#768

Gipsy Moth

The Moth biplane was designed by Geoffrey de Havilland in 1925 as a sport aircraft. The Gipsy Moth was created in 1928 by replacing the original Airdisco engine with the Halford-designed 100 hp Gipsy engine.

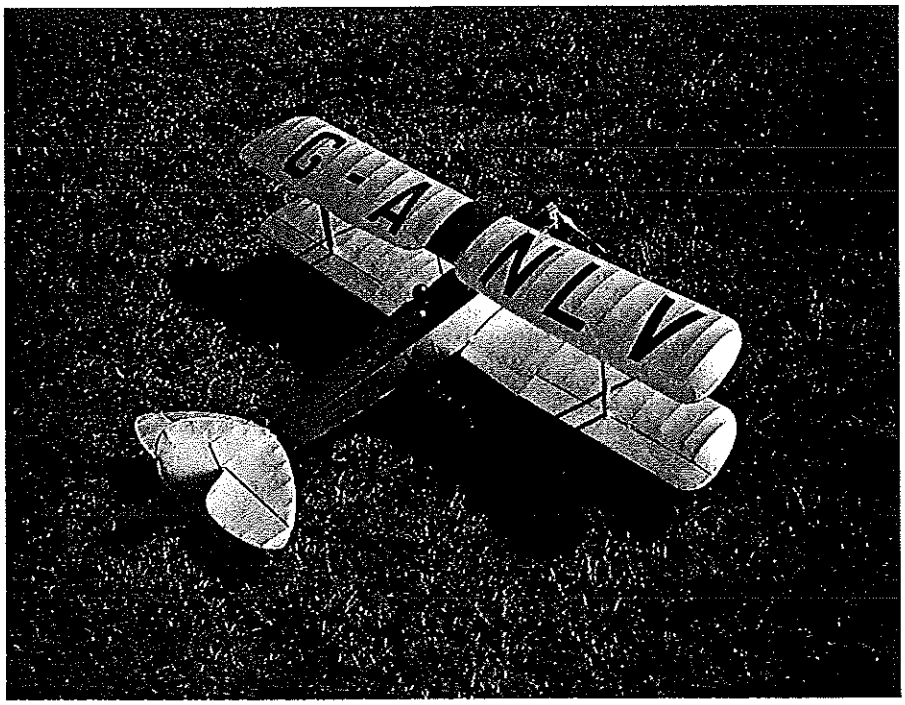
The Gipsy Moth was an instant success, and 1,162 were manufactured. They were even manufactured in the US by Moth Aircraft Corporation of America, thus earning a US-approved type certificate.

During the late 1920s and early 1930s many amazing long distance flights were made in Gipsy Moths. These included Amy Johnson's solo flight from London , England to Australia, Lady Bailey's 18,000 mile solo flight around Africa, and Lt. Bentley's solo flight from London to Capetown, South Africa.

The Gipsy Moth was recently featured in the movie *Out of Africa.* Unfortunately, there are no Gipsy Moths left in the US, as the British have purchased them all and returned them to their homeland. However, there is a fellow in California who is reputed to be converting Tiger Moths back into Gipsy Moths!

A number of years ago, a beautiful all-white Gipsy Moth was temporarily housed in a hangar next to mine between the EAA convention and the Blakesburg

■ Frank B. Baker



Left: The Moth is covered with silk. Finish is silver dope sprayed over a brushed-on clear dope base.

Below: The Moth flies realistically and predictably. Turns require coordinated rudder, elevator, and aileron.

AAA fly-in. The small size and rather fragile beauty of this plane anchored itself in the back of my mind, but it did not come to the fore until I purchased an O.S. 20 four-stroke engine.

I started thinking about biplanes, and the Gipsy Moth became the obvious plane to build. Arbitrarily selecting a 50-inch wingspan, I enlarged an excellent set of three-views that appeared in *Aeromodeller*. The result was a moderately sized model that was ideally matched to its power plant and a 9 x 6 prop.

CONSTRUCTION

By my standards, the Gipsy Moth is not a particularly light model, and you should take pains to keep the weight down. Use epoxy very sparingly; for some reason it adds weight in a very insidious manner. Choosing the weight of the balsa consistent with its use is also important.

Wings: Since the wings are the easiest part of a model and they will be needed to build the fuselage, let's start with them.

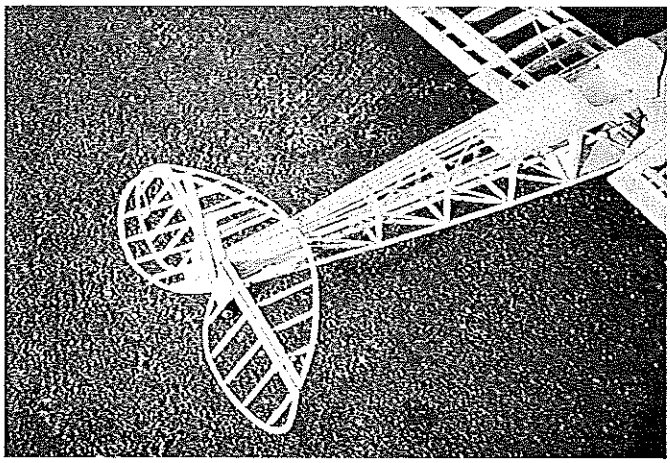
The wing spars consist of top and bottom ⅛ x ¼ spruce with balsa sandwiched in between. Use aliphatic resin glue to laminate the spars, and be sure to secure them in a manner that will ensure that they are straight.

Note that the balsa spacer does not go to the root rib, as the plywood dihedral brace slips in there. Since the wings are longer than a standard 48-inch strip, make spars for each wing panel and cut the spruce pieces for the short center section. Make the wing ribs by stacking 1/16 balsa blanks and cutting them with a band saw. I usually make all the ribs for a wing panel at one time. Although the plans show a false rib between each full rib, I did not put them in, as it just adds weight and is more work.

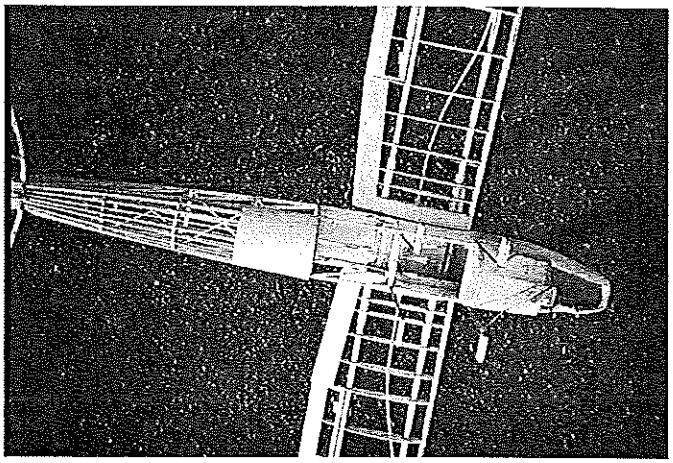
Once the ribs have been cut, lay out a complete wing on a building board and pin the three segments of each spar in place. It is important to keep the three segments properly aligned so that problems do not arise when putting in the dihedral braces.

The remainder of the wing construction is standard; however, you will need to trim the ribs where 1/16 sheet is used at the root end of the wing panels. Do not install this sheeting on the top wing until the wing cabane struts have been fitted.

Once the wing panels have been built, laminate the ⅛ x ¼ spruce spar caps to the four dihedral braces and trim them to fit into the holes in the wing spars. Glue the center section spar stubs, slide them into the holes in the wing panel spars, and block up the wings so that you get 1.2 inches dihedral at the outer



Basswood tail surface outlines are laminated 1/16 strips soaked in water and wrapped around plywood forms.



Wing strut sandwiches were designed to allow addition of top wing either before or after covering.

end of the rear spar. After checking the wings for equal dihedral and no twist, let the glue dry overnight.

Once the panels have been joined, use a razor saw to cut the rib so the 1/32 plywood dihedral plates cam be glued to the front and back of each spar. The eight 3/32 balsa center ribs can be split lengthwise and glued to the center section of the top wing. The top center section is sheeted with 3/32 to provide a sturdy hand hold. There are no center section ribs on the lower wing, as the spars glue directly to the fuselage.

Note that the ailerons are in the lower wing only. I like to use nylon tubing with bronze cable (Hobby Lobby HLH 805) to actuate the ailerons. Bring the nylon tubing forward as per the plans to get a large, smooth-radius turn as the tubing makes the 90° turn to the aileron. This will result in a smoothly functioning aileron.

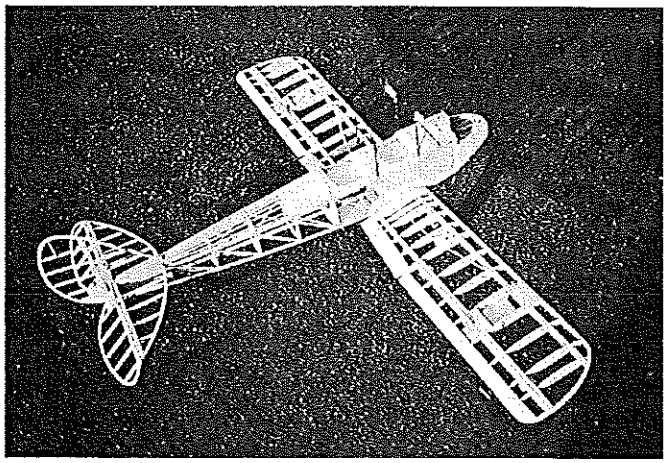
My personal preference is to use a continuous length of aileron cable with a Z piece of wire, soldered at the center, to hook onto the servo arm. Do not install the nylon tubing and this cable until the lower wing has been glued to the fuselage—the tubing runs into the fusleage and the cable runs through it.

Cut the eight outer wing strut supports from some .015 aluminum sheet and bend them per the plans, but do not drill the bolt holes. Use some soft copper wire to bind the strut supports to the wing spars. Be sure that the top strut fittings point down and the bottom fittings point up.

Put a liberal amount of Ambroid glue all over the wire and the fittings, then cut slits in the 1/16 sheet that goes over the fittings and glue the sheets between the appropriate ribs. This sheeting will provide a place to anchor the covering in the area of the brackets. The end result is that about 5/8 inch of metal will be out in the open.

Fuselage: Build two fuselage sides directly over the plans, and be sure to use the hardest 3/16 square balsa that you can find for the top and bottom longerons. Do not install the 3/16 sheet triangles at the rear of the cockpit until the sides have been joined. Glue the 1/32 plywood doubler to the inside of each fuselage side using epoxy.

Make the 3/16 plywood firewall and cut the holes for the engine mounts, but do not drill the gas tank holes. Lay the firewall on a flat surface and use epoxy to glue in the maple engine mount beams. Use several metal triangles to insure that the beams are at 90° to the firewall, and that there is no down thrust or side thrust. Epoxy the 1/8 plywood front beam former in place.



The Moth's lower wing has 2° incidence; top wing is set at 3°. Robart incidence meter was used to set angles properly.

Lay the two fuselage sides top down on a flat surface with about 1/2 inch of the front extending over the end, then pin and block them so that they are straight and even. Glue in the 3/16 square top and bottom crosspieces where F4 eventually goes. Glue in former B3 and the 3/16 sheet (grain crosswise) that goes from B3 to the 3/16 square crosspiece. Do not glue the tail posts together.

Set the fuselage aside while you make the fuel tank. I like to make my own tanks from K&S #254 easy solder tin sheet. Make a pattern by doubling the half-scale pattern on the plans and cut the tin accordingly.

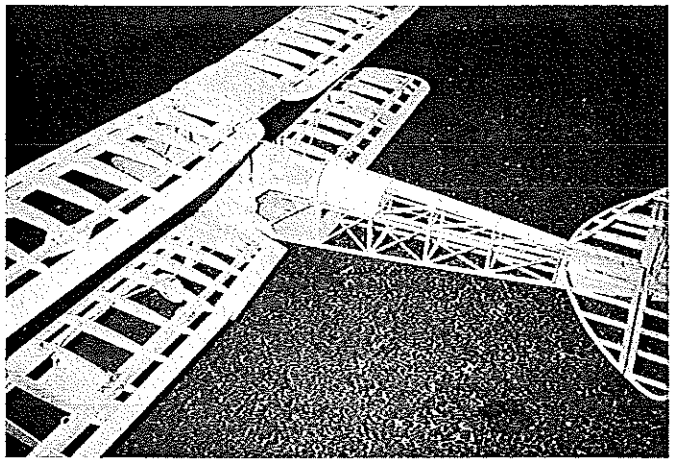
Solder the tank such that the rear can be left open. Cut lengths of 1/8 copper tubing (I get it at auto-supply houses) to make two vents and the fuel line. Run the fuel line to the bottom center of the rear of the tank and solder it to the floor of the tank. Be sure that you have not soldered it shut!

Leave all three tubes coming straight out of the front of the tank and solder them on both the inside and outside of the tank. Close up the back of the tank and solder it shut. Use thinner or some other solvent to remove all the soldering paste. Fill a bucket with water and check the tank for leaks. Once the tank is leak free, drill holes in the firewall to allow the three tubes to pass through.

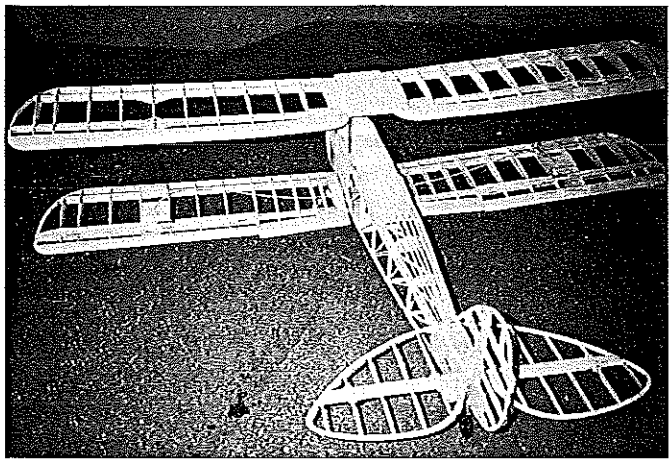
Slip the tubes partially through the firewall, put a bit of epoxy between the tank and the firewall, push the tank forward, and hold until the epoxy has set. Bend the center fuel line upward and cut it off (leave about 1/2 inch of straight tubing for the fuel line to slide on). This scheme makes it a lot easier to run fuel line to the carburetor on the back of a four-stroke engine.

Epoxy the firewall assembly to the fuselage sides. Again, be sure there is no down or side thrust. Glue the 1/8 sheet tank support at the bottom of the tank.

The top wing cabane struts are built next.



Completed framework ready to cover. The 50-inch span proved to be an ideal match for the O.S. 20 or 26 and 9 x 6 prop.



Only the lower wing has ailerons. Author prefers to use nylon tubing with a single length of bronze cable.

Bend the ⅛ music wire as per the plans. These struts will be attached to the fuselage using a plywood sandwich that has the wire in the middle, and attach to the wings with ⅔ of a sandwich (the wing spar forms the third layer).

Cut the sandwich centers from ⅛ plywood and cut the slot to fit the ⅛ music wire. Cut the back of the sandwich for the fuselage end and the wing ends from 1/16 plywood.

Lay each of the three 1/16 plywood plates on a flat surface and coat them with some slow-cure epoxy. Lay the ⅛ music wire down and fit the ⅛ plywood center pieces around it, put on some epoxy, and be sure to fill the space between the wire and the plywood.

On the rear cabane strut only, lay down the top 1/16 plywood plate where the wire goes across the fuselage. The front cabane strut fuselage sandwich top plate consists of former F3, which is ⅛ Lite Ply. At the wing ends of the cabane struts, lay some plastic film over the epoxy and place weights on each of the three sandwiches for both struts. Be sure to check that the plates have not slid when the weights are placed on them.

Remove the fuselage from the building board. Make the two 1/16 plywood rear cabane strut fuselage doublers. Glue in the front cabane strut sandwich at F3, making sure that it is at 90° to the top of the fuselage, then let the glue set.

Block up the fuselage on the workbench and set the top longeron of the fuselage at 0°. Use some small C-clamps to hold the ⅔ sandwiches at the wing ends of the front cabane strut to the front of the front wing spar.

Loosely assemble the rear cabane sandwich and the 1/16 doublers. Apply some slow curing epoxy glue and slip the assembly into the fuselage. Again use some small C-clamps to hold the ⅔ sandwiches at the tops of the cabane struts to the front of the rear spar.

Use a Robart incidence meter to set the top wing to 30°d incidence. Slide the fuselage end of the rear cabane strut and the doublers up or down until the proper incidence is obtained.

It is important to also measure from the wingtips to the workbench surface to make sure that the wing is sitting level. Then use some C-clamps to hold the 1/16 plywood doublers to the fuselage sides. Leave the room until the glue has set!

Two-inch scale Williams Brothers pilot is installed with its head positioned as it would be for landing.

Although the plans show a sharp break at the rear of the cockpit, do not cut the longerons to achieve this break. Simply glue the tail posts together and let the longerons take their natural bend. You may have to make F5-F7 a bit wider to accommodate this bend.

Glue in the top and bottom 3/16 square crosspieces at each vertical of the fuselage, then formers F4a-F7. After you have glued in the top fuselage stringers, use a round file to remove the balsa between the tops of the stringers for a better-looking fuselage.

Rough-cut a balsa block to fit between the firewall and former F3 and carve it to shape. Note that at the firewall it has a square top that transitions to half-round at F3. Hollow this block but do not glue it in.

Bend the front cabane support wire and make the plywood sandwich for it. Use soft copper wire to bind the top of this strut to the front cabane strut and glue the sandwich to the fuselage. When the glue has set, solder the copper wire and the two struts. Be careful not to overheat the wire, as the ⅔ sandwich could be loosened. The top wing can now be removed.

You might as well make the cockpit hatch cover at this time. It is simply a 1/32 plywood floor with formers and 3/32 sheet bent over the formers. The ⅛ square spruce stringers add some strength and prevent the cockpit edges from getting beat up due to handling. Bend the two landing gear wires and glue them into their plywood sandwiches.

Gipsy Moth

Type: RC Scale

Wingspan: 50 inches

Engine: O.S. 20-26

Number of channels: Four

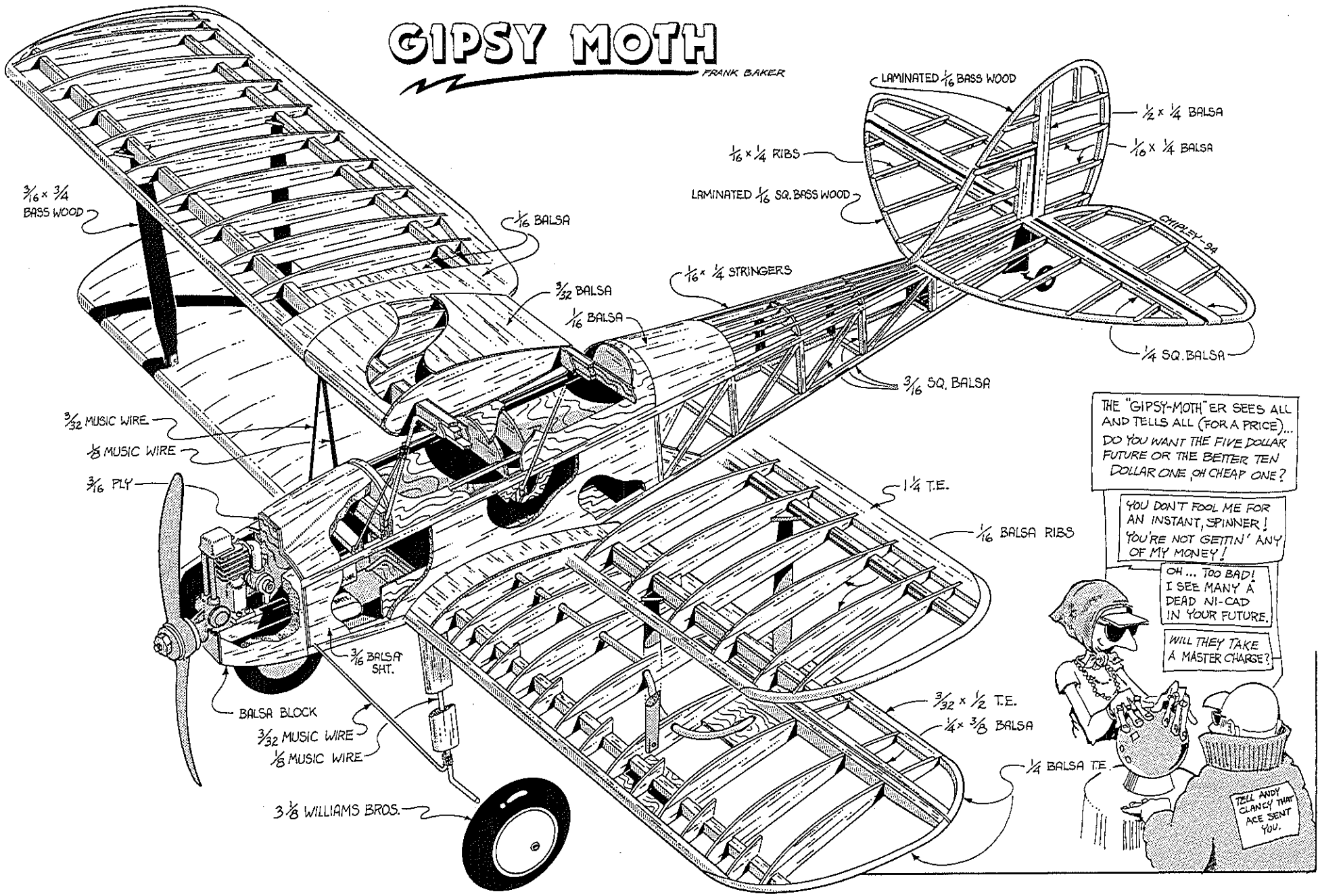
Flying weight: 68 ounces

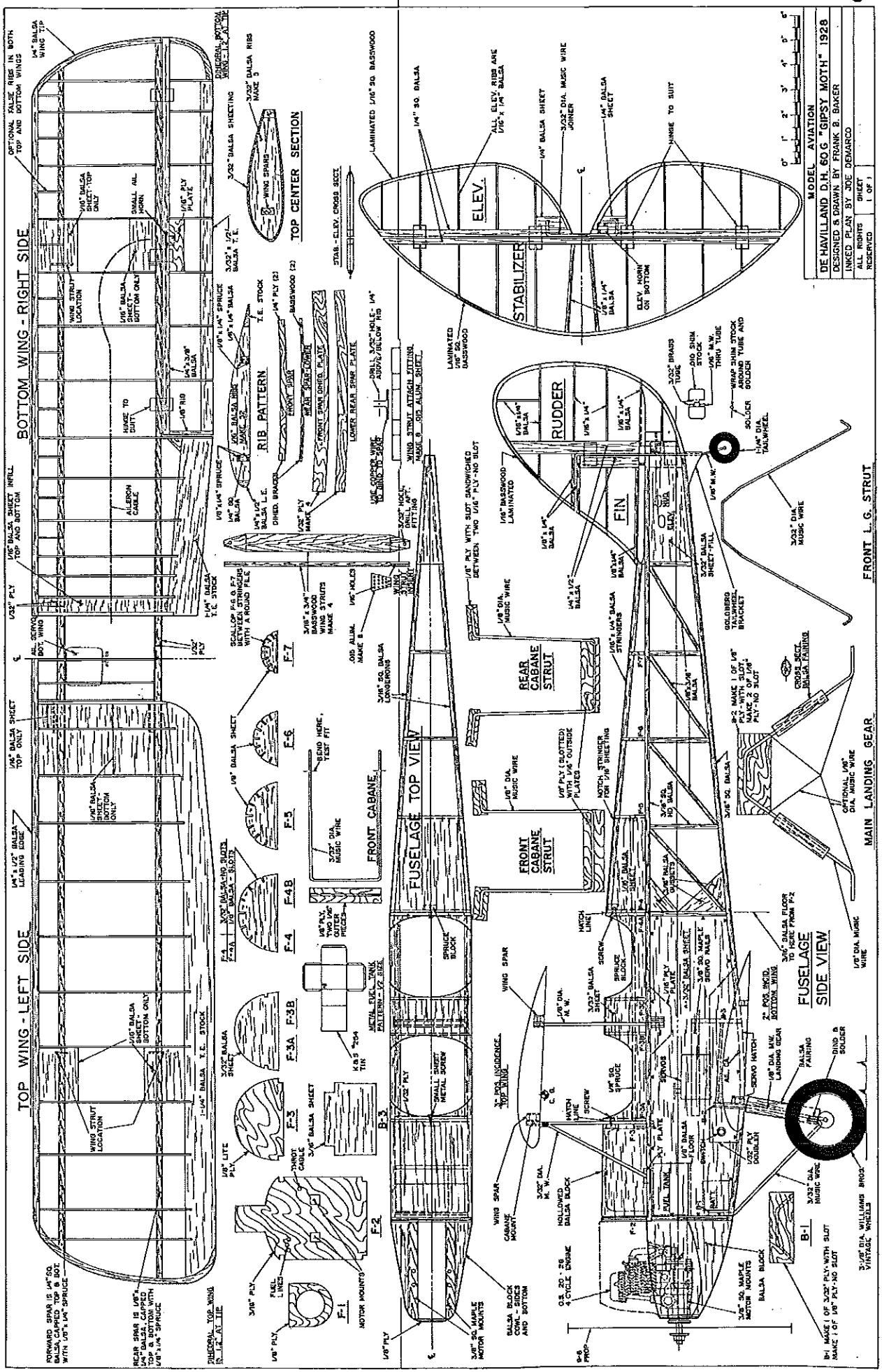
Construction: Built-up

Covering/finish: Silk and dope

GIPSY MOTH

FRANK BAKER




TOP WING - LEFT SIDE
BOTTOM WING - RIGHT SIDE
RIB PATTERN
TOP CENTER SECTION
FUSELAGE TOP VIEW
FUSELAGE SIDE VIEW
STABILIZER
ELEV.
RUDDER
FIN
FRONT L.G. STRUT
MAIN LANDING GEAR
FRONT CABANE STRUT
REAR CABANE STRUT
FRONT CABANE
MODEL AVIATION
DE HAVILLAND D.H. 60 G "GIPSY MOTH" 1928
DESIGNED & DRAWN BY FRANK B. BAKER
INKED PLAN BY JOE DEMARCO
ALL RIGHTS RESERVED
SHEET 1 OF 1

While there is still some working room, let's take care of the servo installation. First, fit the lower wing to the fuselage. Use a razor saw to cut the slots in the lower fuselage to accept the lower wing spars. Note that the rear spar is out in the open and that the trailing edge of the wing is quite a bit below the bottom of the fuselage. This is because the full-size Gipsy Moth had folding wings, and when folded the lower wing trailing edge went under the fuselage.

Be sure to adjust the slots so that the lower wing has 2° incidence, and glue the wing to the fuselage. There should be some space between the root rib and the fuselage side to allow covering of the rib and fuselage side. Measure at the wingtips to ensure that the lower wing is level.

Use some epoxy to glue the main landing gear plywood sandwich into the fuselage and to the forward lower wing spar. Use a piece of 3/32 sheet balsa to serve as a pattern for the aileron servo platform. Trim it until it will fit between the main landing gear plywood sandwich and B3. Once it fits, duplicate it in 3/32 plywood and glue it in place.

Make some 3/32 x 1/4 plywood strips the width of the fuselage and glue them 1/16 below the edge of the lower longerons at the front spar and at B3 to serve as screw plates for the servo hatch cover.

Make the servo hatch cover from 1/16 plywood. Be sure to build some curvature into the hatch cover and hold it with some small glued-on strips so that it matches the lower longeron curvature.

Mount three servos on a side-by-side servo mount or on two 1/2-inch strips of 3/16 plywood. Then slip the 3/8-square maple servo mount rails into the fuselage and slip the three servos into the fuselage.

Mark the screw holes on the 3/8 maple rails. Pull the servos and rails out and screw them together. Slip the whole unit in and glue the rails to the fuselage side and to former B3. Adjust the position of the rails until the bottoms of the three servos are about 1/8 inch above the aileron servo plate. Be sure that the rails are parallel to the top longerons.

Now the bottom of the fuselage can be finished. Clamp the plywood sandwich for the forward 3/32 music wire landing gear to the back of the fuselage. Measure to the main landing gear wire and allow for a bend. Remove the unit and bend the ends of the wires. Some trial-and-error bending and twisting will be needed until the bends fit the front of the main gear wire.

Once this is done, epoxy the plywood sandwich to the rear of the firewall, then wrap the wires with copper wire and solder the front supports to the main gear wire. Solder two strips of 1/4 wide brass shim stock to each main landing gear leg and glue on the airfoil-shaped balsa fairings. Glue in the 3/16 sheet cross-grain from the firewall to the main landing gear sandwich.

Tail: The tail feathers are of standard construction. Note that the 1/4 x 1/2 rear post in the vertical fin goes all the way to the bottom of the fuselage.

Just for looks, I used an old free flight technique to make the curved outline pieces:

Cut pieces of 1/4 plywood to the inner shape of the five empennage parts. Soak lengths of 1/16 square basswood in water, then bend them around the form and hold in place with masking tape. Using white glue, laminate four layers, in the horizontal plane, until there is an outline 1/4 wide and 1/16 thick.

Let the glue dry for a day, then remove the outlines from the forms. Use a small block plane to smooth the surface. The result will be a beautiful outline that is both strong and light. (If this seems like too much work, just cut the outlines from 1/16 sheet balsa.)

The lower rudder hinge is fabricated from .010 brass shim stock. Wrap brass shim stock around a 1/16 music wire and solder the shim stock together (but not to the wire). Remove the wire and use a file to remove the appropriate metal. The result should look just like a standard Du-Bro or Klett nylon hinge.

Bend a length of 1/16 music wire to fit a 1 1/4 tail wheel. Run the wire through a nylon Goldberg tail wheel bracket, then through the brass hinge assembly. Make a 90° bend to the rear and cut off per the plans.

Use a razor saw to cut a 1/4 vertical slot in the tail post of the fuselage. Glue the stabilizer to the top longerons 1/4 inch forward of the end of the fuselage, and be sure to check its alignment from above and from the front.

Cut a 1/4 square slot in the vertical fin post to fit the rear stabilizer spar. Glue the vertical

fin onto the stabilizer and the fuselage. The rear of the vertical fin post should be flush with the end of the fuselage.

Drill a 3/32 hole through the vertical fin post at the centerline of the stabilizer and flush with the rear stabilizer spar. Feed the 3/32 music wire that connects the two elevator halves through the hole.

Install the elevator hinges, making sure they line up. At the same time, glue the connector wire into holes in the elevators. Install the lower rudder hinge, tail wheel assembly, and the upper rudder hinge.

Make two pushrods from hard 1/4 square balsa or 3/16 birch dowel and install threaded rod and Kwik-Links at the control surface ends. You will have to put Z bends where they exit from the fuselage.

Attach the Kwik-Links to the control surfaces and fit the front threaded rods and Kwik-Links to the servos. I wrap the threaded rod with thread and apply a generous coating of Ambroid.While the pushrods are still in place, install the 3/32 sheet that goes in both of the fuselage sides below the stabilizer. The pushrods cannot be removed from the fuselage unless you make very large exit holes, so just leave them. Install the engine and decide which way the engine servo should be mounted. Drill the hole in the firewall and install the nylon tubing. Solder threaded connectors to one end of the cable. Hook up the throttle end, feed the cable to the servo, and cut to the appropriate length, allowing for the threaded connector and the Kwik-Link. It is necessary to support the nylon tubing at a couple of points to ensure that it functions properly.

Glue the hollowed-out balsa block between the firewall and former F3, as well as the balsa blocks around the engine. Leave enough room around the engine to have easy access to the engine mounting bolts and free motion of the throttle arm and its Kwik-Link.

At this point you must decide whether to mount the top wing before or after it's covered. I designed the 2/3 wing strut sandwiches so that the top wing could be covered and painted before it was mounted. There is a lot of room between the wings, so if you are using an iron-on-covering the wing can be covered while on the struts. If covered separately, you will need to cut holes in the sheeting to glue the sandwiches to the spars, then recover the holes.

Once the wing is mounted, make the four outer wing struts from 3/16 x 3/4 basswood. Make eight of the aluminum plates and drill a lot of 1/16 holes in them. Use a coping saw to cut a slot in each end of the struts to accept the plates.

Smear epoxy on the plates and in the slots, then slip the plates into the slots. Be careful not to get any epoxy on the exterior wood.

Use some burnt umber stain to color the struts, then give them a coat of clear dope. Slip the strut into the top metal fitting, leaving about 3/64 clearance between it and the wing, mark a bolt position, and drill a 3/32 hole through the fitting and the strut. Install a 2-56 bolt and nut.

The lower end of the strut should fit nicely into the metal fitting on the top of the lower wing, again leaving about 3/64 clearance. The strut should not put any pressure on the wings. Once it fits, drill a 3/32 hole and install the 2-56 bolt. This procedure should be repeated for all the outer struts.

Covering: On a trip to Japan, I asked my wife to stop in a hobby shop and buy several yards of silk. She went to a number of hobby shops, and none of them carried it! In desperation, she bought me some lightweight silk used to make doll dresses. I used it to cover the fuselage and the tail feathers.

I put it on wet, and after it was dry I brushed on several coats of clear dope and sprayed it silver. It initially appeared to be reasonably tight, but after a short time and one crackup it became loose and baggy. I decided not to recover these parts, as they give the model a well worn look. I'm sure many Moths must have appeared this way after years of hard service.

The wings were covered with regular model silk, and have stayed smooth.

I made an engine cowl for photographic purposes, but I don't use it for flying. I put a two-inch-scale Williams Brothers pilot in the rear cockpit. Since biplane pilots look forward and over the side when landing, glue the pilot's head on to look in that direction.

Flying: To take off, advance the throttle slowly and the plane will trundle along until the tail comes off the ground. It will roll along until you just tap up elevator, then it will begin a steady climb with little or no additional up.

Once at a comfortable altitude, throttle back halfway. Like its full-size counterpart, the model requires coordinated rudder, elevator and aileron to make proper turns; turns with aileron alone tend to look pretty sloppy.

To loop, just dive a bit to build up a little extra speed and pull back on the stick. The Moth will just putt-putt to the top of the loop and down the backside, in what appears to be slow motion.

Loops with a snap on the top are accomplished by giving full rudder and elevator just before the top of the loop and releasing them about halfway through the snap.

To spin, gain some altitude, pull up sharply, and as the speed bleeds off, give either full right or left rudder and full up elevator. The Moth spins with equal facility to both the left and right.

Slow rolls are done by building up a little speed, pulling up, and feeding in aileron and some rudder until a rate of roll is established; the remainder of the roll is accomplished with the elevator.

One of my favorite pastimes is to take the Moth to the flying field just before the sun sets and do wingovers, down sun, at low altitude. Just as you get to the peak of the wingover, the sun glints off the silver wing and the red letters look like they are spotlighted.

Landings are a joy to behold. Throttle back to the point the engine is just ticking over, and make a standard rectangular approach. When the model gets about 18 inches off the ground, hold it level and it will float for what seems like forever. When the wheels finally touch down on the grass, it will roll another 10 yards before the tail settles down.

From a pilot's point of view the Gipsy Moth is totally predictable. It never does anything untoward, it never does any thing unexpected, is completely controllable at all attitudes, and it does everything in a slow, stately manner. In sharp contrast to other models, I do all Moth maneuvers at the lowest possible throttle setting. This adds considerably to the realism of the flight.

Since I built the Gipsy Moth, O.S. has replaced the O.S. 20 four-stroke with the 26 Surpass. Fortunately it fits the same engine mounts and has the same bolt-hole pattern.

With the 26 Surpass, my Gipsy Moth is slightly overpowered. As a result, spend some time adjusting the throttle until you get the lowest possible reliable idle. Otherwise, it will never land! Of all the aircraft I have designed and built, the Moth is the most fun to fly. I always taxi back to the pits with a big grin. My fellow MARCS members never fail to comment on how realistically the Moth flies, and how much fun it is to watch it go through its paces. They are amazed that so much fun can be had with a 20 four-stroke engine at half throttle in a 50-inch biplane.

My Gipsy Moth has hundreds of flights, and each one was just plain fun. I hope that you enjoy it as much as I have. ✈