Der Fle

■Paul F. Denson

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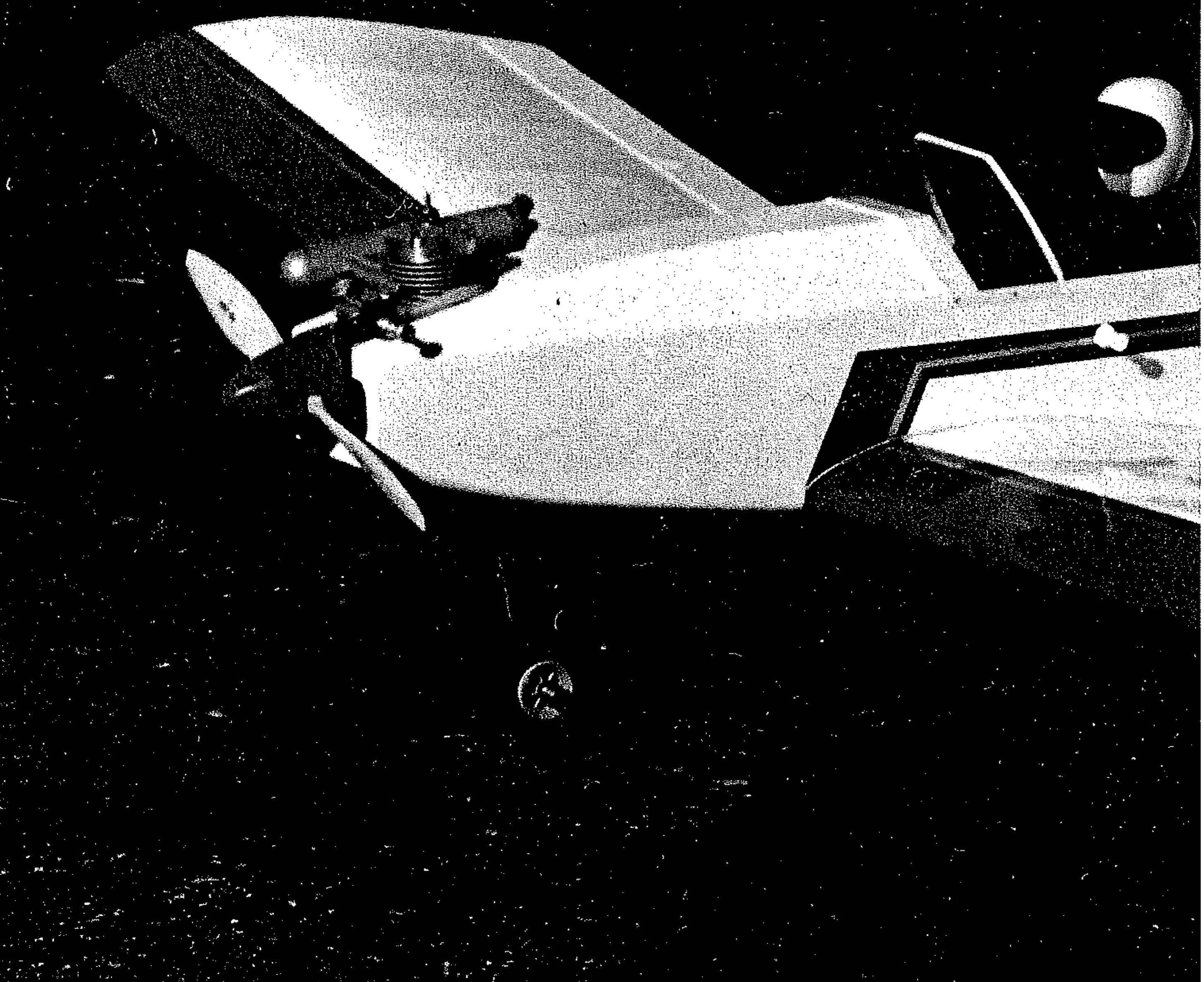
THIS DESIGN is the culmination of years of dreaming about a low-wing sport plane with dihedral in the outer wing panels. A number of small planes have been designed with this configuration, with the Jodels, the D-9 Bebe and D-119 Club, the Thorpe, and the Rollason Beta being among the more prominent.

I'm not too impressed with a flat center wing section with dihedral at the tips. I prefer a slight dihedral in the center section and pronounced dihedral at the tips as in Old-Timer Free Flight models. They had stability plus.

During the last year or so Charlie Parker's Pelican plans have been hanging on the wall of my workshop. The Pelican is a low-wing cabin job with tip dihedral wings and is .15-powered. This model has been one of my favorites for years. Pelican debuted in the January 1982 issue of *RC Modeler*. Charlie kitted it for a short time,

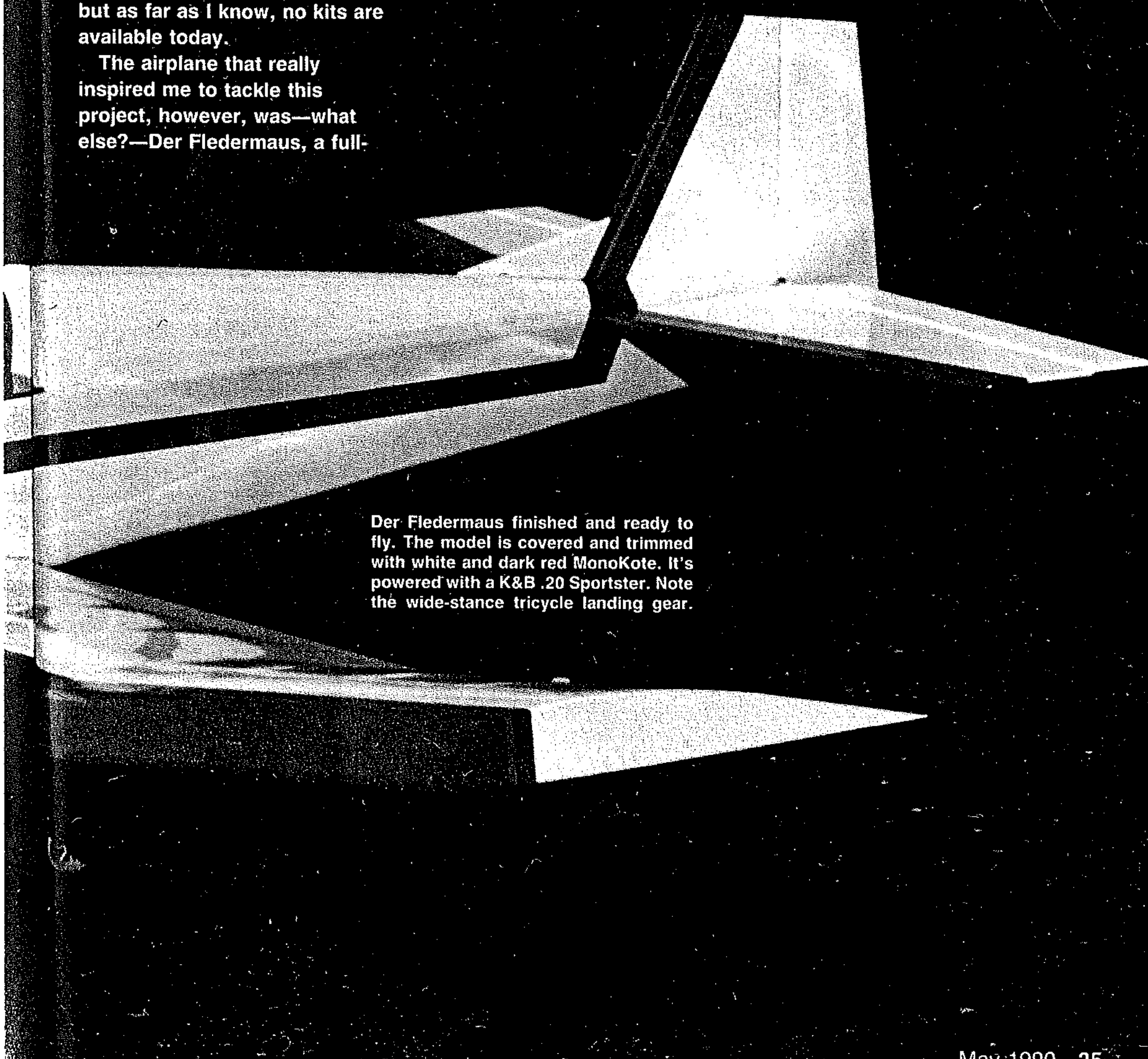


dermaus

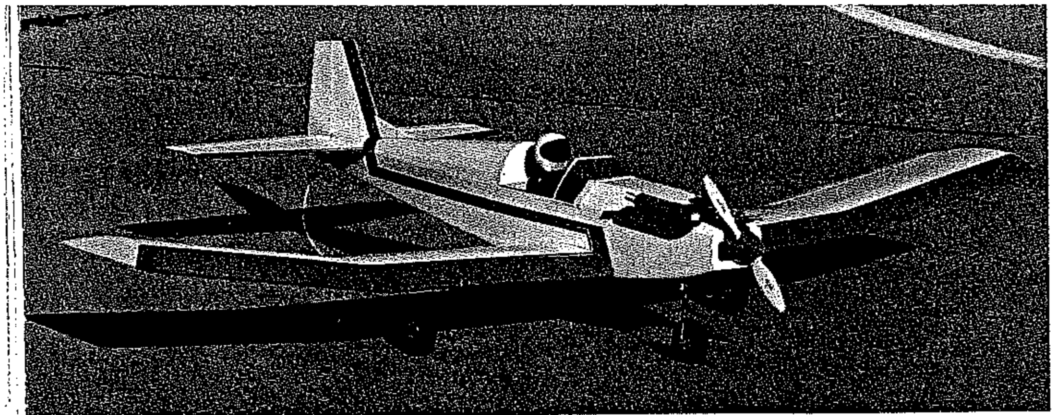
This .20-size RC sportster makes a great, superstable low-wing fun flier with its unique polyhedral 55-in.-span wing. It's designed for four-channel control but can also be flown three-channel.

but as far as I know, no kits are available today.

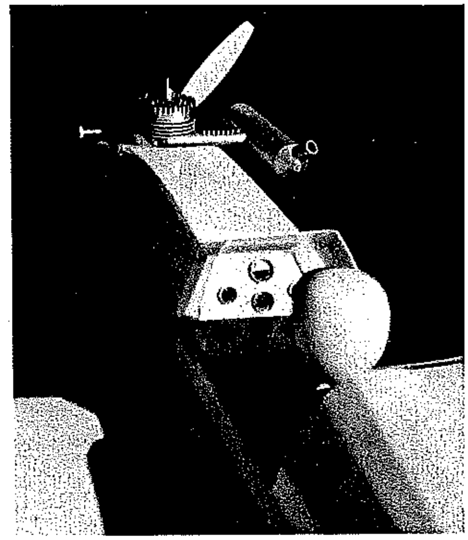
The airplane that really inspired me to tackle this project, however, was—what else?—Der Fledermaus, a full-



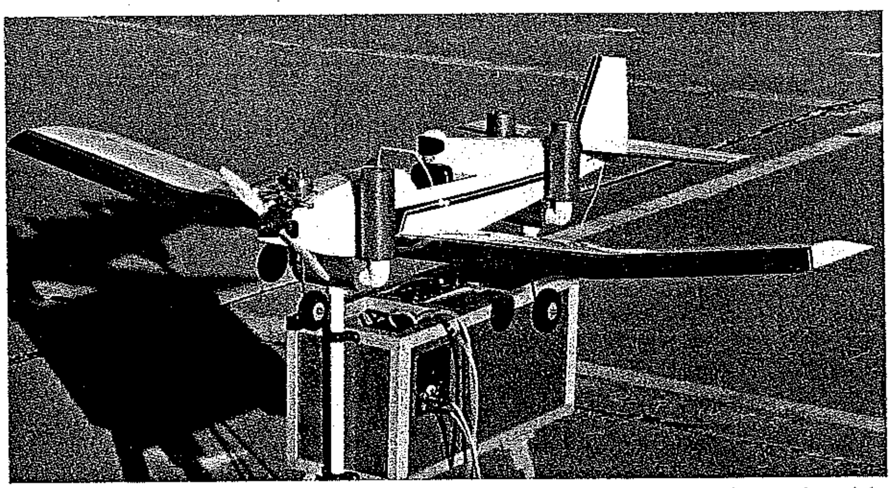
Der Fledermaus finished and ready to fly. The model is covered and trimmed with white and dark red MonoKote. It's powered with a K&B .20 Sportster. Note the wide-stance tricycle landing gear.



Der Fledermaus sitting on the half-mile-long concrete runway available to the Condors Flying Club at Luke AFB, Arizona. The flat-bottomed polyhedral wing is quite apparent at this angle. The model is very stable with this wing configuration, making it a great low-wing trainer.



Over-the-shoulder view of the cockpit. The pilot sits on a removable $\frac{1}{16}$-in. aircraft ply cockpit cover which has been covered by black MonoKote. The instrument bezels are small sections of brass tubing cut and epoxied in place. The windshield is trimmed with white striping tape. Access to the servos and fuel tank is through the cockpit opening.



Der Fledermaus sitting in its custom-made PVC cradle atop what appears to be a rather elaborate field box on foldup legs, complete with built-in electrical and fueling connections.

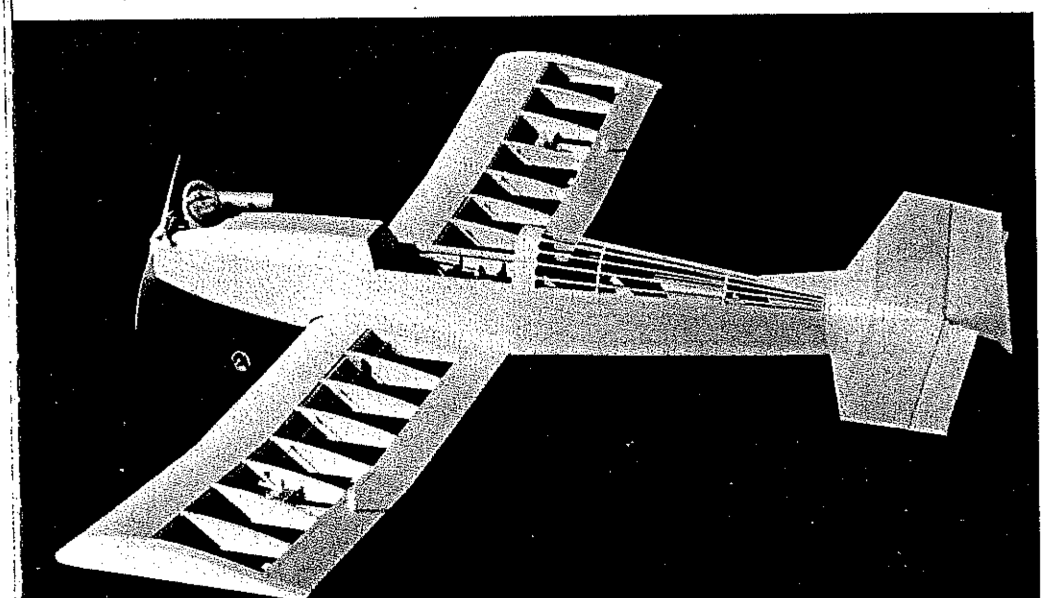
The author holding his latest creation. He reports that the model has excellent flight characteristics. It performs all the standard maneuvers, is stable, and even flies inverted.

size home-built aircraft that I ran across in an old February 1975 copy of the EAA journal, *Sport Aviation*.

This aircraft was designed and built by E. Alvin Schubert, EAA 3408. As far as I could tell from the one side-view photo available, the plane had a flat center section wing with dihedral outer panels and an open cockpit. Der Fledermaus was a tail-dragger with its gear in the wings.

Though I borrowed the German name, my Fledermaus is not intended to be a Scale, or even Stand-off Scale model of the full-size ship. Its lines are similar to those of the original aircraft, but not identical.

Der Fledermaus has a 9½-in. airfoil with an aspect ratio of approximately 6:1, giving a wingspan of around 57 inches. I actually used a 54-in. span, making each panel 27 inches. This neatly divided into nine 3-in. wing bays. Three-inch rib spacing allows vertical webbing to be cut from stock balsa. Also, 26-in.-wide MonoKote leaves only a narrow 2-in. section in the center of the wing, which may be covered with a contrasting color. I used other design parameters gleaned from Chuck Cunningham and Romey Bukolt articles published in past issues of various hobby magazines.



Der Fledermaus in its bare bones, sanded and ready for covering. Construction is straightforward and should present no difficulty. If you decide to build for three- channel control but think you might want to go to four-channel in the future, it's best to build in the ailerons and lock them in place. Modifying the finished wing to add ailerons and linkage would be difficult.

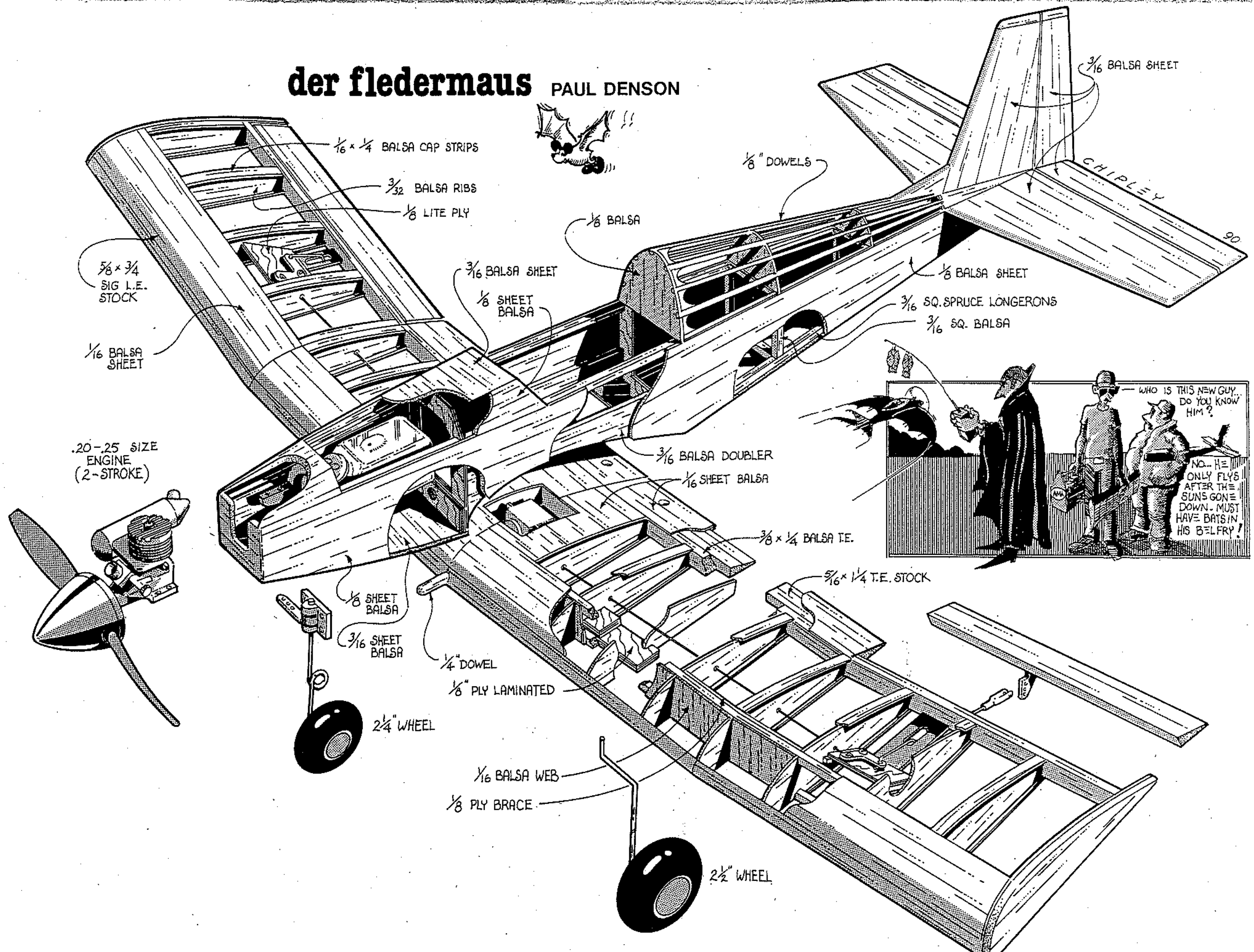
Construction

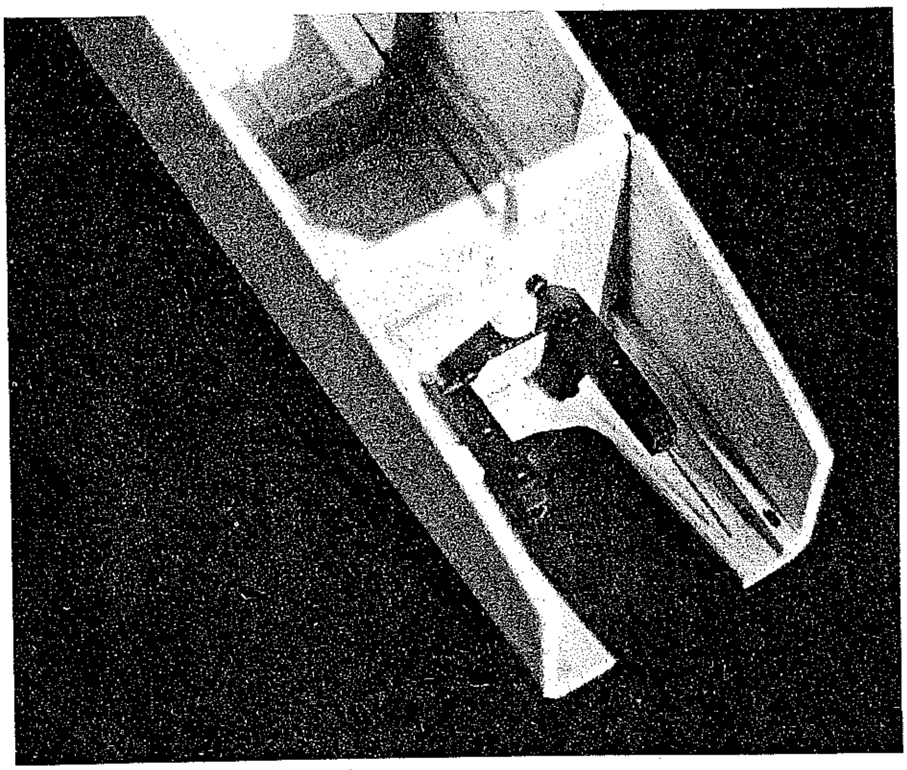
A materials list is included in the article. Collect the necessary materials, and kit the plane first by cutting out all the ribs, spars, trailing edge (TE), ailerons, and longerons to shape and length. Make a pattern, and cut out the fuselage sides. Cut out the firewall and fuselage formers, then cut all the empennage pieces to shape. You may glue all these pieces into appropriate units at this point.

Wings. Before beginning the wing construc-

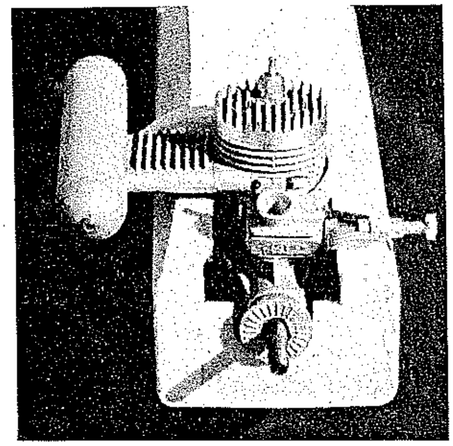
der fledermaus

PAUL DENSON

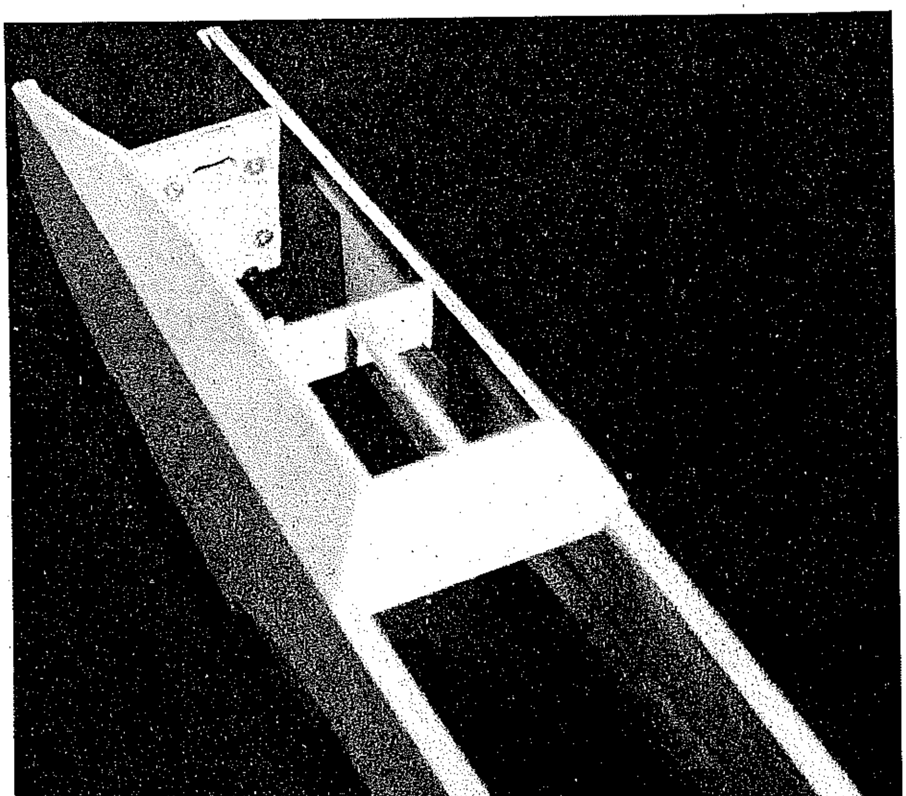




An inverted view of the partially finished engine compartment showing the engine mount and the 5/32-in. nose wheel assembly. The nose wheel steering pushrod and throttle control cable are in place. Note that the entire engine compartment has been thoroughly fuel-proofed.



The installed K&B .20 Sportster engine. Carefully align and position the engine mount before final drilling and mounting to make sure that the muffler doesn't contact the fuselage. After the engine is installed the bottom and front sheeting can be put in place.



The partially finished nose section. The beveled instrument panel has been braced to former F1, and the front side cowl panels are in place. Note the blind nuts in the back of the firewall and the strong triangular bracing. The top paneling goes on after the fuel tank is installed. Make sure that provision is made for removing the fuel tank through the cockpit opening.

tion, you have a decision to make: Do you want three- or four-channel control? Der Fledermaus was designed as an aileron trainer but will fly beautifully on rudder/elevator control only. If you really want to build for three-channel but think you might want to convert later, build the aileron version. The ailerons lock in place at the center of the wing where the pushrods meet.

The wing is built flat in four sections which will be joined later when you put in the polyhedral. As far as I know, the idea of installing Sig symmetrical leading edge (LE) stock at an angle on flat-bottomed wings originated with Doc Mathews' My-O-My. It works great. Thanks, Doc!

Begin construction of each section by pinning the bottom 1/4-in.-sq. spruce spar to the plans (use waxed paper or Saran wrap between plan and structure). Using the ribs as spacers, pin the 1/4 x 3/8-in. TE stock to the plan. Insert all the ribs except the two center ribs and the two dihedral joint ribs. Glue the top spar and the LE in place. When installing the LE, be sure to maintain a 1/16-in. overlap at the top and bottom to allow for fitting the LE sheeting.

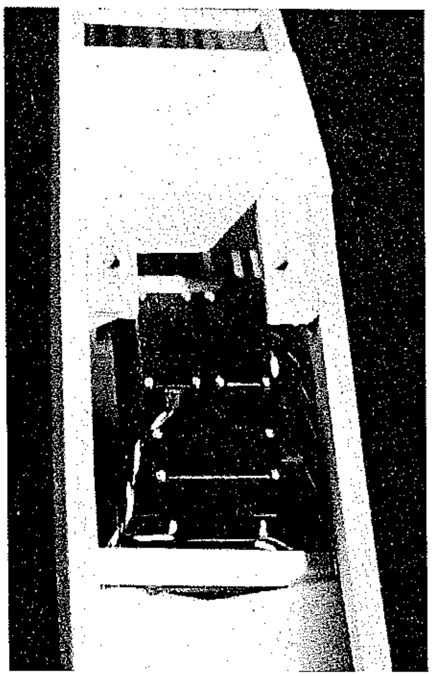
Install the 5/16 x 1 1/4-in. TE fillers on all four wing panels. If installing ailerons on the outboard panels, pin the TE filler stock (which will become the ailerons) in position through the TE. Use no glue on the centerline. Sand the TE to fair in with the tapered TE filler.

Some of the photos show triangular fillets between the TE and the ribs. I found that using cap strips rendered these fillets unnecessary.

When all four panels are structurally complete, it's time to join them into one polyhedral unit. Leave one inboard panel pinned to the building board, and prop up one outboard panel to measure 1 1/2 in. from the board surface at the wing tip. Check the dihedral joint fit, and sand it to the correct bevel. Epoxy the 1/16 ply spar and TE dihedral braces in place, making sure to maintain the correct angle and alignment while curing. Don't glue the TE filler butt joints. Fit and glue the dihedral joint ribs in place. The same procedure applies to the other inboard and outboard wing panels.

Assemble the two wing halves by pinning one inboard panel to the building board, then propping up the other to measure one inch from the board surface at the polyhedral joint. Sand the upper and lower spars and the leading and trailing edge butts for a snug fit. Double-check alignment and angle, pin the spars and LE and TE butts in place, and glue them together. When cured, clamp the spar and TE ply dihedral braces

The servo compartment looking aft. The three servos are accessed through the removable ply cockpit deck. The receiver is tightly wrapped in foam and installed forward of the crosswise throttle servo. The elevator and rudder pushrods are not in place.

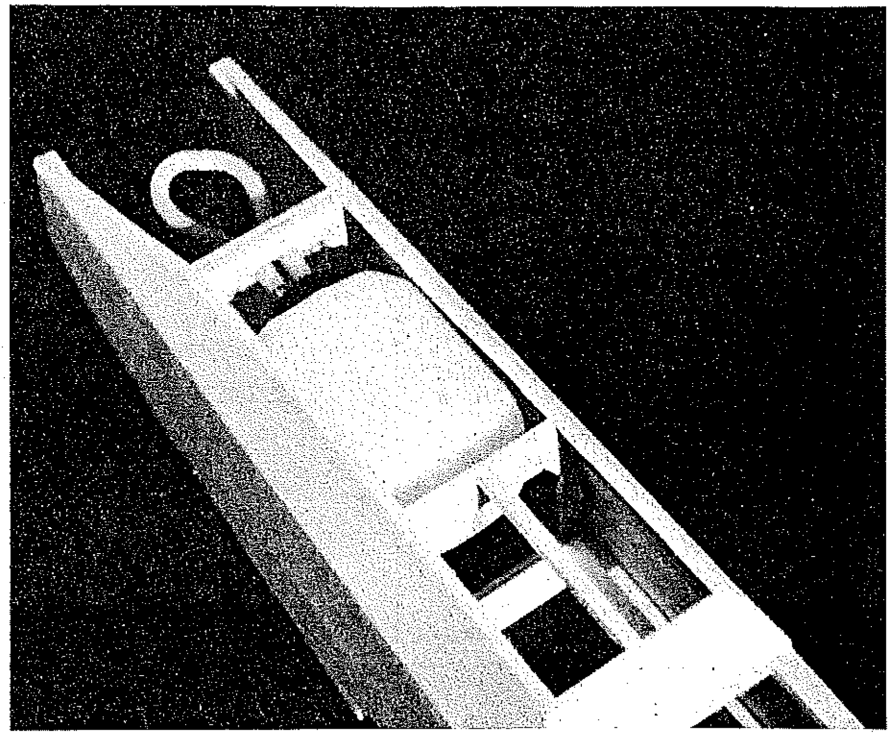


Bottom view of the servos looking through the wing mount opening. The plywood servo rails and wing hold-down anchors are visible in this shot. The wing anchors are drilled and tapped for ¼-20 nylon wing bolts. The leading edge of the wing is held in place using a ¼-in. dowel and socket arrangement.

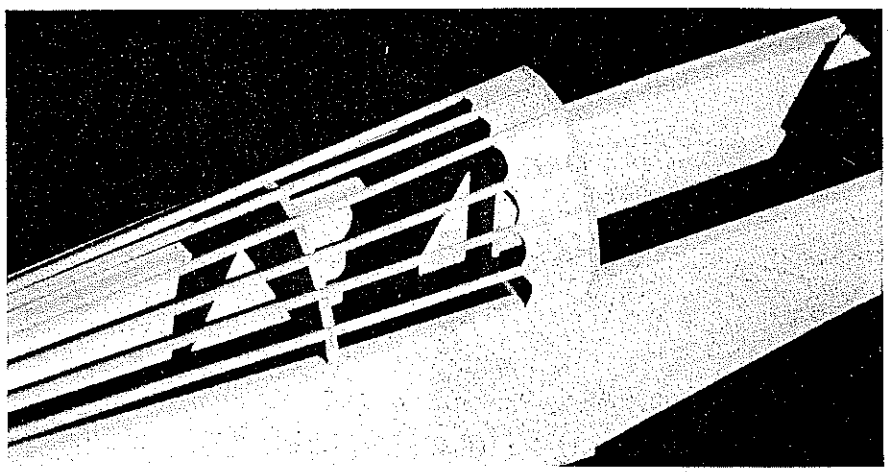
in place, making sure they don't protrude above or below the upper and lower spars. Once you're satisfied with the fit, epoxy the braces in place.

Cut and fit the vertical-grain webbing, then glue it in place.

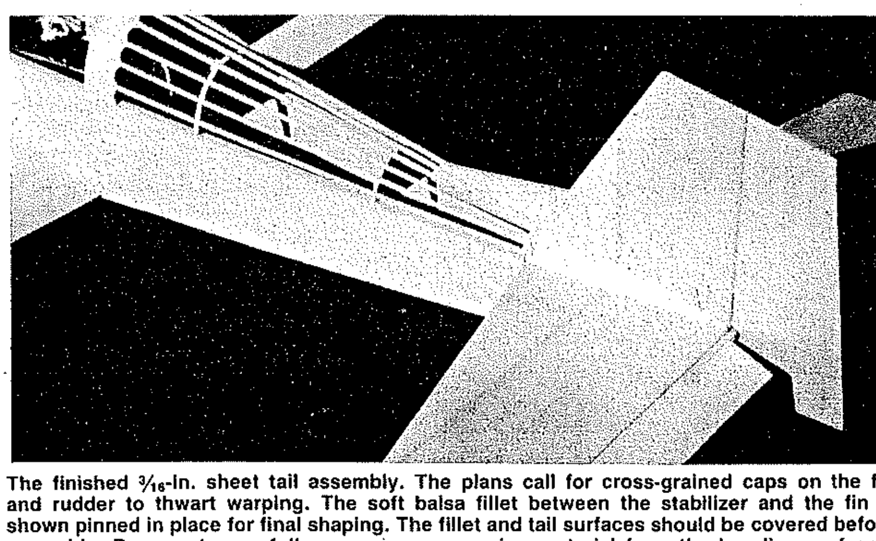
Trim the $\frac{1}{16}$ x 2-in. balsa inboard and outboard TE sheeting (top and bottom) to



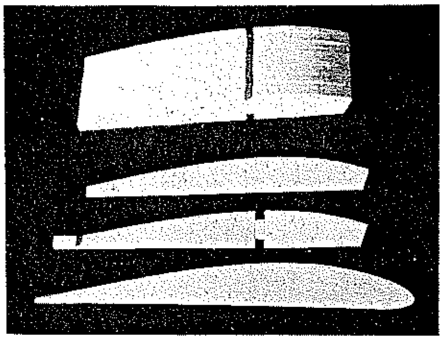
This shot of the partially finished nose section shows the fuel tank installed. Note that the fuel tubing is also in place and temporarily joined to keep dust out of the tubes and tank.



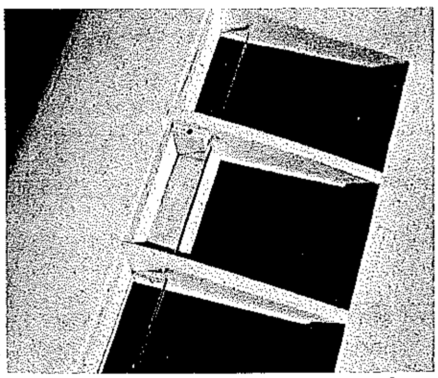
The rear turtledeck is made up of ⅛-in. dowels which run between formers F2A and F5 and on top of formers F3 and F4. The ⅛ balsa filler pieces between the dowels are sanded to an arc with a Dremel tool and sanding drum, then each one is cut to width and glued in place.

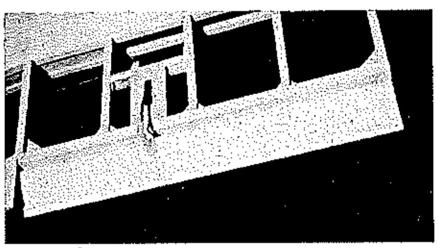


The finished $\frac{3}{16}$-in. sheet tail assembly. The plans call for cross-grained caps on the fin and rudder to thwart warping. The soft balsa fillet between the stabilizer and the fin is shown pinned in place for final shaping. The fillet and tail surfaces should be covered before assembly. Be sure to carefully remove any covering material from the bonding surfaces.

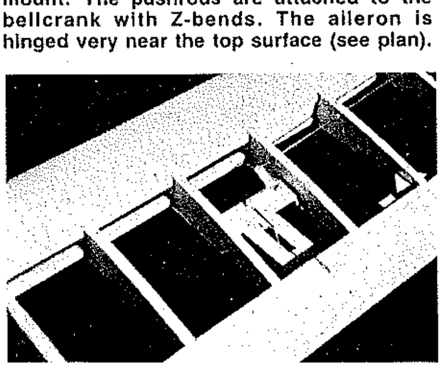


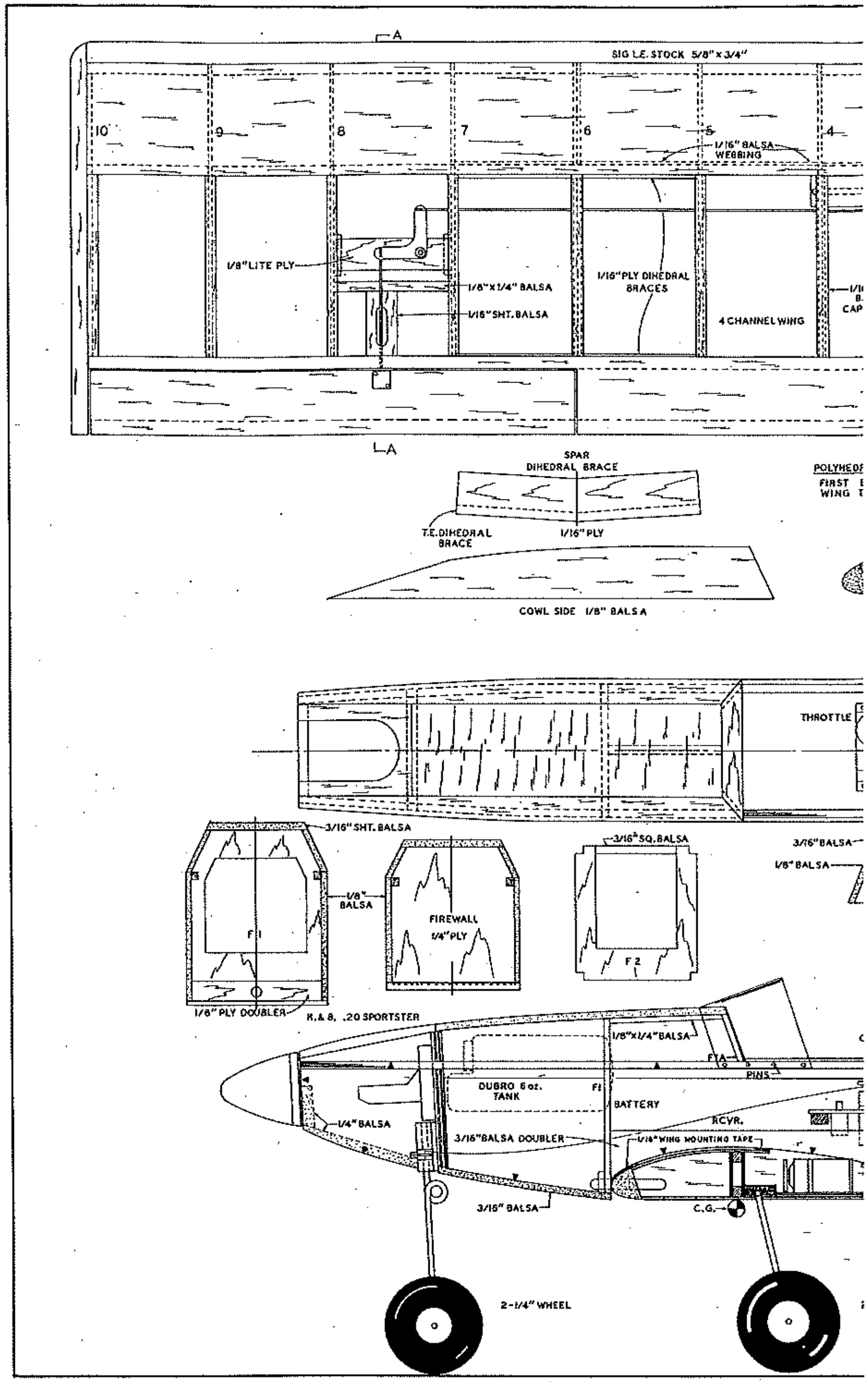
Above: It's easier to build the wing by kitting it first. The ribs (top) are all cut using the upper plywood template to ensure uniformity. Each rib is then butted against the trailing edge block (middle) so that the spar notches may be cut uniformly. The (bottom) template is used to make identical wing tips from ⅜-in. balsa. Below: Close-up of the structurally complete wing showing some details of the plywood landing gear mount and the aileron pushrod. Short pieces of inner Gold-N-Rod sleeves are inserted into each rib, giving exceedingly smooth pushrod movement.





Above: The aileron pushrod between the aileron horn and the bellcrank passes through a rectangular hole in the sheet balsa covering support. The gussets seen in the photo are not shown on the plans, as the cap strips on the ribs obviate their necessity. Below: The bellcrank installed on its plywood mount. The pushrods are attached to the bellcrank with Z-bends. The aileron is hinged very near the top surface (see plan).





length, and epoxy in place. Mark a line on the outboard TE sheeting to show where to separate the aileron.

Glue the two center wing (No. 1) ribs together. When dry, cut to fit and glue in place. Add the $\frac{1}{16}$ x 2¾-in. balsa upper LE sheeting, gluing it snugly to the LE spar.

Install the bottom LE sheeting and add the bottom center sheeting.

Install the 1A ribs, positioning them in accordance with the size of your servo. Cut and fit the $\frac{3}{32}$ ply servo mount between these ribs. Set the wing aside until later.

Fuselage. Make a right and left fuselage side from ⅛-in. sheet balsa. Add the $\frac{3}{16}$ spruce longerons, the wing cradle doublers, and the vertical ⅛ x $\frac{3}{16}$ braces aft of the wing position. Mark lines on the inner surfaces of the sides for the formers and the firewall.

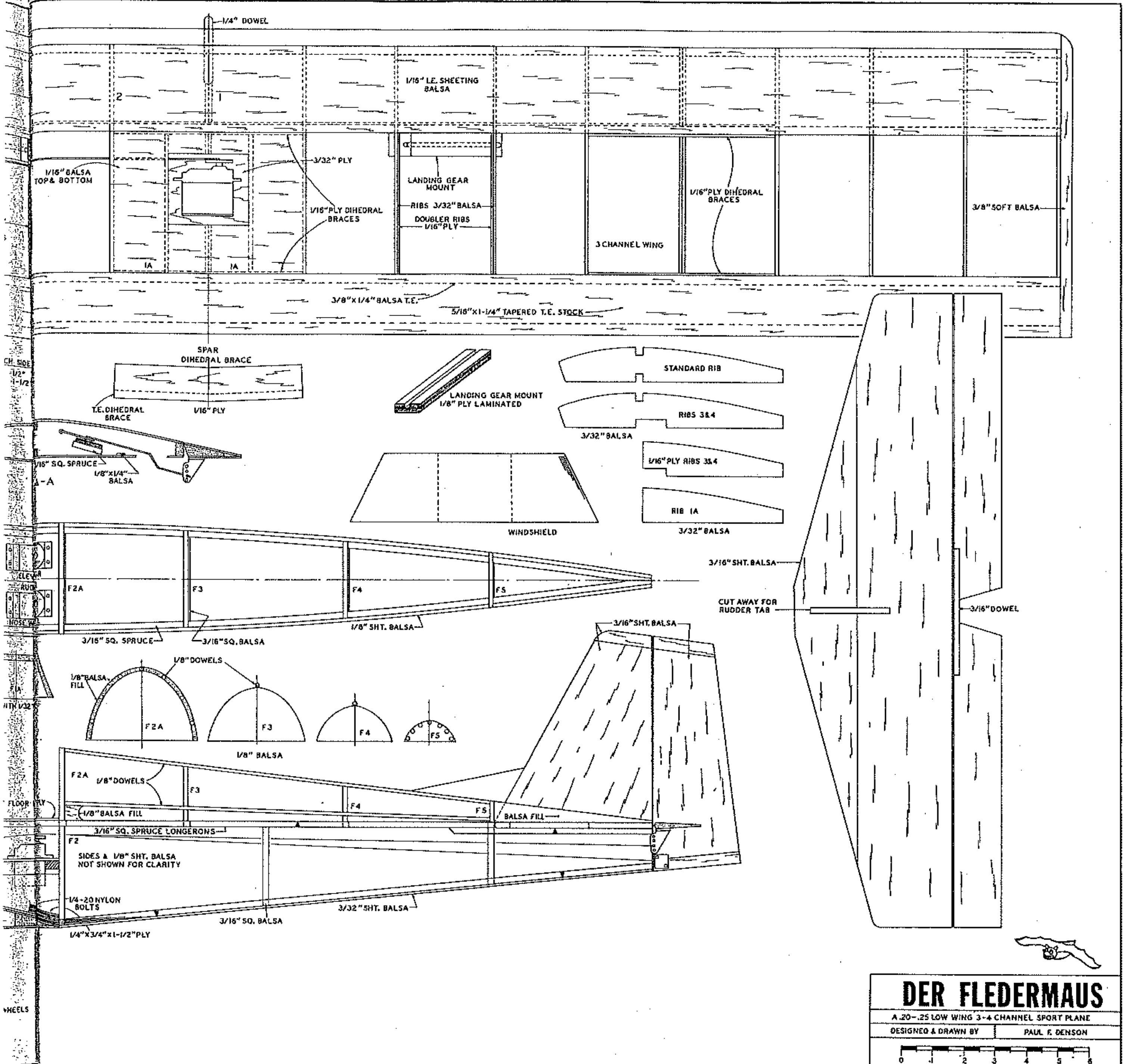
Lay the right side over the plan side view. Install former F1 and F2, checking for vertical alignment. Remove the structure from the side view, and place it over the top view with the wing attachment point facing down. Glue the left side in place, using masking tape and pins to hold it in position until the glue sets.

Bring the aft ends together over the center line, glue them, and clamp until dry.

Drill holes in the firewall for the fuel lines, throttle pushrod, and nose wheel block and pushrod. Install blind mounting nuts. Install the firewall in the fuselage with epoxy, using padded clamps until it's dry. Remember, the firewall must be installed so that it will provide 3° of downthrust for the engine.

Glue in all the side-to-side cross braces

Full-Size Plans Available . . . See Page 202



and add the topside formers. To keep the instrument panel at the correct angle, a 3/16-sq. stringer is installed between the panel and former F1.

The turtledeck aft of the cockpit is made from 1/8-in. hardwood dowels glued between formers F2A and F5 and atop F3 and F4. The spaces between the dowels next to F2A are filled with 1/8-in. sheet balsa, which can be cupped with a 1/2-in. drum sander in a Dremel tool prior to fitting.

Using the pattern on the plans, cut two sides for the front cowl from 1/8-in. sheet balsa. The pattern should make them a bit oversize to compensate for the double bevel. Bevel the bottom edges so that they fit snugly atop the main longeron and side panels, then glue them in place. Sand the top surface with a sanding board, making it even with the top of the main longerons.

Cover the top of the cowl with 3/16 cross-grained sheet balsa. From the center of the firewall forward, the cowl is fashioned from 1/4-in. sheet balsa with the grain running lengthwise. Sand the top surface of the cowl to achieve a pleasing curve from the instrument panel forward to the nose.

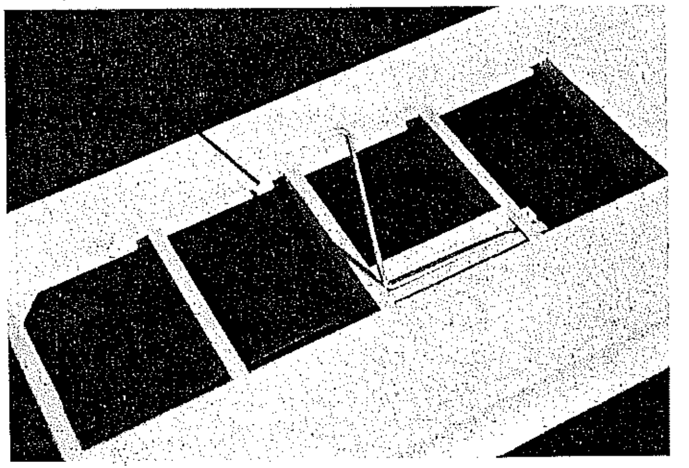
Cut an opening in the cowl forward of the firewall to accommodate the engine you intend to use (see plans). This opening should be just wide enough to allow the engine to slide in slightly tilted. (The engine will be straightened out once the bolting flanges have been slipped inside.)

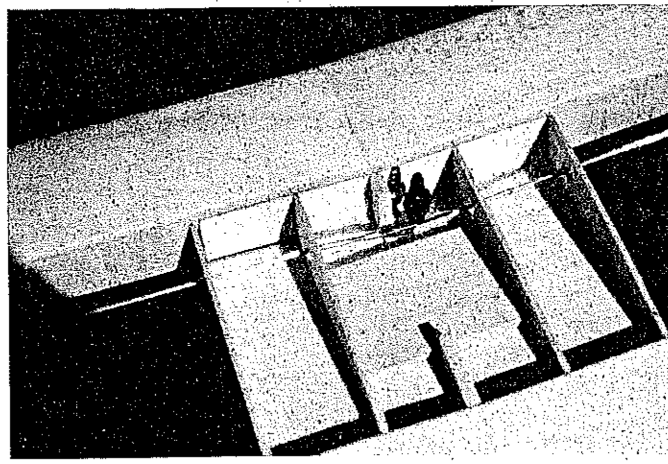
To fit the engine and engine mount, insert the mount from the bottom and set the engine in the mount. Raise the mount and engine high enough to install the muffler, then lower it until the muffler just clears the top of the cowl to locate and mark the engine mount holes. Drill the holes, install blind nuts, and attach the mount.

I installed the engine mount prematurely and ended up having to cut away 1/8 in. of the cowl surface. That's what I call "planning ahead!"

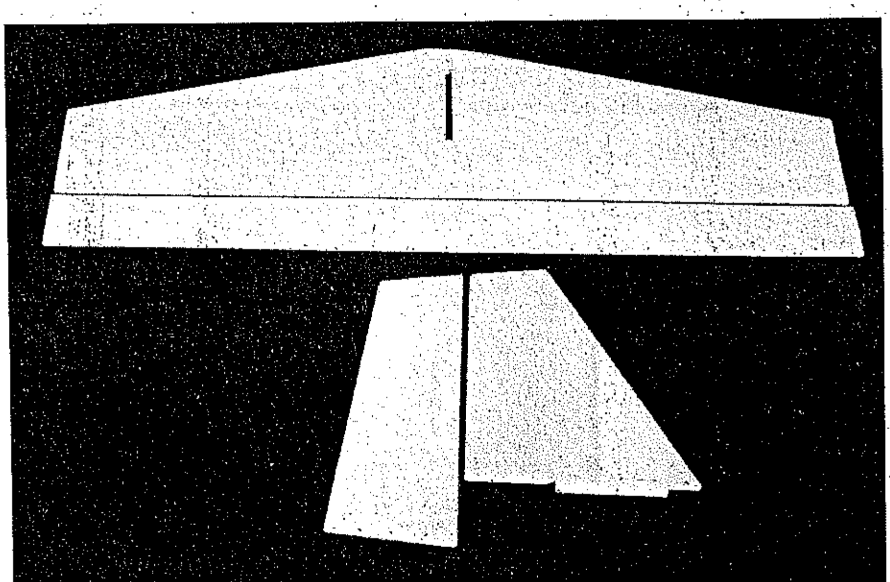
Finally, install the wing hold-down blocks.

Empennage. If you haven't done so already, cut the empennage surfaces from 3/16 sheet balsa. After sanding the surfaces smooth and rounding the edges, install the hinges. I recommend the newer Sig hinges

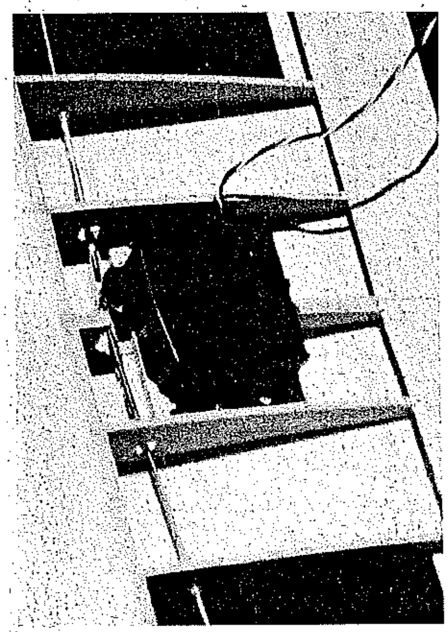




Left: The $\frac{1}{8}$-in. landing gear wire is inserted in the slot of the plywood fabricated mount (see the construction drawing on the plans). The gear is secured with metal landing gear straps. The $\frac{1}{4}$ x $\frac{1}{16}$-in. balsa crosspiece behind the gear is added for securing the covering on that side of the opening. Right: The servo pushrods have Du-Bro threaded couplers soldered to the inner ends. The pin has been cut away from the vane on the left clevis. The other clevis holds the system together. The plywood servo platform is drilled and ready to receive the servo and case.



The finished tail sections ready for hinging, covering, and installation. All the sections are cut from $\frac{3}{16}$-in. sheet balsa. The tab in the fin is installed through the narrow slot in the stabilizer.



The completed aileron servo installation. The Futaba S-28 servo is mounted in its case, which is then screwed to the servo platform. The inner two ribs have slots cut away to allow up-and-down movement of the pushrod.

that you can glue in place with a drop of CyA (cyanoacrylate). First glue the hinges to the stationary surfaces, cover all surfaces, and then glue the movable surfaces to the hinges.

Other construction. To finish the wing, install the landing gear mounts, the ailerons, their control linkage, the $\frac{1}{16}$ x $\frac{1}{4}$-in. cap strips, and the $\frac{3}{8}$-in. balsa wing tips. Covering is the very last operation.

The landing gear shown on the plan is made up by laminating $\frac{1}{8}$-in. aircraft ply. A 10-in. strip should be long enough for both mounts and the vertical supports. If you opt for a commercial mount, the notches in the wings will have to be altered. The top and bottom views in the photos and the plans should clarify this structure.

Mount the bellcranks between ribs 7 and 8. The crossmember that supports the bellcrank is $\frac{1}{8}$-in. Lite Ply cemented on top of $\frac{3}{16}$-sq. balsa strips attached to each rib.

The aileron pushrods that connect the servo to the bellcranks are fabricated from a length of $\frac{1}{16}$ brazing rod or music wire. Form a Z-bend on the outboard ends, and fit the threaded couplers on the inboard ends. The pushrods to the ailerons are made exactly the same way, but with a Z-bend in the middle. *Don't* solder the threaded couplers until all the control linkage is installed and checked for correct alignment and free movement.

The aileron pushrods make a straight run through the polyhedral wings from servo to bellcranks. They originate near the bottom of the wing at the servo and pass through each rib at a progressively higher point through nearly the top of rib No. 6 at the polyhedral break. Inner Golden Rod cut to $\frac{1}{2}$-in. lengths and glued to the ribs ensures free movement and reduces vibration.

An easy way to connect the two clevises to the servo is by cutting the pin from the vane of one clevis so that it overlaps the other. The remaining pin is used to lock both clevises to the servo (see photos). Use metal clevises if you opt for this system.

Cover the top wing center section, and add the $\frac{3}{8}$-in. balsa wing tips. If you haven't done so already, cut the ailerons away from the TE of the outboard wing panels. Bevel the aileron leading edges, then hinge and install them. Install and adjust the pushrods between the aileron horns and bellcranks.

Install the pushrods in the fuselage. After the throttle and nose wheel pushrods are installed, the engine cowling can be finished with sheet and block balsa.

Drill the hole for the $\frac{1}{4}$-in. hold-down dowel in the center of the wing LE, and install. With the wing seated in its cradle, mark the position of the dowel hole in the bottom of former F1. Drill this hole a bit oversize. Using cross-grained balsa strips the same width as the wing-seating tape, seat the wing.

Carefully measure from each wing tip to the center of the fuselage at the tail end. Square the wing to the fuselage by making sure the two measurements are identical. Drill a hole through the wing TE and the wing hold-down block with a No. 9 bit, then thread the block with a ¼-20 tap. Check the threads with a ¼-20 nylon bolt, then apply a drop of CyA into both the wing and block holes and retap. Ream out the wing hole to a ¼-in. diameter.

Drill a ¼-in.-dia. hole in the center of a ½-in. strip of 2¾-in.-long $\frac{3}{32}$ ply. Place this strip over the end of the wing hold-down dowel on the forward side of former F1, and epoxy it in place. Remove the wing before the epoxy sets up.

Cover the bottom of the tank compartment and the fuselage bottom from the back of the wing to the tail. Sand the entire structure smooth and thoroughly clean all surfaces. Cover the fuselage, and install the foam wing-seating tape. Carefully fuel-proof the engine compartment before installing the engine.

The only engine I've tried in Der Fledermaus is a K&B .20 Sportster. However, any .20-size two-cycle engine will work just as well. I don't recommend a four-cycle installation. However, the .26 O.S. Surpass would probably work fine, although the center-of-gravity would have to be adjusted to compensate for the extra weight.

As a rule, the wings on airplanes this size remain in place, since the plane will fit into almost any automobile without disassembly. Radio gear access, therefore, is primarily through the cockpit. The cockpit cover is made from $\frac{1}{16}$ ply. It has a hold-down lip on the forward edge and is secured by two screws fitted at the aft end.

I use a Futaba Conquest-AM FP-T6NLK transmitter and four S-38 servos. One is mounted flat in the wing and the other three are in the radio compartment. They cause no structural interference, and clearance is more than adequate.

Flying. Right from the beginning I had no doubt that this airplane would *fly.* With the polyhedral wing, stability is its middle name. Though I had the ailerons hooked up just to be on the safe side, I discovered that Der Fledermaus flies quite well on rudder and elevator only. You'll need to use the ailerons for rolls, however—the polyhedral wing configuration is just too much to overcome. With ailerons, the model rolls quite nicely.

I had serious doubts as to whether Der Fledermaus was capable of flying inverted with its flat-bottomed polyhedral wing. Believe it or not, on my first attempt to fly inverted I was able to circle the field three times with the wheels pointed skyward.

The model will fly all the basic maneuvers, but at a leisurely pace. Landings were solid. When it was down, it was down with no bouncing. This airplane hugs the runway!

At present, I'm flying Der Fledermaus with ¾ in. of rudder deflection right and left. The elevator moves ½ in. up and down at high rate, and ¼ in. at low rate. On high rate the ailerons move up ⅝ in. and down ⅜ in. On low rate they move up ⅜ in. and down ¼ in. I fly the plane on low rate most of the time. *Continued on page 154*

Safety/Preston

Continued from page 22

tors of these power tools, nor had Dremel back in 1981. If you have either the belt sander or the table saw you might want to check the motor for accumulated sawdust and, if necessary, vacuum it out.

By the time you read this column, those who hibernate during the winter will be about ready to return to the flying field. Is your equipment going to function just the way it did last year? Maybe some servicing might be in order. Meanwhile:

Have a safe month.

Der Fledermaus/Denson

Continued from page 33

If your radio doesn't have dual rates, set the control surface movements somewhere between the high and low settings indicated above. Differential movement on the ailerons is not necessary.

This rock-stable trainer will bring you as much building and flying fun as it's given me.

Specifications:

Wingspan—55⅛ in.; wing chord—9½ in.; wing area—524 sq. in.; wing loading—16.6 oz./sq. ft.

Elevator span—20 in.; elevator chord—5⅗ in. avg.; elevator area—115 sq. in.

Fin/rudder height—36 in.; width—5½ in.

Fuselage length—36 in.; radio compartment—9½ in. long by 2½ in. high by 2½ in. wide.

Recommended engine sizes—.20-.25 two-stroke, .26 four-stroke.

Fuel tank—6 oz.

Landing gear—tricycle.

Radio channels—three or four: ailerons, elevator, rudder, throttle.

Weight ready to fly—3½ lb. (60 oz.).

Parts list:

Six 1/16 x 3 x 36-in. balsa sheets for wing sheeting.

Three 3/32 x 3 x 36-in. balsa sheets for wing ribs and fuselage bottom.

Three ⅛ x 3 x 36-in. balsa sheets for front decking, aft turtledeck formers, and fuselage sides.

Two 3/16 x 3 x 36-in. balsa sheets for rudder, fin, elevator, and fuselage bottom.

Four 3/16-sq. x 36-in. spruce sticks for fuselage longerons.

Four 3/16-sq. x 36-in. spruce sticks for wing spars.

Two pieces of ⅝ x ¾ x 36-in. Sig LE stock for the wing LE.

Two pieces of ⅜ x 1¼ x 36-in. tapered balsa stock for the wing TE filler.

Two ⅜ x ¼ x 36-in. balsa sticks for the wing TE spars.

One 8-in.-long length of ⅜-in. triangular stock for the firewall doubler.

One piece of 1/16 aircraft ply for the wing dihedral braces.

One piece of ⅛-in. Lite Ply for the fuselage formers and the bellcrank supports in the wings.

One piece of ⅛-in aircraft ply to doubleformer F1.

One piece of 3/32 aircraft ply for the servo doubler in the wing.

One piece of ¼-in. aircraft ply for the

firewall.

One 1/8-in.-dia. x 36-in.-long length of hardwood doweling for the turtledeck.

One 1/4-in.-dia. x 3-in.-long piece of hardwood doweling for the wing hold-down.

One length of 1/8 x 36-in.-long music wire for the landing gear.

One 5/32-in. front landing gear assembly and accessories.

Two 2½-in. wheels for the main landing gear.

One 2-in. wheel for the nose gear.

One 6-oz. Du-Bro (or equivalent) fuel tank.

Assorted nuts, bolts, machine screws, sheet metal screws, clevises, threaded connectors, pushrod ends, 1/16 brazing rod or music wire, 1/4-20 nylon wing hold-down bolts, and Gold-N-Rod pushrods.

One .20-.25 two-stroke engine.

Appropriate glues, fillers, covering materials, and any sundry items and merchandise that I may have forgotten to include.

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the pins for voltages of 4.8 (four cells), 6.0 (five cells), 7.2 (six cells), 8.4 (seven cells), 9.6 (eight cells), or 10.8 (nine cells).

Again, the label is confusing, because the plug position actually refers to the number of cells in the battery. Actual cutoff takes place at a lower voltage (probably to take account of voltage drops around the circuit which could otherwise cause the cutoff to happen at too high a voltage).

An LED *(light-emitting diode—RMcM)* display reports battery capacity at cutoff as a percentage of the capacity selected by the discharge-current plug. The display actually measures "elapsed time during discharge," which is adequate, because the discharge current is held constant. I always use a stopwatch when performing battery discharge tests, because the elapsed time is a reliable indication of performance.

A piercing whistle signals the end of the discharge activity. The device does not enter any other mode after discharging terminates.

Testing the unit:

• *Fast-charge testing:* I ran several tests on this device. My notes of a typical test procedure of the charging function and the results follow:

Number of cells/capacity of battery: 6 x 1,000 mAh
VDD-protected, time-limited, constant-current fast charger
Charge current plug position: 900 mA
Charge/Efficiency switch position: "Charge under 8.4 VDC"
Measured charge current: 1.1 ± .25 amps DC (5A scale on 5% analog ammeter)
Measured charge cutoff volts: 8.40 ±.21 VDC (3.5-digit, 1% digital voltmeter)
Measured trickle current (pulsed DC): 200 mA peak, 20% cycle
Time to reach whistle (8.40 VDC): 60 minutes (integral timer)
[Notes: 1) Battery is cool. Doing a discharge test at this point shows 80% charge; 2) Pressing the Start button again at this point will stop the whistle and restart the charging process.]
Time to second whistle (9.21 VDC): 14 additional minutes (VDD cutoff). [Note: Battery is still cool. Elapsed charging time is about right for a full charge.]
A piercing whistle signals the end of the charge activity. When fast charging is terminated, the charger drops into a trickle-charge mode.

• *Discharge testing:* As with the fast-charge section of the Multi Charge-A-Matic, I ran several tests of the discharge function. My notes of a typical test procedure of the discharge function and the results follow:

Voltage-cutoff, constant-current (2C) discharger

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