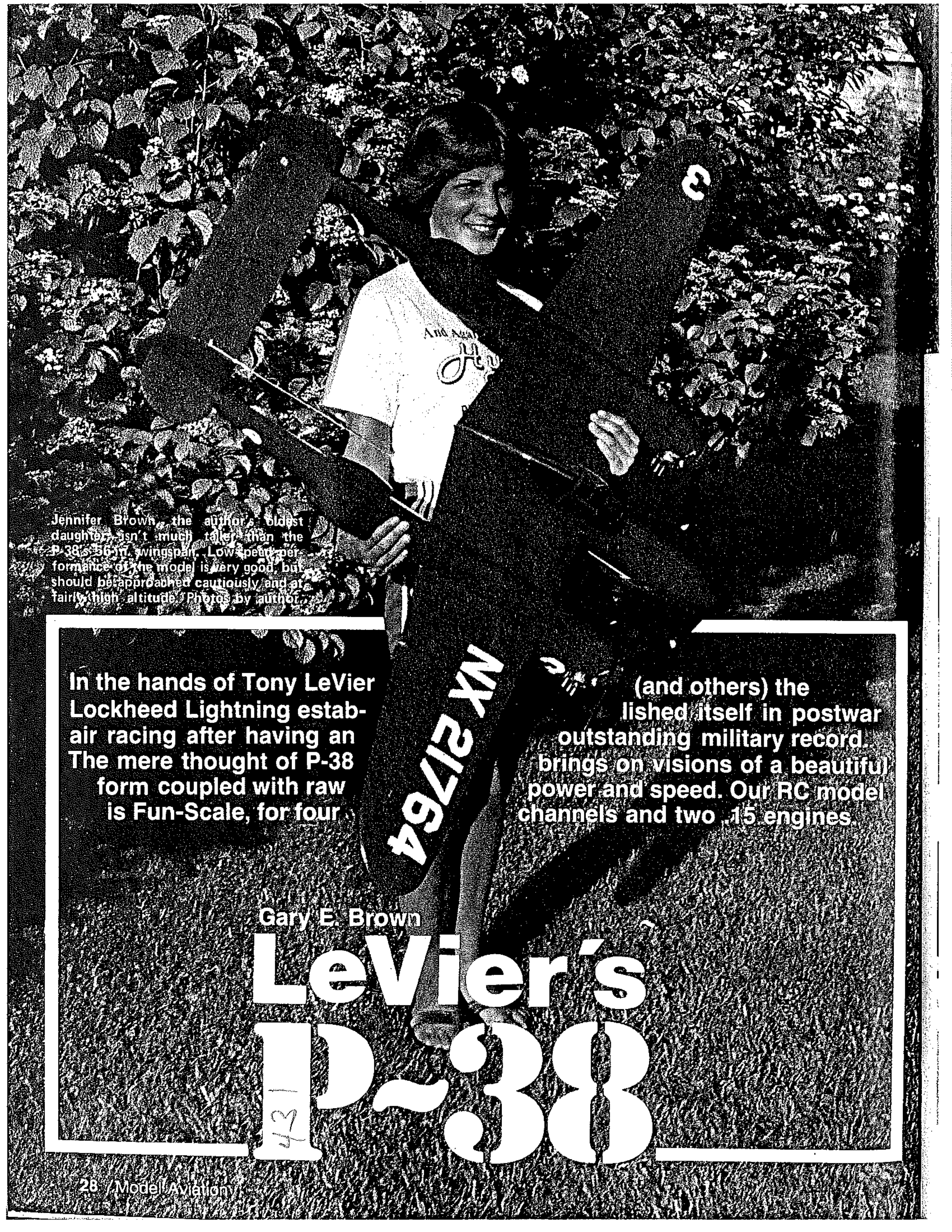
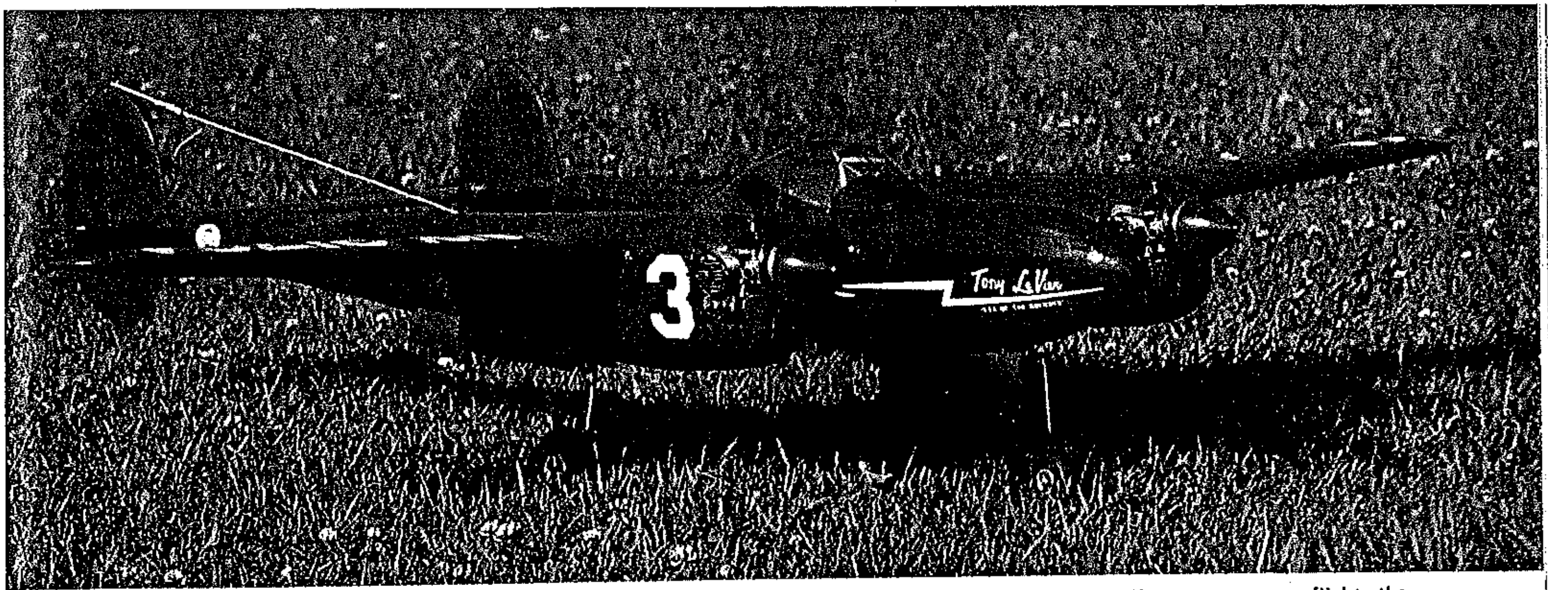


Jennifer Brown, the author's oldest daughter, isn't much taller than the P-38's 56-in. wingspan. Low-speed performance of the model is very good, but should be approached cautiously and at fairly high altitude. Photos by author.

In the hands of Tony LeVier (and others) the Lockheed Lightning established itself in postwar air racing after having an outstanding military record. The mere thought of P-38 brings on visions of a beautiful form coupled with raw power and speed. Our RC model is Fun-Scale, for four channels and two .15 engines.

Gary E. Brown

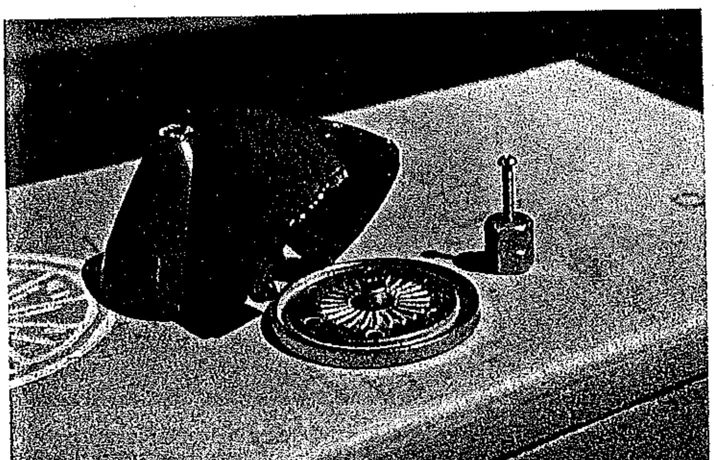
LeVier's P-38

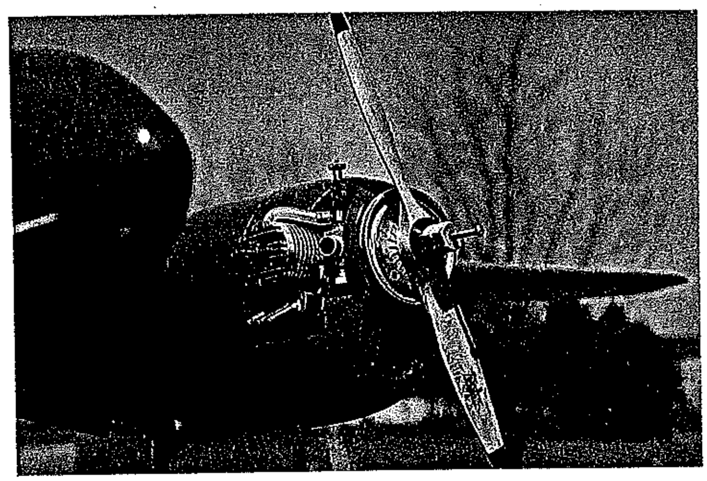


The P-38 is certainly an eye-catcher. In this view, the two OS .15s have been synched, and she's ready for takeoff. In many, many flights the author has never experienced engine failure (but isn't tempted to purposely have a flameout!). Make sure engines are running well before takeoff.

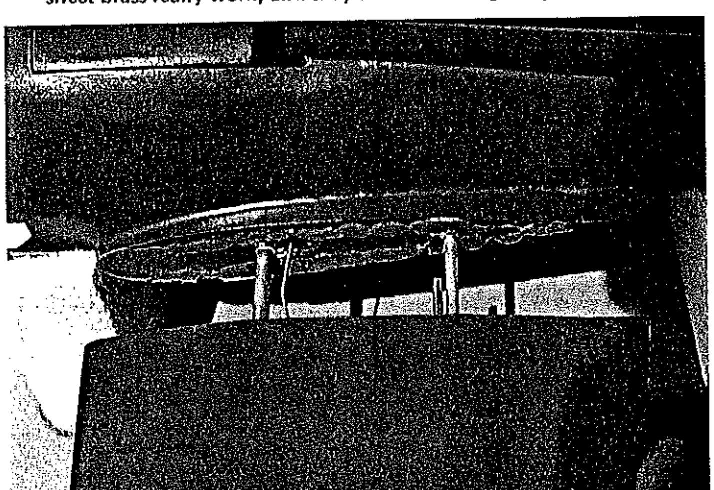
EVEN CASUAL acquaintances to the world of fighter aircraft have little trouble conjuring up an image of this "off the beaten design-path" bird. It was 1937 when the distinctive lines of the P-38 evolved at the hands of Lockheed designers Hall Hibbard and Clarence Johnson in answer to Army specifications for a new, high performance pursuit-fighter aircraft. Lockheed won the competition and eventually earned a contract to build the first XP-38.

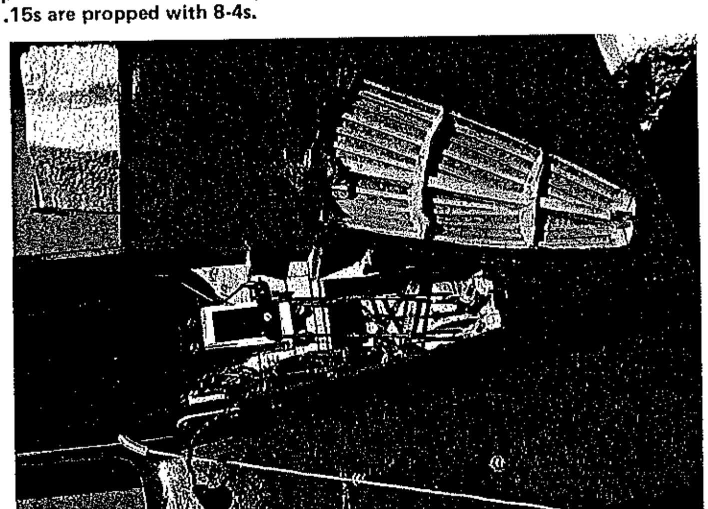
Many of its features we might take for granted today, but remember the year was 1937, and the XP-38 was quite a radical design when you pause to consider that the military had just stepped out of the wire-braced-biplane era. The tricycle landing gear, a desirable feature made more practical by the lack of an engine in the pod, was the most noticeable difference from other planes. Other notable features included twin



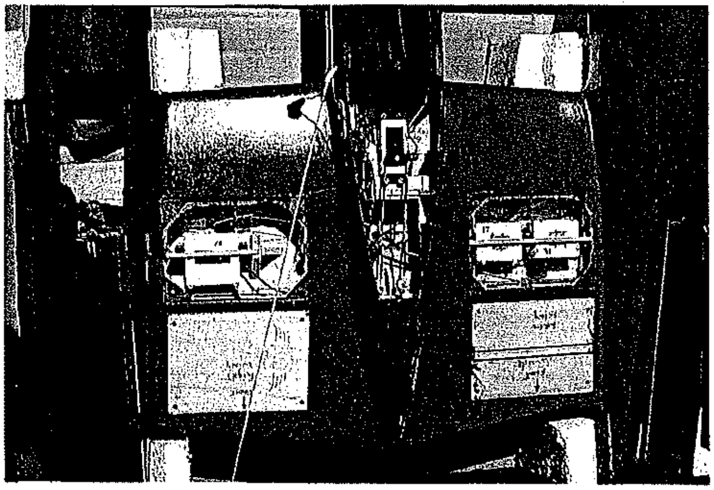


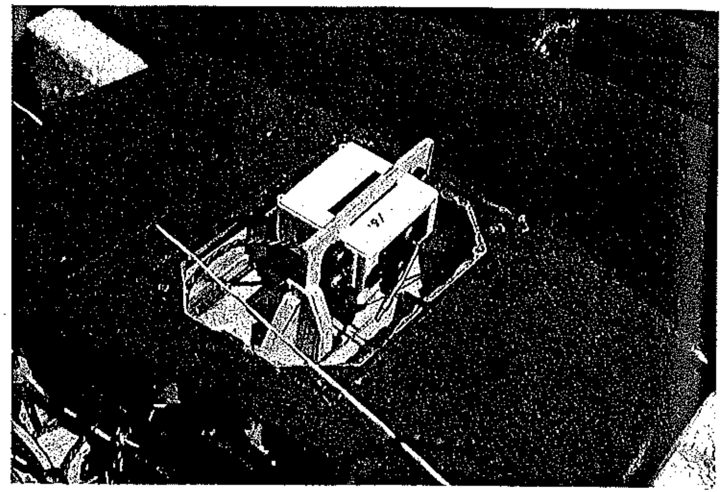
Left: Spinners, backplate, and prop nut. Note ridge on the base of the spinner cone; this fits into the backplate groove. Spinners are turned from balsa and coated with fiberglass and polyester resin. More details of this process are in the text. Right: Homemade mufflers from hobby shop sheet brass really work, and they aren't too tough to put together. The OS .15s are propped with 8-4s.



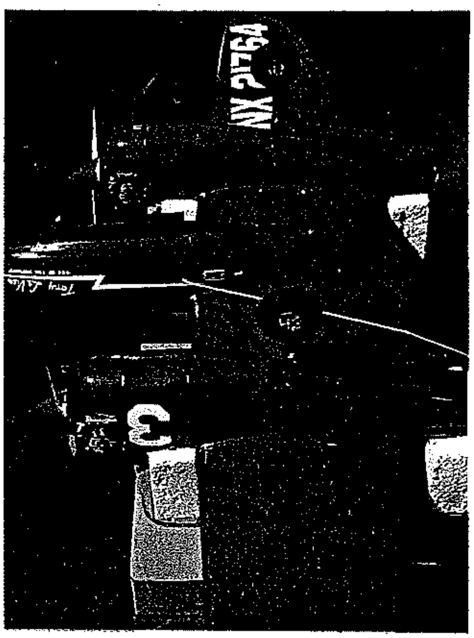


Left: Make sure the square aileron torque tube is lined up and connected as the wing panels are slid in place. Silicone rubber sealer is used on the root to keep out engine oil. Note the retaining hook of music wire. Right: Aileron servo installation is accessible via the pod hatch that is retained by a 1/16-in. wire pin at the rear and hooks and rubberband at the front. Nose-wheel steering is operated from the aileron servo.





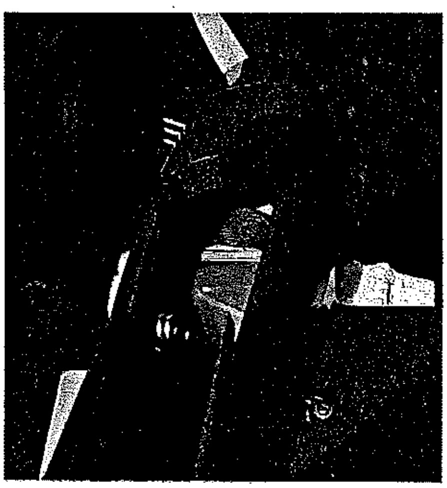
Left: With radio access hatch covers removed, we see the servos for the engine throttles (L) and rudders and elevator (R). All hatches are sealed with silicone. Servos are mounted in 1/8 ply trays. Note aileron torque rods running through rear of servo compartments. Right: Throttle servo is shown pulled halfway out of the ply tray. The 1/16 ply hatch covers hold the servo trays in place. Study of the pictures will help in construction.



Cradle for author's P-38 was made from heavy corrugated cardboard with curved foam blocks at the corners. It's handy for working on the underside of the model.

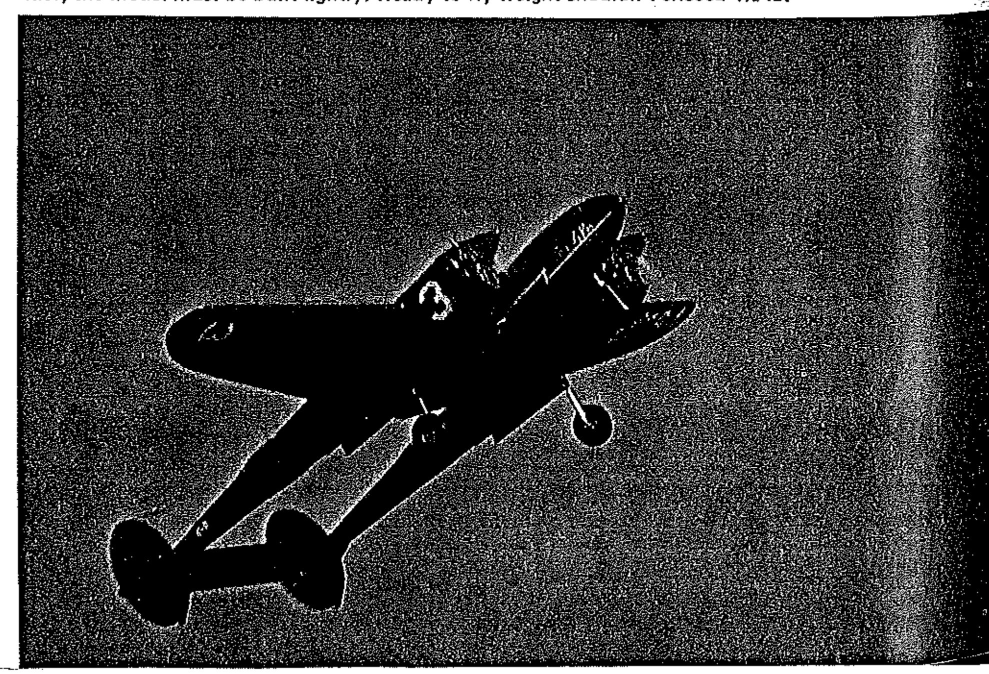
Nyrod conduit for control cable is sanded flush for a neat exit. Bar connecting the rudders is 1/16-in. music wire.

Main landing gear mounting comes into view with forward hatch removed. Brass straps are soft-soldered to L.G. and drilled for mounting with 4-40 screws and blind nuts.



From the underside we can see the 4-oz. Sullivan fuel tank that is held in place with rubberbands. Depending upon the tank used, some of the wing sheeting may have to be cut away to place it correctly with respect to the engine—important for satisfactory running.

The P-38 grabs some altitude after having made a low pass at high speed. To be a really good flier, the model must be built lightly. Ready-to-fly weight shouldn't exceed 4½ lb.



turbo-supercharged V-1710 Allison liquid-cooled engines swinging counter-rotating propellers to cancel the torque effect. The design also allowed the aircraft's guns to be placed in the pod directly in front of the pilot.

Early in 1939, during an attempt to set a new cross-country speed record (to break the one held by Howard Hughes), the XP-38 crashed during a landing; it had flown only a little more than 12 hours. However, the Army recognized a good thing and gave Lockheed an order for 13 more aircraft, to be designated YP-38. Thus was the beginning for the Army Air Corps' most commonly unique and versatile fighter.

During the war, the P-38 served in a number of capacities. In addition to fighter and bomber escort duties, it was one of our most successful photo reconnaissance aircraft. In this job, it was able to employ its superior speed to outrun a threatening adversary.

With the end of WW II, 1946 saw the reopening of the National Air Races at Cleveland, OH. However, it was never to be the same as the prewar years. Gone were the small home-built racers of steel tube, wood, and fabric. In their place were the war surplus fighters that were rapidly being outdated by the recent development of the jet engine. The Mustangs, Corsairs, Cobras and other war birds dominated both the closed-course Thompson and cross-country Bendix, as well as other lesser races.

There were a small number of P-38 Lightnings entered in the Nationals. One of the more successful ones was flown by Tony LeVier; his aircraft is the subject of this article. LeVier was a very experienced pilot who flew in many of the prewar and postwar air races. During the war, he worked for Lockheed as a test pilot, gaining intimate knowledge of this aircraft. Though lesser known than famous P-38 aces Maj. Richard Bong and Maj. Thomas McGuire, LeVier could match their skills at the controls of a P-38.

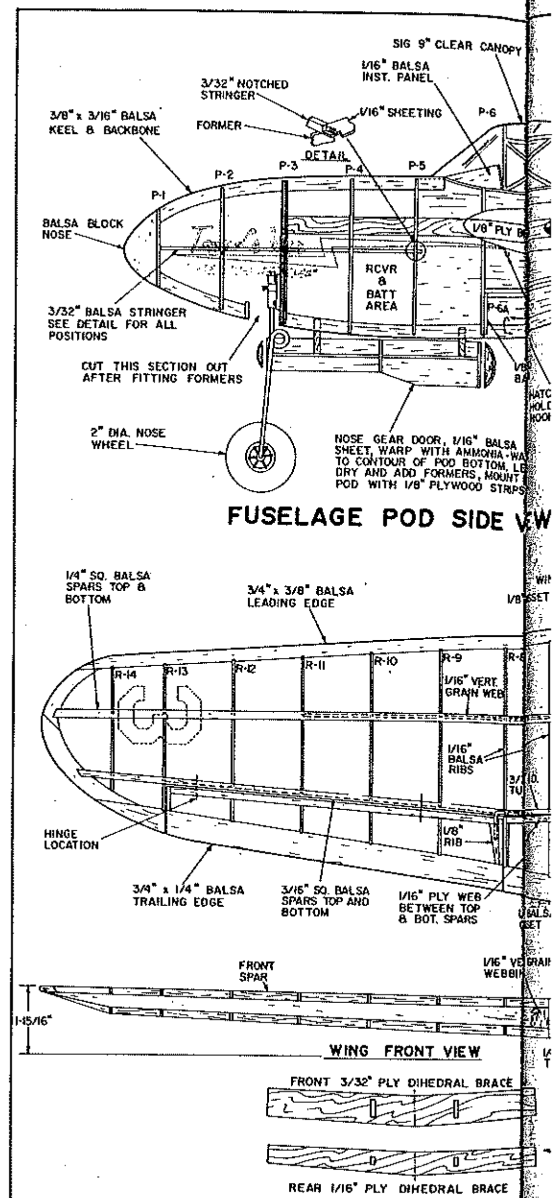
LeVier's P-38L was somewhat refined for its specialized task of air racing. The superchargers and trailing edge air intakes were removed and faired over, and additional gasoline capacity was provided. Some of his air racing achievements with the P-38L: 1946, 2nd place, Thompson Trophy Race, average speed of 370.2 mph; 1947, 5th place, Thompson Trophy Race, average speed of 357.5 mph; 1947, 1st place, Sohio Trophy Race, average speed of 360.9 mph.

Construction. The goal of this project was to produce a lightweight twin engine "fun" Scale model with eye appeal and, most importantly, good flying characteristics. In order to achieve this, the model consists entirely of built-up construction. During the building process, you should make every effort to keep the model light. After completion of the original model, though, I had to add equal amounts of lead to each tail boom to correct for the plane's nose-heaviness; therefore, although the plans show built-up tail surfaces, sheet wood could be substituted with no weight penalty. Plan on a ready-to-fly weight of no more than 4½ lb. If you are careful, you should have no problems.

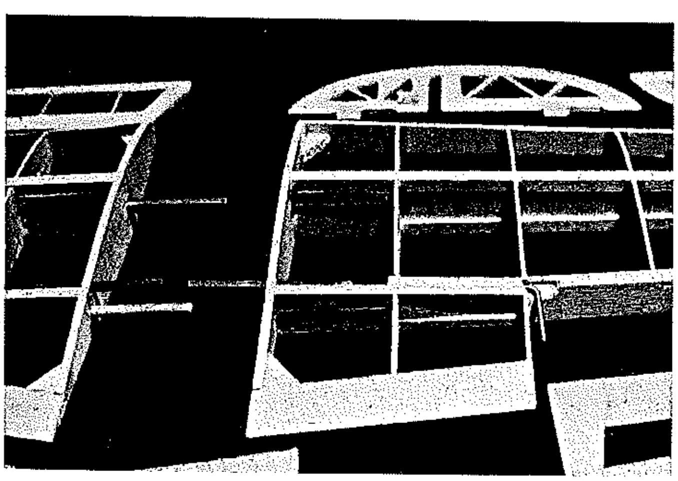
Wing. The halves are joined by ¼-in. o.d. brass tubing at the front spar and 3/16-in. o.d. at the rear spar. The brass tubing slips into aluminum tubing of the same size i.d. which has been epoxied between the top and bottom spars, front and rear. This system has worked well with no failures. Aileron torque rods connect through the wing joint via square brass tubing of the same i.d. and o.d. measurements (⅛-in. o.d. in the outboard wing panels). Also in the outboard wing panels are 3/64-in. music wire hooks that snap through a hole in a 3/32 plywood plate mounted in the wing root. The hooks are engaged and released by reaching in through the main landing gear openings with a screwdriver.

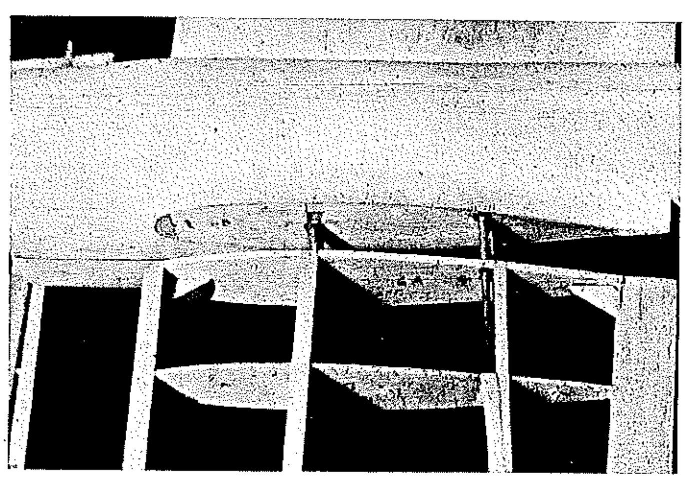
As with any twin, use two identical engines from the same manufacturer, and make sure both operate flawlessly. Never attempt to fly a twin with an engine running less than perfectly.

The wing is divided into three parts—the center section and the two outboard panels. Basically, this model is built up around the

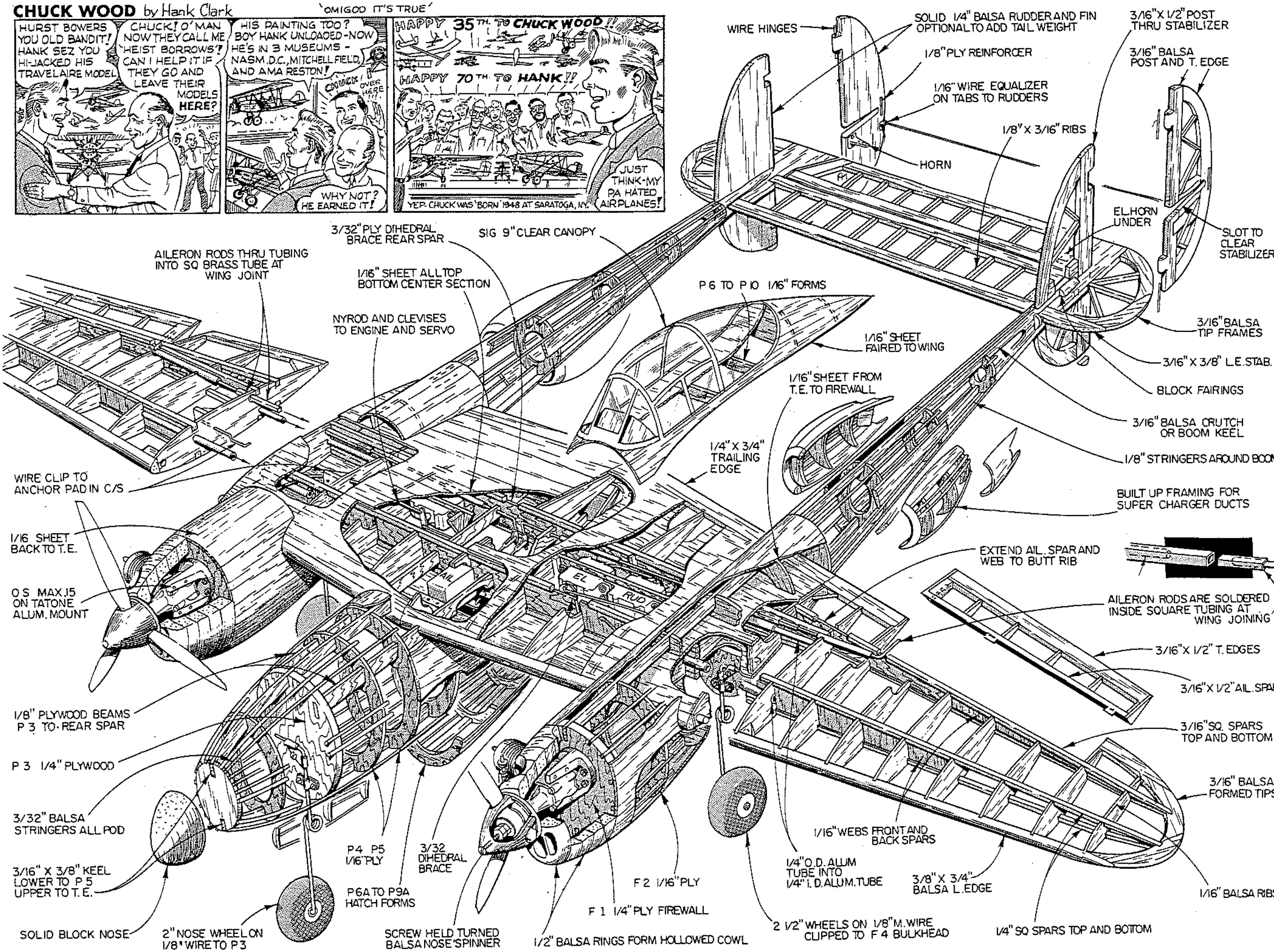


center section front and rear spar. Accuracy and alignment are very important, as all flight and landing loads are tied into this unit. Before beginning construction of each of the various subassemblies, cut out all

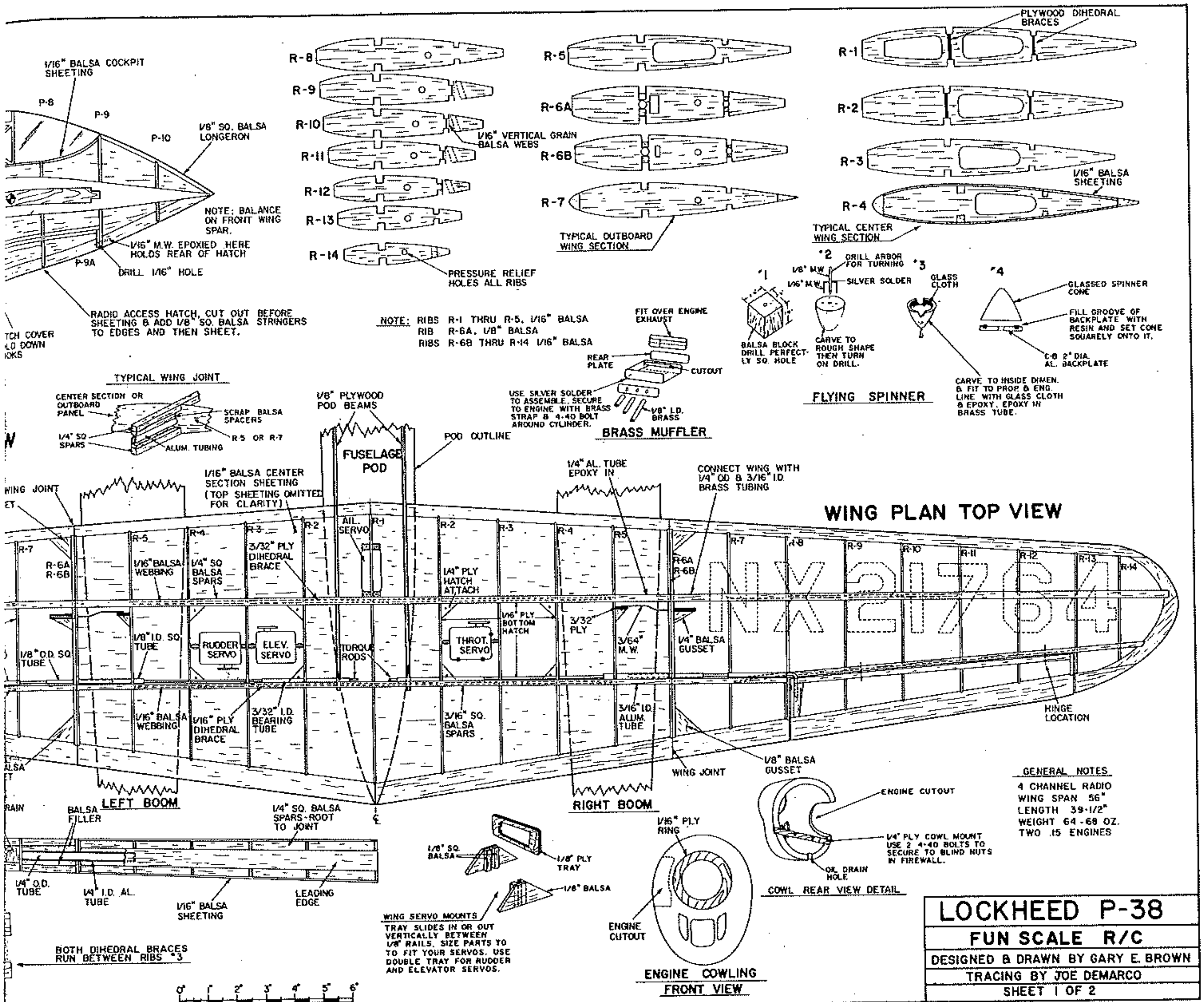




Left: Inboard area of the two wing panels shows the mounting system. Note square tube aileron torque rod connectors and aluminum tubes epoxied between the front and rear spars. Right: Wood dowels were tried initially for joining the wing panels but were discarded when it was found that removing or joining the panels was sometimes difficult due to humidity changes. Substituting brass solved the problem.



CHUCK WOOD by Hank Clark
'OMIGOD IT'S TRUE'
HURST BOWERS YOU OLD BANDIT! HANK SEZ YOU HI-JACKED HIS TRAVELAIRE MODEL
CHUCK! O' MAN NOW THEY CALL ME 'HEIST BORROWS'! CAN I HELP IT IF THEY GO AND LEAVE THEIR MODELS HERE?
HIS PAINTING TOO? BOY HANK UNLOADED-NOW HE'S IN 3 MUSEUMS - NASM D.C., MITCHELL FIELD, AND AMA RESTON!
CHUCK! OVER HERE!
WHY NOT? HE EARNED IT!
HAPPY 35TH. TO CHUCK WOOD!!
HAPPY 70TH. TO HANK!!
JUST THINK-MY PA HATED AIRPLANES!
YEP. CHUCK WAS 'BORN' 1948 AT SARATOGA, NY.
WIRE HINGES
SOLID 1/4" BALSA RUDDER AND FIN OPTIONAL TO ADD TAIL WEIGHT
1/8" PLY REINFORCER
1/16" WIRE EQUALIZER ON TABS TO RUDDERS
HORN
3/16" X 1/2" POST THRU STABILIZER
3/16" BALSA POST AND T. EDGE
1/8" X 3/16" RIBS
EL. HORN UNDER
SLOT TO CLEAR STABILIZER
3/32" PLY DIHEDRAL BRACE REAR SPAR
SIG 9" CLEAR CANOPY
AILERON RODS THRU TUBING INTO SQ BRASS TUBE AT WING JOINT
1/16" SHEET ALL TOP BOTTOM CENTER SECTION
P 6 TO P 10 1/16" FORMS
NYROD AND CLEVISES TO ENGINE AND SERVO
1/16" SHEET FAIRED TO WING
3/16" BALSA TIP FRAMES
3/16" X 3/8" L.E. STAB.
1/16" SHEET FROM T.E. TO FIREWALL
BLOCK FAIRINGS
3/16" BALSA CRUTCH OR BOOM KEEL
1/4" X 3/4" TRAILING EDGE
1/8" STRINGERS AROUND BOOM
WIRE CLIP TO ANCHOR PAD IN C/S
BUILT UP FRAMING FOR SUPER CHARGER DUCTS
1/16 SHEET BACK TO T.E.
EXTEND AIL. SPAR AND WEB TO BUTT RIB
AIL
EL
RUD
O.S. MAX .15 ON TATONE ALUM. MOUNT
AILERON RODS ARE SOLDERED INSIDE SQUARE TUBING AT WING JOINING
3/16" X 1/2" T. EDGES
3/16" X 1/2" AIL. SPAR
1/8" PLYWOOD BEAMS P 3 TO REAR SPAR
3/16" SQ. SPARS TOP AND BOTTOM
P 3 1/4" PLYWOOD
3/16" BALSA FORMED TIPS
3/32" BALSA STRINGERS ALL POD
1/16" WEBS FRONT AND BACK SPARS
P4 P5 1/16" PLY
3/32 DIHEDRAL BRACE
1/4" O.D. ALUM TUBE INTO 1/4" I.D. ALUM. TUBE
3/16" X 3/8" KEEL LOWER TO P 5 UPPER TO T.E.
F 2 1/16" PLY
3/8" X 3/4" BALSA L. EDGE
1/16" BALSA RIBS
P6A TO P9A HATCH FORMS
F 1 1/4" PLY FIREWALL
SOLID BLOCK NOSE
2" NOSE WHEEL ON 1/8" WIRE TO P 3
SCREW HELD TURNED BALSA NOSE SPINNER
1/2" BALSA RINGS FORM HOLLOWED COWL
2 1/2" WHEELS ON 1/8" M.WIRE CLIPPED TO F 4 BULKHEAD
1/4" SQ SPARS TOP AND BOTTOM

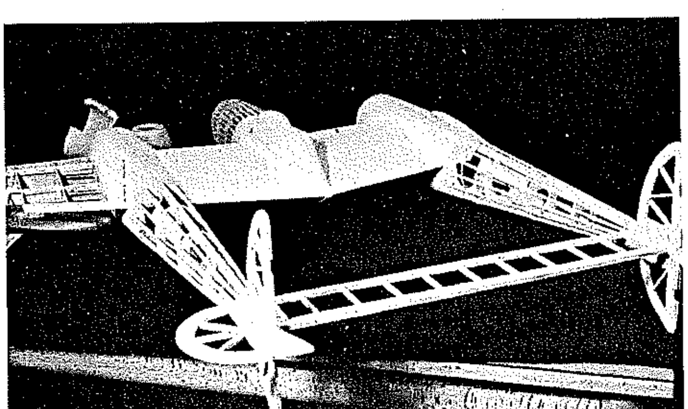


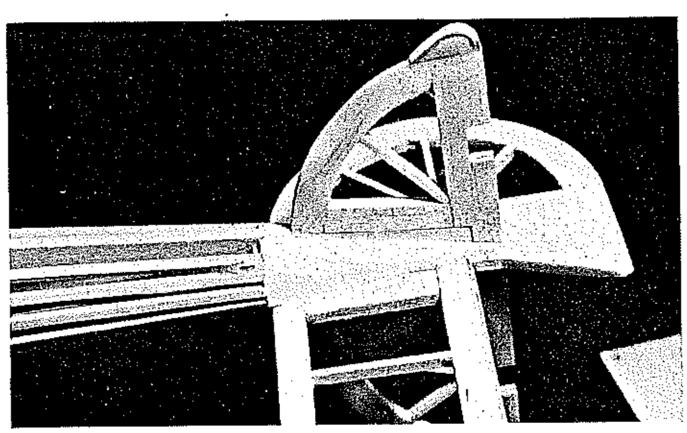
parts and gather together all necessary component materials.

Begin the wing by cutting out a complete set of ribs. An alternate method is to sandwich balsa blanks for Ribs 3 to 12 between plywood templates of No. 2 and No. 12, with one extra blank for Rib 1 on the outside of the template of No. 2. A slight spot of glue between each blank will keep them from sliding during sanding and carving. This method will leave beveled edges and ends on each rib which need to be carefully sanded square. If you have sanded accurately, you will have produced a very accurate set of ribs.

Start assembly by gluing Ribs 3, 4, 5, and 6B to the top and bottom front and rear spars. Next, join the left and right center sections with the plywood dihedral braces. Add Ribs 1 and 2 and the leading and trailing edges to complete the center section framework.

The outboard panels are built in typical symmetrical-rib fashion. Assemble the ribs





Left: Author used built-up tail feathers; his prototype came out nose-heavy, so hindsight told him he could have used sheet balsa without a weight penalty. Right: Skids on bottom of fins are 1/8 plywood. Scrap balsa was used for the fillet. The control cable exits at rear of stringers.

and spars and add the leading and trailing edges; finally, add the wing tips. Ailerons are built as separate units. The next and most important step is to join the wings via the brass tubing which telescopes into the aluminum tubing epoxied between the top and bottom spars. Cut shims to space the aluminum tubes evenly between the spars; the important thing is to make sure the aluminum tubes in the front and rear spars are perfectly parallel in the horizontal and vertical planes.

Join the outboard panels to the center section while the epoxy is still wet and with the brace tubes in place to assure exact alignment of the wing panels and the tubes. Of course, if your transportation is large enough, there is really no reason why the wing cannot be built in one piece.

The final step for completing the wing is to add the 1/8 plywood beams which carry the formers for the pod forward of the wing leading edge to the 3/16 plywood bulkhead that will mount the nose wheel. Be sure to incorporate the 1° positive wing incidence by adjusting the beams to 1° below the centerline of the airfoil; epoxy securely to the plywood dihedral braces. After this is done, the center section can be sheeted with 1/16 balsa, except for the radio hatches. The wing servo hatch covers are cut from 1/16 plywood and held in place with four corner screws.

Booms. Assemble the 3/16-in. keel and backbone pieces over the plans. Mount Formers 6 through 10 and the firewall. (At this point, if you wish, you may angle each firewall outward a couple of degrees. The resulting engine out-thrust may help to keep the model under control in a one-engine-out situation. However, don't let this technique be an excuse to use a not-so-reliable engine.)

Glue on all stringers from Formers 6 to 10, and notch the ends to accept the forward flush 1/16 sheeting. I used 1/8 sq. spruce stringers on the booms, but would now recommend the substitution of balsa to save additional weight.

Now we are ready to glue the booms to the wing center section. If you have cut out the top of the keel for the boom correctly between Formers 2 and 6, you will have a curve that duplicates the top curve of the airfoil at the point where the booms attach. Make sure the booms are parallel in the horizontal and vertical planes. At this point, be sure to adjust them for the 1° of positive incidence in the wing. After the booms are joined to the wing, add the remaining formers to the top and bottom of the wing.

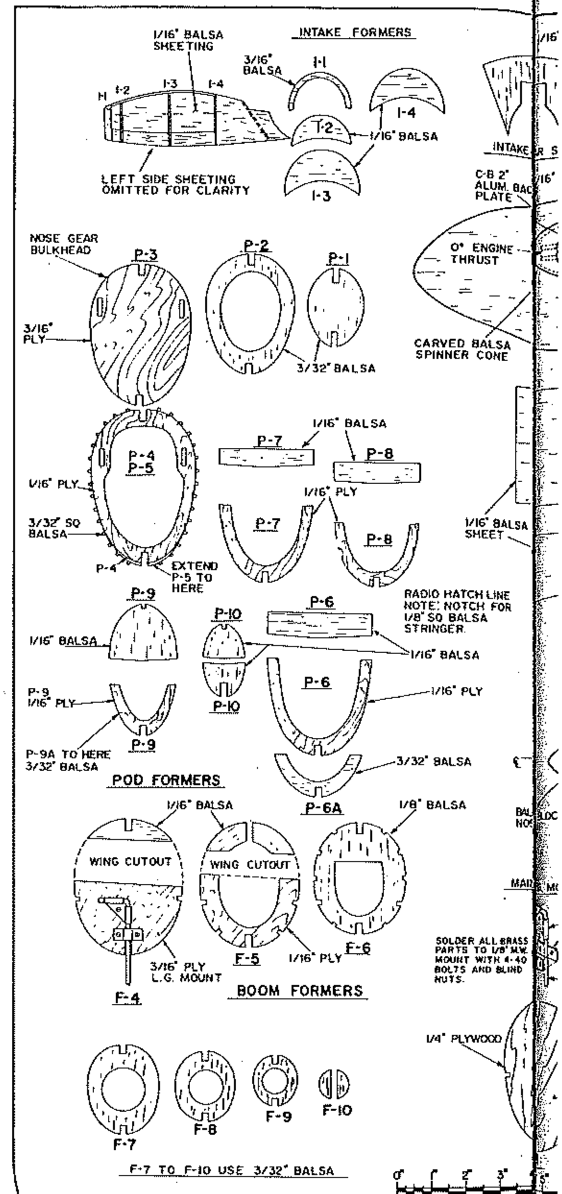
Drill the landing gear mounting holes for the main gear in Former 4 before gluing it in place. Sheet the booms with 1/16 balsa forward of Former 6. The P-38 had small fillets where the booms and the pod join the wing. The fillets are easily accomplished with spackling compound or Sig Epoxolite.

As you can see from the photos, I have mounted my engines horizontally, but they can be mounted any way you prefer. Just be sure, for maximum engine reliability, to mount the fuel tanks so that their centerlines are just below the needle valves of the carburetors.

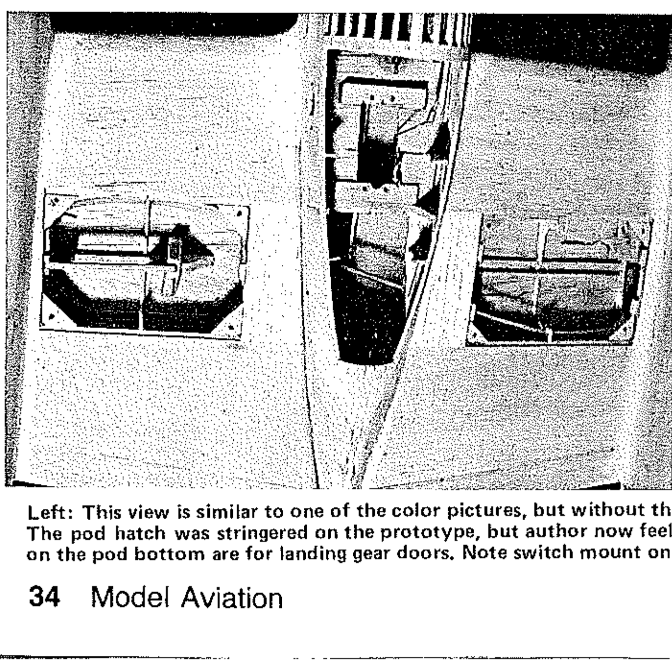
Use epoxy or polyester resin to fuel-proof the tank area and firewall. The air intakes are built up of 1/16 balsa pieces between the boom stringers where they will provide a gluing base for the intakes. Add the intakes after covering the booms.

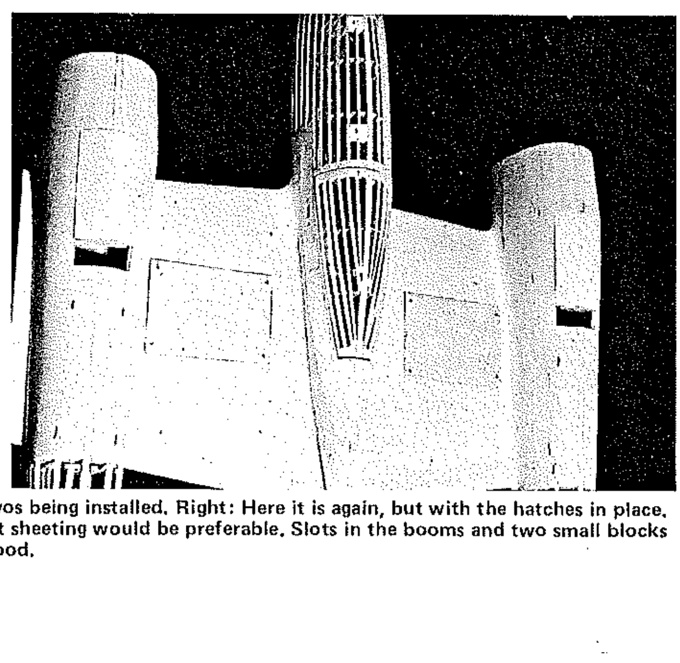
Pod. As you have seen, the support for the pod is the two plywood beams rooted in the front and rear wing spar dihedral braces. The first step is to squarely cement Formers 3, 4, and 5 to 1/8 plywood beams. Add the 3/16 balsa keel and backbone. Glue in Formers 6, 7, 8, 9, and 10 between the keel and wing center section, then glue in Formers 1 and 2. Sheet the pod with 1/16 balsa from Former P-5 rearward above and below the wing center section. Cut the access hatch for the battery, receiver and aileron servo. Finally, add the 3/32 stringers ahead of Former P-5. Notch these into the sheeting for greater strength. (Don't forget to bolt in the nose wheel mount before adding the stringers!) Add the nose block last and any cockpit detailing you wish.

Tail group. The rudders and stabilizer are built over the plans in the usual way. My

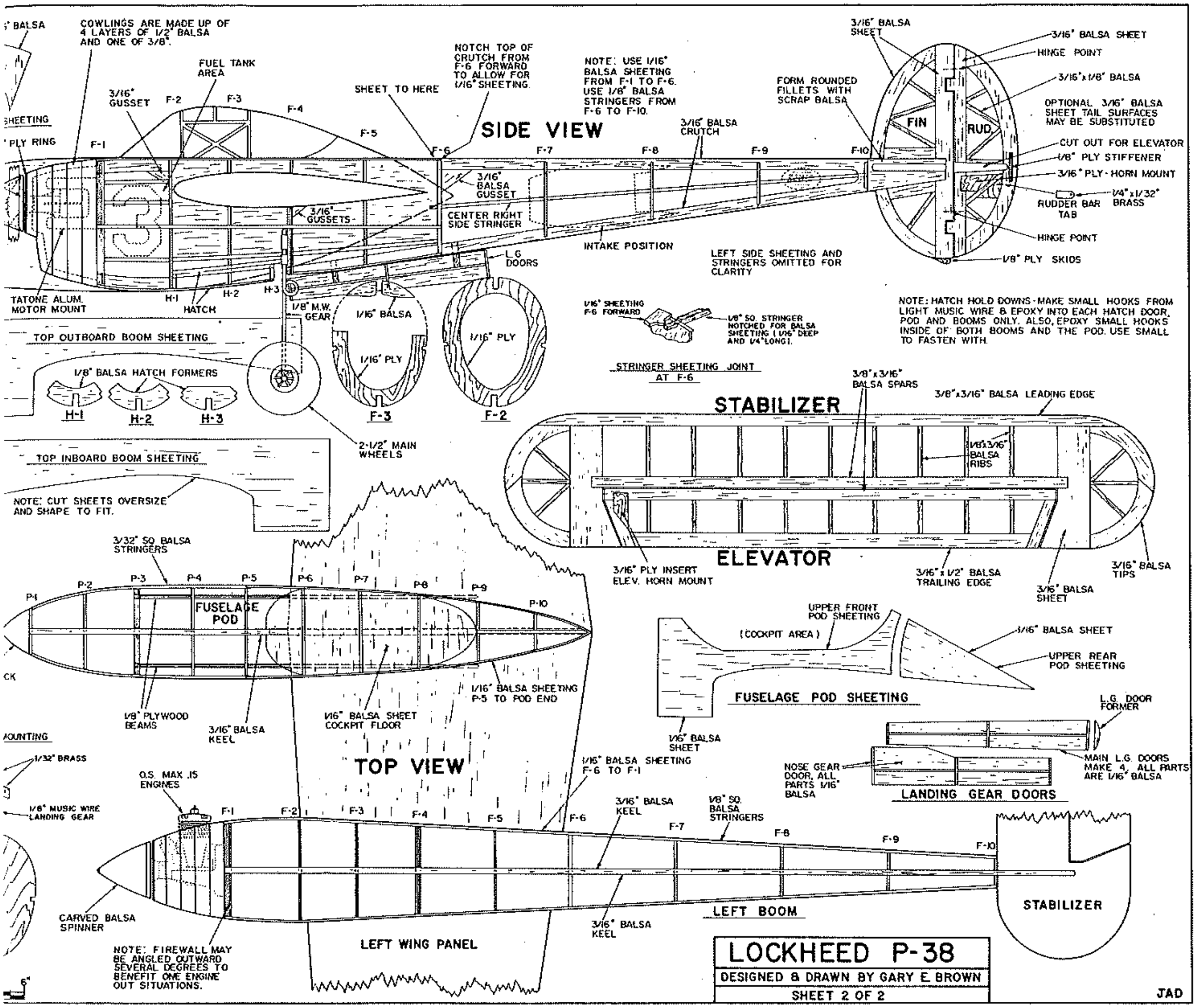


model came out nose heavy with the built-up tail feathers, so you could easily construct solid sheet surfaces, saving a little time and gaining the needed weight in the tail. The rudders are coupled by a 1/16-in. music wire





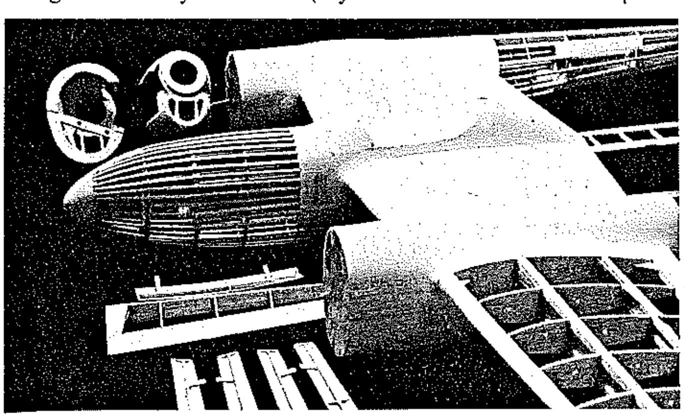
Left: This view is similar to one of the color pictures, but without the servos being installed. Right: Here it is again, but with the hatches in place. The pod hatch was stringered on the prototype, but author now feels that sheeting would be preferable. Slots in the booms and two small blocks on the pod bottom are for landing gear doors. Note switch mount on the pod.

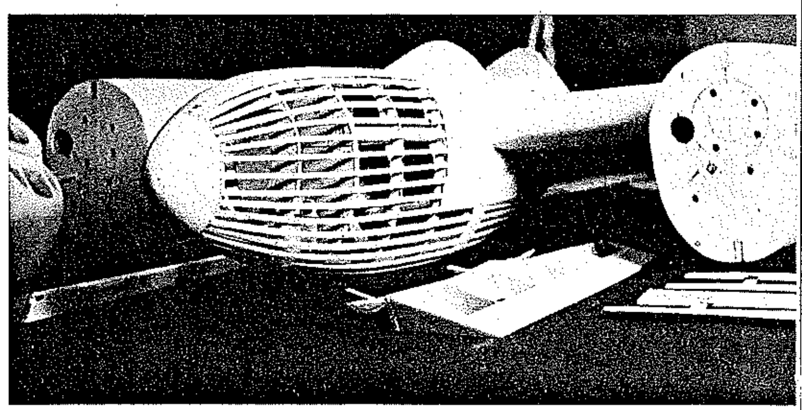


pushrod which works well and avoids the need for more internal control cables. If you don't care for the looks of the wire, you can run cables to both rudders and synchronize them.

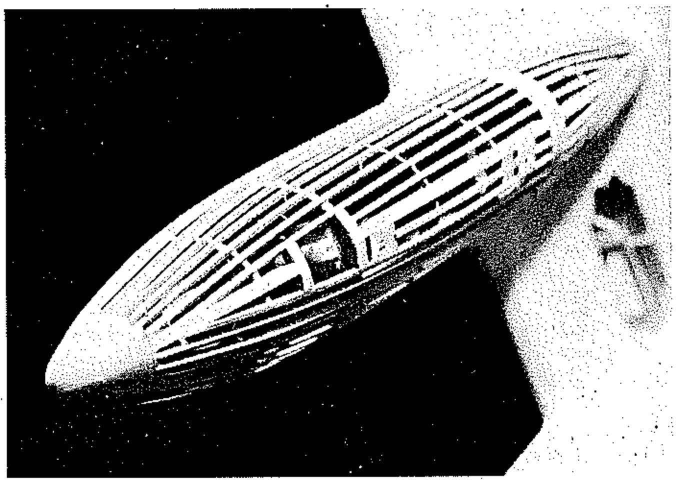
Covering and finish. Carefully sand the entire framework in preparation for the covering material of your choice. (My model was covered with medium weight silkspan.) After the wing panels are covered and before they are painted, twist in about ¼-in. of washout in the tips. This is easily accomplished with silkspan by holding the framework over a steaming pot of water for several minutes. Continue to hold in slightly more twist after removing it from the steam until the silkspan dries. Measure carefully to ensure that you get the same amount of washout in each wing panels; steam again, if necessary.

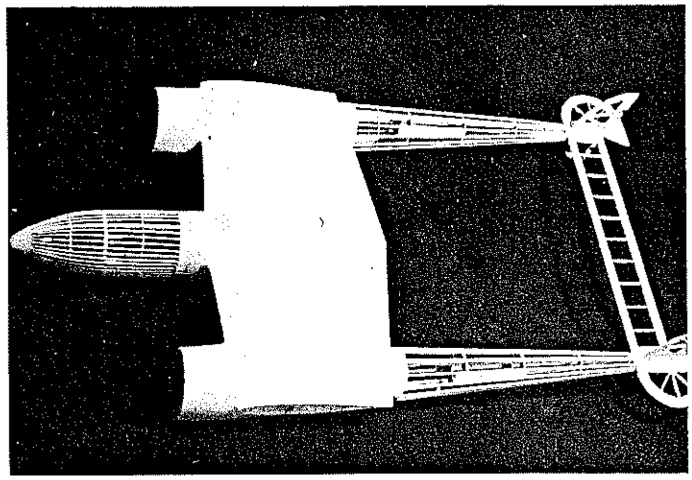
Practically any lightweight model finish can be used if silkspan is not to your liking. The lettering was cut from MonoKote Trim, the "Tony LeVier" on the pod was hand-lettered with a brush and dope, and the "Fox of the Skyways" was done with transfer let-





Left: On the far side of the pod, note the bar diagonally across the back of the cowl—this is for mounting. The nose gear door is warped to fit the contour of the pod. Right: Beams of 1/8 ply can be seen in the top half of the pod. Install the nose wheel mount before applying pod stringers.





Left: That's a nylon nose gear mount just barely visible between the stringers. Slot in small balsa squares is to mount the nose gear door. Right: Cockpit detailing is optional. It looks nice, but be careful to keep it lightweight if used. A WW II 9-in. canopy (from Sig Mfg. Co.) fits nicely.

tering (available at art supply stores). The overall finish was done with red fuel-proof dope and several top coats of clear.

Spinners, mufflers, etc. Off-the-shelf hobby shop spinners don't have the correct contour for a P-38, so here's how to make your own. You will need two C.B. Associates 2-in. aluminum backplates and prop shaft nuts to fit your engines. Cut two balsa blocks a little larger than the backplate diameter and 1⅝-in. long. Drill a hole perfectly centered and perpendicular to the rear of the spinner (block) for the drill arbor. Rough-carve the block to shape, and then chuck the arbor in a lathe or an electric drill for turning the block to final spinner shape.

After the outside dimensions are finished, you will need to carve out the inside. Be sure to begin balancing the spinner as you carve in order to initiate and preserve a good balance. Remember that one side of the block is likely to be heavier even before you start.

When carving and balancing is complete, line the inside with light glass cloth and polyester resin. Also, give the outside several coats of resin. Use thin coats to avoid uneven weight distribution.

The final step is to mate the spinner to the backplate, creating a resin lip on the base of the spinner to fit into the groove of the backplate. For a release agent, melt a little candle or ski wax onto the backplate; allow it to flow evenly around the groove and well over the edge. Fill the groove completely with resin. Roughen the base of the spinner cone where it will contact the resin in the groove. Now, with the backplate on a level surface, squarely place the spinner cone on the backplate so that the resin in the groove will adhere to the base edge of the cone. Once the resin sets up, you will have a perfect male mold of the backplate groove on the base of the cone. Finish the spinner with epoxy paint for durability.

Cowls are made of five laminations of ½-in. balsa with a 2-in.-dia. ring of 1/16 plywood under the spinner. The cowls are held to the firewalls by a 4-40 screws through a ¼ ply bar, epoxied diagonally across the rear of the cowl to contact the firewall, into blind nuts mounted in the firewall. The screws are installed and removed through the air intakes in the front of the cowls. This method eliminates the need for external screws or fasteners.

My mufflers were fabricated out of K&S sheet brass and tubing to fit the O.S. .15s. If you like to experiment, I urge you to try building your own mufflers. Particularly for Scale projects, the end results can often look better if you design a muffler to the model, rather than design the model around a commercially-available muffler. If you try building a muffler from brass stock, use a silver solder with at least 30% silver content. Soft solders will not hold up.

For the fuel tanks, I used rectangular 4-oz. Sullivans. They will give you plenty of capacity for a .15-size engine. I suggest that you consider nothing but aluminum for mounting the engines. I started with glass-filled mounts and found them flexible enough to allow the engines to vibrate intolerably at a certain rpm setting. I switched to

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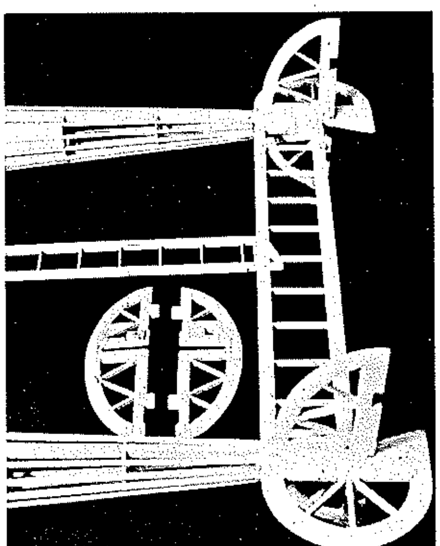
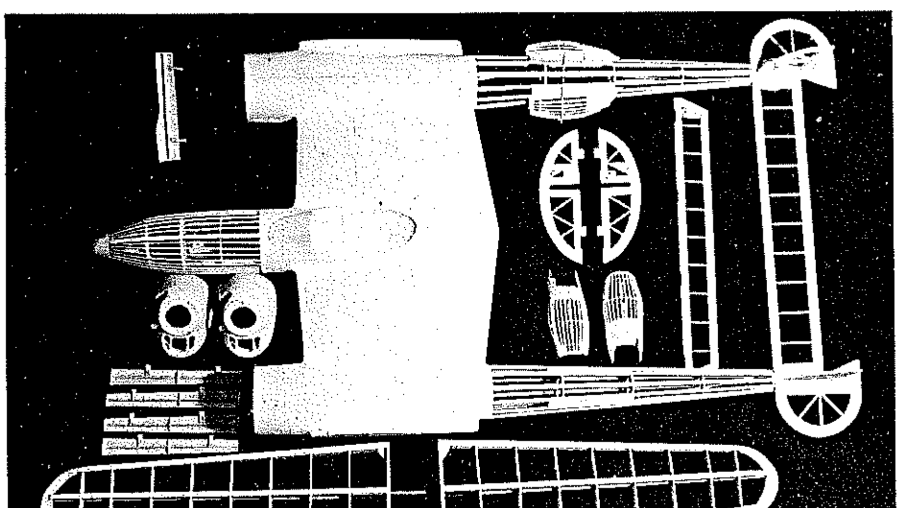


The bare bones of a built-up structure, the tail section shown here, have a charm and beauty unmatched by foam and fiberglass.



It's ready for covering. Dummy supercharger intakes on booms were later rebuilt and sheeted. Cowls, firewalls, and fuel tank areas were fuel-proofed with polyester resin before painting.

is Gerald Martin of Herford, TX—a very good flying buddy. He was in the *Battle of Britain* series and *Baa, Baa Blacksheep.* My next project will be the obscure Dayton-Wright of 1918 or so, which had an early retract gear and the first round cowl. Still researching . . ..

"I leave you with the thought that Just For the Fun of It is certainly the name of the game, if you are going to get the very best out of modeling as a hobby . . .."

Now, as we were saying . . ..

Notice: Would the contributor who sent the photos of Ray Arden's miniature historic engines please contact the author.

Bill Winter, 4426 Altura Ct., Fairfax, VA 22030.

P-38/Brown

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Tatone mounts securely bolted to the firewalls.

Most radio equipment should fit the P-38, but the smaller and lighter, the better. The throttle, rudder, and elevator servos are mounted on their sides in the wing and operate the surfaces and throttles via cables. The aileron servo is mounted underneath the cockpit just ahead of the front wing spar. The ailerons are torque-rod operated. In order to allow the outboard wing panels to be removed, the $3/32$-in. music wire torque rods connect with telescoping square brass tubing. The receiver and battery pack are placed in the forward portion of the pod.

The landing gears are bent from ⅛-in. music wire with a coil bender. There is a wide variety of ready-made landing gears on the market that will also do the job. Brass mounting tabs were soft-soldered to the upper ends of the two main gears and mounted to Former 4's $3/16$ ply with three 4-40 screws and blind nuts. The nose gear mount and linkage are quite routine, the only major difference from normal being that it is operated by the aileron servo.

Flying. Though it is not a beginner's model, the P-38 is not at all difficult to fly. For the first flight, you might want to leave the cowls off until you get your engines properly adjusted. Prior to starting, prime both engines. Start the left engine first. Peak it, being careful not to let it get overlean. Now, start the right engine, and synchronize it by ear to the left engine at full throttle. Be particularly careful not to overlean either engine. That extra tweak of the needle valve usually gains nothing in rpm and might cause the engine to go dead after takeoff. Be certain that both engines idle reliably and respond in unison to throttle changes. With both engines running smoothly, you are ready for takeoff.

The takeoff run and climb-out are of average length and speed. As with any model, avoid abrupt, nose-high attitudes after takeoff until the aircraft has gained sufficient airspeed. Once in the air, the model will feel quite stable, and control surface responses are normal. *Continued on page 126*

product review product review product review

The Stampe SV4 French primary trainer @ $100 from Champion Model Aeroplane Company Inc., P.O. Box 891, Woodbridge, NJ 07095.

Some slight deviation from scale provides lots of construction simplicity and, in this case, produces a Stand-Off Scale super kit. If you love bipes, but hate making cabane struts, this is the kit for you. The cabane struts are prebent, assembled, and brazed to the proper angles. They are simply installed using two wheel collars, a nut, and a bolt. All other component parts are individually packaged. High quality balsa is used throughout, with many of the parts machine-cut to shape. The formers are individually saw-cut, while the leading edge is machine-shaped, notched for the ribs, and grooved for the leading edge planking. The maple parts are cut to shape, drilled, and tapped. A two-piece rolled plan is included. The Stampe SV4 from Champion uses .45-.80 engines, a 4-channel radio, and sports 1,003 sq. in. of wing in a 6 to 7½-lb. package.

product review product review product review

P-38/Brown

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Surface movements should be approximately as follows: rudders, 3/8-in. both ways; ailerons, 1/4-in. both ways; elevator, 5/16-in. both ways—with a little bit of up-trim to start with. Aileron response is positive, but like the full-size aircraft, the roll rate is slow. Ailerons and rudders needed no trim adjustments, but the elevator on my model needed a bit of up-trim to offset the nose-heaviness.

Landings, while not Cub-like, need not be at full throttle. On your first flight, make a few landing approaches well before your fuel runs low to get the feel of the sink rate. Don't try to come in on final with the nose too high; keep it level or down slightly until just before touchdown, then flair slightly. I have done some low-speed testing of the model (at altitude, of course), and it hangs in there without stalling surprisingly well.

If you've always wanted to try a twin, and the boxy, add-an-engine designs turn you off, try this racy P-38. There's nothing like a twin—on the ground and, especially, in the air.

Radio Technique/Myers

Continued from page 39

would confuse voice or music. RC systems designers are very concerned with spatter, however, so they don't actually use ON/OFF switching. Instead, they use a shaped transition from ON to OFF to ON that minimizes spatter.

Just to make things a bit more complex, there are significant deviations from ideal performance in the hardware of both systems.

As a consequence of that ON/OFF signal-shaping mentioned above, your AM transmitter puts a little frequency shift into the transmitted RF signal each time it turns the signal ON or OFF. That shift is FM, its a minor amount, and it's needed to control spatter. But that shift is decoded by a *narrow-band* FM receiver because the receiver is designed to detect exactly that kind of small shift in frequency! Reminds one of Catch 22, doesn't it?

At this point, I should point out that all of our servos are controlled the same way: we send little pulses of voltage to them. The ON-time of the pulse determines servo output shaft position (see Fig. 2).

Your FM receiver is a little less than ideal, too. In theory, an ideal FM receiver amplifies all received signals to the point where it can clean off all incidental AM by use of its limiting stages (see Fig. 3). However, the AM coming from an RCnbAM transmitter goes all the way to zero, *and it also has exactly the same configuration as a valid control signal.* You should be able to see that the limiter *can't* get rid of it. (If you really wanted to jam RCnbFM, you'd be hard put to find a better way than using RCnbAM.)

By now, you should grasp how an RCnbAM transmitter can control an RCnbFM receiver. But the amount of AM put out by an RCnbFM transmitter is negligible. So how does the RCnbFM transmitter manage to control an RCnbAM receiver?

The bandwidths of RC AM and FM systems have essentially the same characteristics. Without becoming overly technical, you should be able to visualize why RC systems spaced 10 kHz away from other (Common Carrier) systems must, of necessity, use bandwidths equal to (or less than) half the distance between channel centers. Therefore, our new, narrow-band RC systems must use bandwidths of ± 5 kHz—or less—for both AM and FM systems. The IF (intermediate frequency) section of your RC receiver must be designed to cut off information sharply, at or slightly before the ± 5 kHz points, to minimize adjacent-channel interference problems (see Fig. 4).

Now, let's take a look at what happens when an RCnbFM signal passes through a real RCnbAM receiver.

If, by the happiest of circumstances, the center frequency of the interfering RCnbFM transmitter happens to land in the passband of the RCnbAM receiver so that the deviated FM signal *also* lands within the passband, the outputs of the two signals will be equal (as shown in Fig. 5a), and a voltage will be sent to the servo, but it won't pulse. As a consequence, no interference (or control) will result.