start and set, a super neat spinner set up (and finally a safe one), and most of all, incredible power."

Larry Maltman, Winnipeg, Canada — "Thank you kindly for so promptly and courteously filling my last order. I appreciate the excellent service. It seems that in today's hurried ways few businesses take the time to do what just seemed natural for Fox Mfg. Co. I have been an active builder/flyer since 1962. My first Fox engine was reliable and durable, and I am also happy to state that the additional 17 Fox engines I have purchased since 1962 are all running reliably and consistently."

Lester Goldsmith, Action Hobbies, Memphis, TN — "I am writing to tell you that the Fox 60 Heli Engine has cranked and run flawlessly right from the start. Enclosed are pictures of it in a Schluter Scout 60. I did test run the engine before installing it. I believe that was not really necessary because I just cranked a Fox 45 Heli today new and unrun (except by your factory) in a new Schluter Junior and it was as though I had test run it. It too cranked and ran immediately, idled perfectly and was very smooth. I believe the word is getting around that Fox is one of the best buys now because the compression is always good making starting good. The power output is always above average or tops, as confirmed by test articles in magazines. Life is always good because you do not appear to cut corners on important features, such as bushed conn rods and grades of material. Parts are always on hand and on tap and your factory service is unmatched anywhere."

Eugene Mathis, Daphne, AL — "Took your Fox 40BB out to the Club field last Saturday, kicked the tires and lit the fires and took off. I leaned it a bit and flight number two went the whole tank and really started to come in. Flight 3 was very spectacular; pulling vertical to do a stall turn, I finally had to throttle off as it hung on the prop and just kept going. A veritable hoss it is because the Kaos 40 weighs a ton."

Walter Pawlukanis, Oakhurst, NJ — "I don't normally write to manufacturers (or anyone else as far as that goes) matter of fact — I can't remember when I wrote last. However, I am really impressed with the Fox 40BB Delux. WOW — what an engine. I have mine mounted in a 40 size Ugly Stik type airplane, with about 2-1/2 gals of fuel through it so far. Eyes were popping when it started right up and required only some hi-speed adjustment. Since then until now it has gotten better and better. Vertical performance just doesn't quit — throttle response is so certain and sure that I'm willing to wager (bet money) on its certainty."

Al Mancini, Los Angeles, CA — "I salute and thank you for the incredibly fast turn around on my phone order. Onward and Upward."

Andy Keeley, Memphis, TN — "I bought an Eagle III and put it on a 6-1/2 pound airplane. The next day at the flying field I had great airplane with all the vertical performance I needed and more. Thank you for the great engine. I also like Duke's Mixture in Model Airplane News."

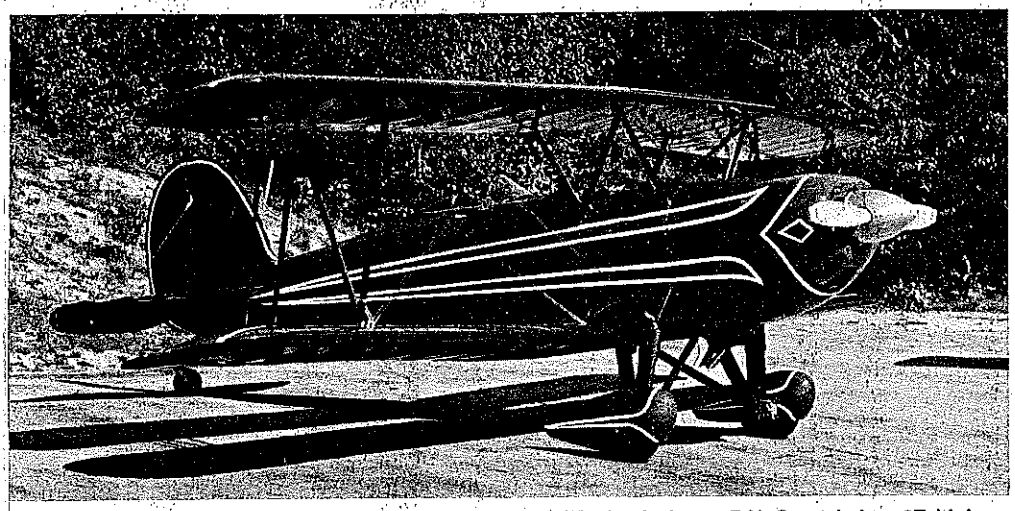
Happy Flying,

Duke Fox

George M. Myers

Radio Technique

70 Froehlich Farm Rd., Hicksville, NY 11801



Too bad this isn't in color! Larry Bashore's (Mechanicsburg, PA) Great Lakes 2T biplane gleams in red/white/blue paint. It might be the prototype of George's next Scale ship. This plane uses a flat-4 Lycoming AEIO-360 engine instead of the original inverted, inline Menasco engine. Myers has seen it entered in Aerobatics competition in Jaffrey, NH and Red Lion, NJ.

ABSTRACT: Predicted 1991 operating conditions, whether or not AMA goes to 50 channels. (Part 1) Single-conversion receivers.

WHAT'S AHEAD? I recently received this letter:

"Dear George,

"I just recently joined AMA and am now worrying about '1991 specifications' for radio. Will I be able to use my 1988 *(name deleted)* AM radio equipment, or for that matter, any other 'non-1991' equipment after 1991?

"Will the manufacturers continue to offer their 'cheaper' line of radios, like four channels for $100 or so? I am very confused on this."

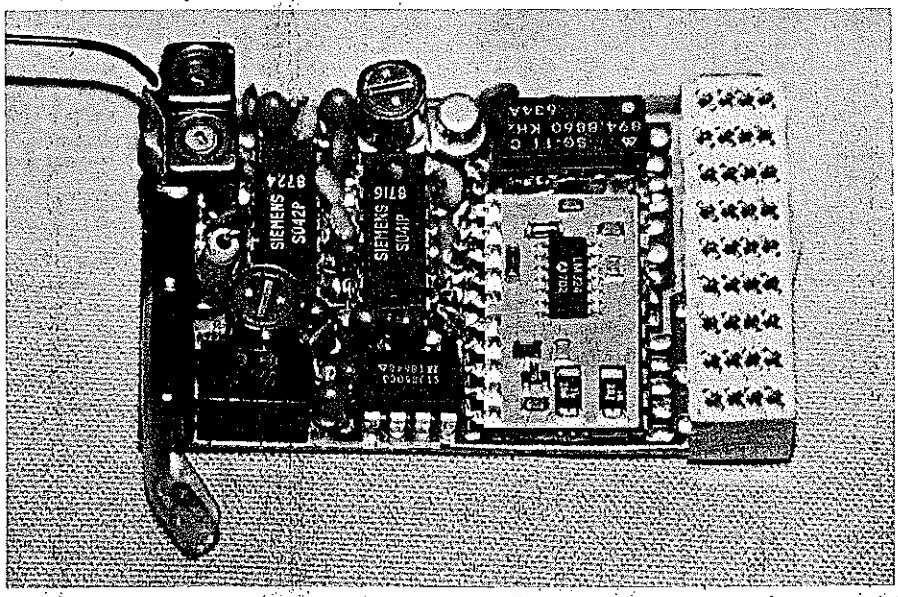
s/Jim Hobelsberger, 2956 Kelly Rd., La Crescent, MN 55947.

My answer to him follows:

Dear Jim,

First, and most important, your 1988 system has a narrow-band transmitter (Tx) and a pretty good receiver (Rx). It will work through 1991 and beyond. The people who are confusing you probably have older equipment which isn't as good as yours.

Now, let's look at the situation of the folks with the old equipment. I am not a lawyer, so this is not "legal advice," but it is the way I understand the situation.



Polk's Powermax Merlin PCM single-conversion, narrow-band receiver is free from the interferences which will be introduced when all 50 aircraft-only RC channels are opened up in 1991. The PCM computer is vital to this type of performance, since it can reconstruct valid control information from previously received signals, thereby continuing to maintain control even in the face of 50% interference! Myers has more to say about this radio this month.

Equipment manufactured to a Type Acceptance certificate issued to the manufacturer by the FCC can be legally used for RC flying so long as it is on one of the 50 "Aircraft Only" 72 MHz channels or six "all models" 27 MHz channels approved for RC use by the FCC. If you have an Amateur Radio Operator's license, you can fly in the ten 50 MHz or eight 53 MHz channels. That's 74 channels available! You have a right to fly Type Accepted equipment until it either wears out or you dispose of it. So, you can fly what you have in 1991 and beyond.

The difficulty here is that Type Acceptances don't have expiration dates on them. If FCC regulations change, production of obsoleted equipment ceases, but you, the owner of the equipment, have no way of knowing about it. All you know is that the transmitter you are holding has a Type Acceptance sticker on it. Therefore, something built in 1970 under Type Acceptance or Type Certification in force THEN (before the current narrow-band channels existed) is legally usable NOW. You can see the danger in that, can't you?

There has been talk about asking the FCC to put a time limit on the legal use of obsolete equipment, but nothing has come of it. The sticking point is the definition of "obsolete."

The AMA's program to put Gold and Silver stickers on transmitters has been conducted to filter out the dangerously inadequate—but otherwise legal—equipment that is still around. It is a credit to modelers everywhere that they understood what was being done and reacted responsibly. The "AMA Radio Guidelines" published in your *Membership Manual* describe the performance characteristics of radios that should be able to work together in the 50-channel 1991 environment. You might guess that anything which doesn't conform to the guidelines is obsolete, and in one sense that could be true, but you have to remember that *the guidelines are not FCC regulations.* Therefore, they can't obsolete anything. As written in the 1988 *Membership Manual* on page 11, the guidelines are a little vague about single-conversion receivers. That will be corrected.

You can ignore the guidelines until you want to fly in AMA-sanctioned competition, in which case you will need a narrow-band transmitter (as defined in the "AMA Radio Guidelines") to enter competition on channels RC12, 14, 16 . . . 34 right now. Wide-band transmitters are acceptable in channels RC38, 40, 42 . . . 56 right now.

Beginning in 1991, you'll need narrow-band transmitters (with Gold stickers and whatever other documentation AMA requires) to fly in competition on any channel. There is no distinction between AM and FM—or between PCM and other encoding schemes—in these guidelines. FM isn't the only way to go.

The AMA does not require a narrow-band RECEIVER for competition use at this time, but in my opinion it should. Until narrow-band receivers are required, AMA Contest Directors must be counted on to schedule the use of RC channels in competition events in a way that minimizes modeler-to-modeler interference, taking into account the characteristics of receivers currently in use.

None of the manufacturers' representatives

I've spoken with reports any plan to continue producing what they used to sell. They all stopped producing what I would call "low-performance equipment" five years ago. There has been steady improvement in the performance of the equipment offered for sale, to the point that some of the cheapest radios of 1988 outperform the highest priced radios of 1982 and earlier, even when they don't meet the AMA guidelines.

Expect to see high-performance, narrow-band, four- to six-channel channel FM sets—and/or five-channel FM/PCM sets—as everybody's "low-cost" model in the immediate future. Since practically all RC equipment comes from the Far East, the price will be a function of the U.S. dollar's value relative to Far East currencies. It is anticipated that future price leaders will cost less than $200.

You know that AMA plans to sanction use of all 50 aircraft channels in 1991. You also know that there is some "40 kHz forever" sentiment, intended to prolong the use of old wideband equipment. Let me get out my crystal ball to see what changes of operating conditions will result, depending on which plan is followed.

First, if AMA sanctions only even-numbered channels (40 kHz forever), then the FCC is almost certain to assign the odd-numbered channels to someone else. The critical point to remember is that *all 50 of our channels are exclusive to us now,* BUT WE ARE ONLY ACCORDED THE STATUS OF "SECONDARY USERS." That means we must accept interference—but can't give any—if we let some other service capture the odd channels. You think that can't happen? The Amateurs have just lost 2 MHz of their 220 MHz band because the FCC believed that they weren't using it.

If you now accept the concept that SOMEBODY will be using all 50 channels in 1991, then the first thing to consider logically follows from that fact and from the mathematics of radio frequencies. Most single-conversion (SC) superheterodyne receivers use a 455 kHz local oscillator (LO) frequency (let's call them "SC455s"). Under the very specific circumstances following, wideband SC455s may see an increase of interference when all 50 channels are used (by somebody). *Most* old wideband AM (OWBAM) radios are SC455s.

Direct Interference:

1) The SC455's local oscillator (LO) frequency almost coincides with that of any RC transmitter (Tx) 23 channels away. It also almost coincides with any Common Carrier Tx (those guys in between our RC channels) located 22 channels + 10 kHz away. Whether or not they cause interference depends upon position in the band (interfering Tx above or below) and receiver (Rx) properties.

One way to avoid most of the bad effects of this situation is to build SC455s for RC11-35 with a LO frequency below their Tx frequency, and SC455s for RC36-60 with a LO above their Tx frequency—so long as you do not interfere with, or suffer interference from, other services outside the RC band when you do it. The AMA guidelines say the opposite, but they are written around dual-conversion receivers that have no "23-channel problem." A large number of receivers exist which have their LO placed inside the RC band, in accordance with the guidelines. The AMA Phase-In Plan masked the 23-channel consideration for a while by not sanctioning use of any odd-numbered RC channels.

Even with the LO placed correctly, SC455s on RC11, 12, 59, or 60 can be interfered with by Tx

Continued on page 141

Push-Pull/Masters

Continued from page 137

prop. The author owned a full-scale Lake Amphibian pusher for many years, and found that protecting the propeller from loose nuts and bolts (and fishing rods) was always a major concern. A twin engine with a push-pull arrangement is especially vulnerable. The front prop can kick up stones, starter cables, wiping cloths, etc., and promptly present them to the rear prop for digestion!

Flying a twin pusher also requires special watchfulness. One flight of the Push-Pull 240 was a near-fiasco. Immediately after takeoff the carburetor on the aft engine became loose and moved into the pusher prop, which promptly self-destructed. The engine, at full bore and extremely unbalanced, all but tore itself from the firewall—before fuel starvation saved the day! The whole scenario lasted about three or four seconds, and pilot Ray Doan brought the ship back on single engine. A thorough preflight check would have spared the pusher prop.

The main thing to remember, to get the Push-Pull smoothly aloft, is to advance the throttle(s) steadily during takeoff. Ground control will be positive with no torque correction required. Climbout will be solid, and as you watch her slice through the ether the sound of those twin .40s is something else!

Radio Technique/Myers

Continued from page 37

on RC34 through RC37, and vice versa.

2) The next condition change comes out of the mathematics of frequencies, too. "Image interference" will return for a few of the SC455s. Some folks will remember how 72.96 (Y/W) used to "image" with 72.08 (Bn/W). Well, only those SC455s on RC11-14 and RC57-60 can be affected by Tx within the band, and even then only if they have their local oscillator on the wrong side. I assume that the manufacturers simply won't sell SC455s on those channels. Besides, the image coincides exactly with Common Carrier Tx frequencies, not with RC Tx, which helps. But Rx with low LO have the possibility of imaging with TV4 (the RC44 problem we know and love). So you see, nothing is simple.

One cure for all the above is simple: Use a dual-conversion Rx.

The entry-level RC system almost always uses an SC455. The manufacturers will have to narrow-band them, pay attention to proper LO assignments, and keep them off RC11, 12, 13, 14, 34, 35, 36, 37, 57, 58, 59, or 60. Jim, you didn't mention the channel you are on, but I doubt that it is any of the above. The manufacturers just aren't selling them.

Indirect Interference:

A condition comes out of the numbers called "Second Order Intermodulation Product Interference (2IM)," which is generated by ANY PAIR of Tx operating 23 RC channel numbers apart. The difference of the two frequencies is a modulated 460 kHz signal that often goes right through an SC455 to be detected as interference. Think of this: 2IM generated by JUST ONE PAIR of Tx *might hit OWBAM SC455s on every one of the 50 channels simultaneously,* including their own Rx, depending only on signal strength at the Rx antenna and on the RECEIVER CHARACTERISTICS. Nobody uses the odd-numbered RC channels, RC11, 13, 15 . . . 59 today, so we don't see any 2IM. Can you predict what will happen if we give the 25 odd-numbered channels to another service?

Now remember, we are only discussing RECEIVER problems here, on the assumption that everyone is already using Gold-stickered narrow-band transmitters. Practically every Tx built since 1987 is good enough to warrant that sticker.

The easiest way to avoid all of the problems listed above is to use a dual-conversion receiver. Then you don't have to block out ANY channels. Jim, your manufacturer offers one of the best dual-conversion receivers on the market, and it is relatively cheap, so I recommend a letter to the appropriate person named at the end of my last month's column.

Even so, a narrow-band SC455 *can* work, because the interferences discussed above are ±5 kHz off the 455 kHz intermediate frequency (IF), not "dead on" like 3IM.

Narrow-band SC455s exist. For example, we (Bob Aberle and I) recently tested a Polk's Powermax Merlin system. The receiver is an SC455 on RC46, with its LO on the low side. An IF bandwidth of −6 dB at ±2 kHz is claimed, but nothing is quoted at ±8.5 kHz.

Merlin performance meets the AMA guidelines, except that its LO is on the wrong side, and it does not use dual conversion (DC). It outperformed every 1991 DC system we have tested, except one, but its PCM computer is slow. With the