

THE PIPSQUEAK

BY DAVE ROBELEN

Outstanding .010 Sportster for Galloping Ghost. Plus Complete Construction Details for Lightweight Actuator.

THE Pipsqueak model is a general purpose small-field airplane, scaled down from the Midwest Esquire and designed for the Cox Tee Dee .01. Special emphasis is made on the airplane's ability with a dual proportional system. The author has developed what he feels is the smallest and lightest Galloping Ghost system that will yield smooth, positive control. The heart of any GG system is the actuator, so a special unit was built to meet the following requirements:

- (1) High neutral pulse rate to eliminate any trace of gallop.
- (2) Light weight (25 grams).
- (3) Sufficient control movement for stunting and tight turns in severely restricted areas.
- (4) Enough control power to fly an average .010 or .020 model.

I have flown the Pipsqueak for well over a hundred flights and now feel that all of these goals have been met. Once the system has been installed in the plane and put into operation, no further adjustments need be made. Two additional fringe benefits that have resulted from this actuator are low battery drain (150 Ma. pulsing in neutral), and an excellent fail-safe. Upon loss of signal, the actuator will yield neutral rudder and up-elevator.

The only electric motor that has been

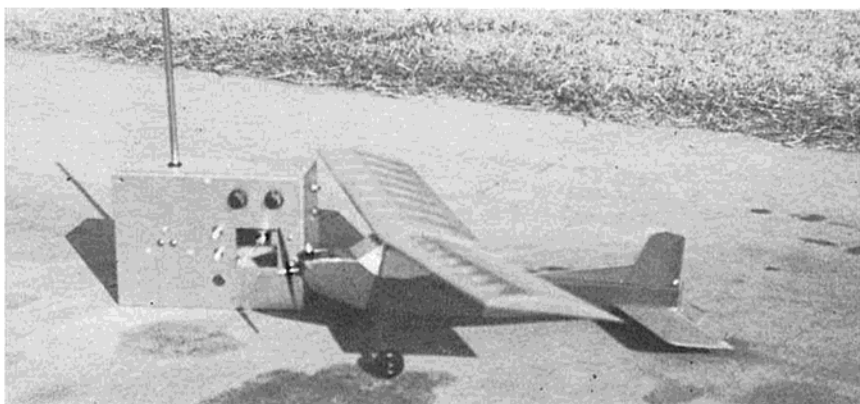
found completely satisfactory for our requirements is the Micro-Mo series. I have used the smaller TO-5 for this actuator. For larger ships in the .049 range, the TO-3 should be more than adequate. All actuator dimensions given with this article will be for the smaller unit and the Micro-Mo TO-5. Construction of the actuator itself requires access to a small drill press and some scraps of aluminum, the latter available from any local machine shop. Detailed instructions for building this actuator are given later on in this article, but a few general

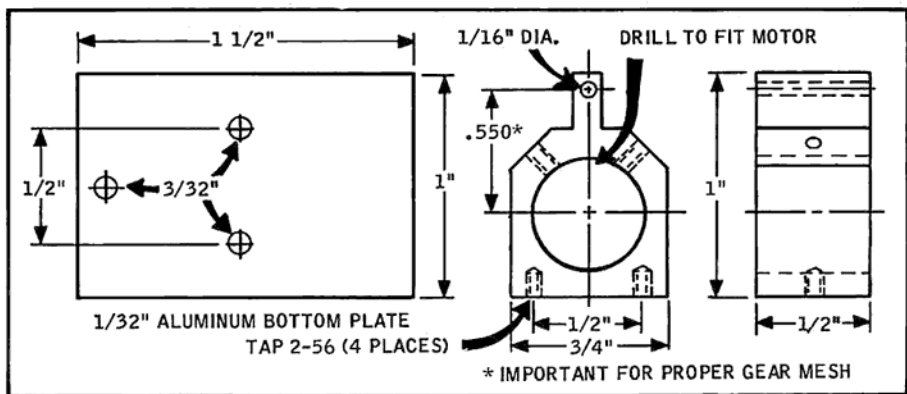
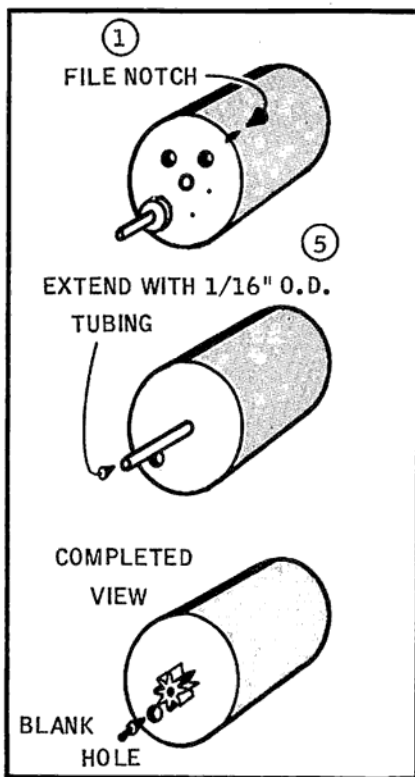
notes are in order at this time.

The main idea behind this entire project is lightness—remove as much metal as possible without affecting strength. Good gear mesh is important for minimum friction, so take a little care at that point. The foam pad upon which the actuator is mounted is very important—don't leave it out! The Micro-Mo motor has a very delicate armature and will not tolerate excessive impact shock or vibration.

The balance of the radio system is quite straightforward. I have used sev-

Note relative size of Pipsqueak next to normal transmitter-pulsar.





stick to achieve this condition. On some pulsers, such as the Phelps, the shift of the rate and width may be adjusted to about any range desired simply by offsetting the trim pots and then re-neutralizing with the control stick adjustment. When satisfied that all is working well, proceed on to the model itself.

The Pipsqueak is a small model, and therefore quite sensitive to variations in weight. All of the balsa used should be carefully chosen for its light weight. Try to select straight wood as any small model is critical where warps are concerned. The model does not require very much in the way of materials, so select the very best. The tissue covering shown for the wing is quite strong, and unless you fly out of a briar patch or cornfield, will give you excellent service. The only puncture on the original model was the result of careless handling while packing the plane for a mail trip from my home in Virginia to Uncle Don's cabin in California! Tissue also has the added bonus of not warping a structure nearly as much as other material, as well as requiring very little

dope for a nice gloss. Color dope, in any large quantity, by the way, should be avoided, as it builds up weight very rapidly on a model of this size.

If you fly in a small field, the .010 engine should be ideal. The propeller indicated will give plenty of power and it keeps the noise way down. I have found that Cox Blue Label fuel works quite well with the Tee Dee as well as helping to keep the model's finish intact. The addition of R.G.A. Glo-Life detergent to the fuel will just about eliminate varnish problems.

This just about covers the preliminary information and we're ready to begin the actual construction. Build the actuator first, if used - it is much easier to install this way. If you wish, a Citizen-Ship SE-2 escapement can be used for rudder only operation. Many such flights were put on the Pipsqueak prior to converting it to dual proportional operation.

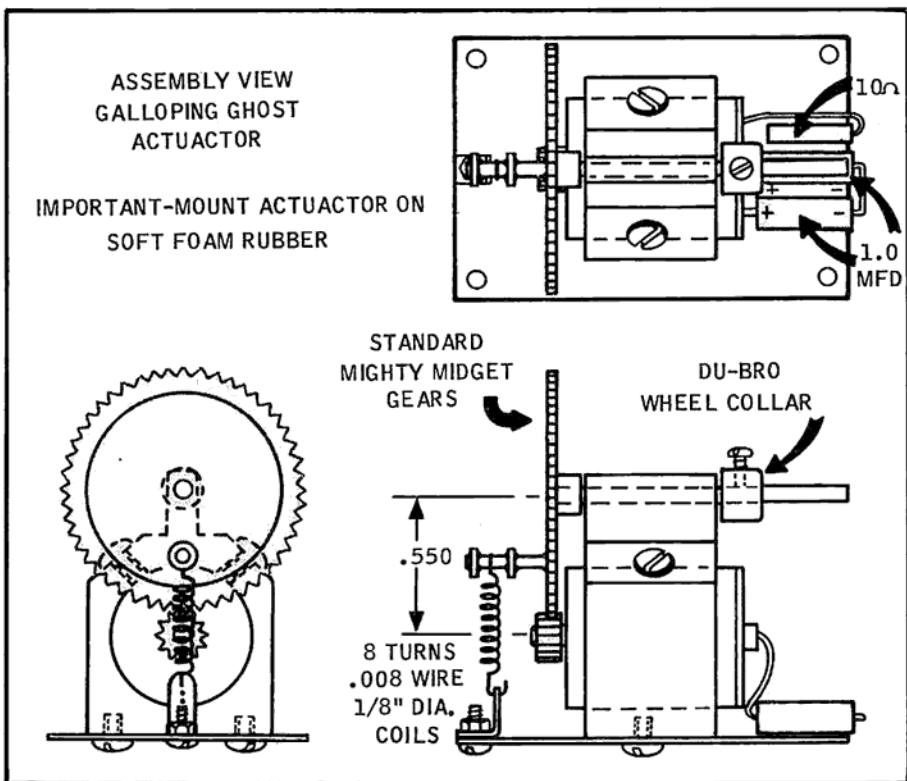
Steps To Alter Micro-Mo TO-5

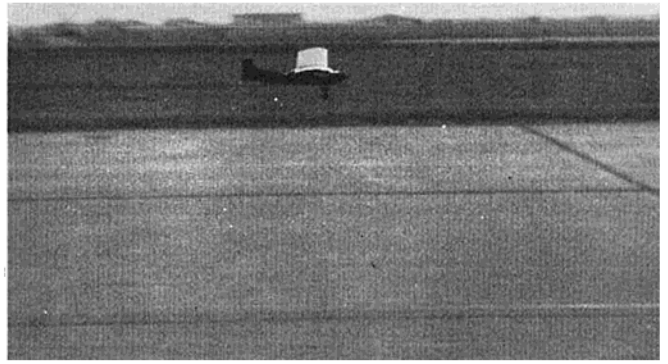
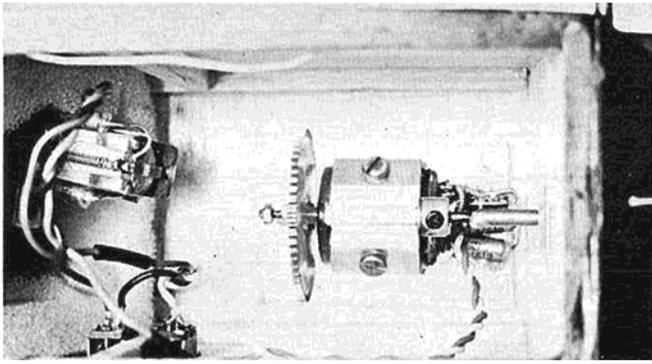
- (1) File shallow notch in edge of motor case adjacent to gear box.
- (2) Insert a pointed tool in this

eral relayless receivers, both superregen and superhet, and all worked well with the schematic shown. I will, however, be quite specific insofar as the arc suppression components are concerned. The ones indicated are tiny, light, and do an excellent job. The wiring diagram shown for relay receivers works fine with a Controilaire SH-100. Incidentally, the SH-100 is quite light and compact if you remove it from its case, and will fit quite nicely in the Pipsqueak. The tiny slide switches used are those sold by World Engines, and are excellent for this model, being light, inexpensive, and quite reliable. The entire radio system should be test wired together on the workbench before installing anything in the airplane. Check carefully for good range and lack of noise interaction. If any problem is encountered in the relayless conversion, the four 225 Mah battery hookup should be substituted.

This is also a good time to match the pulser to the actuator. First, the rate should be adjusted to yield 180 degrees of crank rotation at the centering pin on the actuator when the stick is in neutral. Full up rate should now be set so that the actuator will not cycle (spin completely around - full up is slow rate). On some pulsers a suitable stop will have to be made for the stick. Ideally, full up should result in about 270 degrees total crank movement. Full down will be almost automatic. It's rather difficult to get too much here.

Next, the rudder movement of the stick should be adjusted so that the actuator will not cycle through with full rudder and neutral elevator. Again, stops may have to be installed on the





Actuator in place in Pipsqueak. Pioneer superhet in foam package with relay protruding.

The Pipsqueak comes in for a landing at its Virginia flying site.

notch and carefully pry the end plate, complete with gears, out of the motor housing.

(3) Remove all of the gears and brackets from the end plate.

(4) If necessary, enlarge the hole in the center of the end plate to clear $\frac{1}{16}$ " brass tubing.

(5) Solder a length of $\frac{1}{16}$ " O.D. brass tubing to the armature shaft to extend $\frac{1}{8}$ " beyond the edge of motor case.

(6) Reinstall the end plate on the motor housing so that the brass tubing extends out of the hole in the center.

(7) Carefully solder a Mighty Midget pinion gear on the end of the brass tubing.

(8) Test the motor on 1.2V to see that it runs smoothly in both directions. Simply reverse battery leads to change motor direction.

Construction Of The Actuator

(1) Cut base to size from $\frac{1}{32}$ " sheet aluminum and drill holes as indicated.

(2) Fabricate the motor mount from $\frac{1}{2}$ " thick aluminum. The only dimension that is critical is the .550" center distance of the holes, inasmuch as this sets up the gear mesh. Tap all holes 2-56. The individual mounts will have to be drilled to fit the Micro-Mo as they vary slightly in size. All of the external surfaces may be filed to shape. Try to get this piece as light as possible.

(3) Fasten the motor mount to the

actuator base with two 2-57 screws.

(4) Slip the modified Micro-Mo into the hole provided and secure with two 2-56 screws.

(5) Take the large gear from a Mighty Midget gear set and drill as many holes as possible in it — the idea being to make it as light as possible. If there is access to a lathe, the gear may be machined to a thinner size in lieu of lightening holes.

(6) Solder a $\frac{1}{16}$ " diameter pin approximately $\frac{3}{8}$ " long into a hole drilled $\frac{1}{4}$ " off center in the large gear. At this time, a pair of small washers may be soldered on the end of this pin about $\frac{1}{8}$ " apart.

(7) Cut a piece of $\frac{1}{16}$ " O.D. brass tubing to a length of $1\frac{1}{4}$ ". Slip this into the large gear and solder on the outside face only.

(8) The tubing and gear assembly may now be slipped into the $\frac{1}{16}$ " diameter hole in the motor mount. Put a drop of light oil on the bearing and check for good gear mesh. This is indicated by smooth bind-free rotation without excessive noise at the gears.

(9) Fasten a $\frac{1}{16}$ " I.D. Du-Bro wheel collar on the tubing with about .010" clearance so that the shaft will spin freely.

(10) Now bend up a small scrap of the $\frac{1}{32}$ " aluminum in the shape of an "L." Drill a $\frac{3}{32}$ " hole on one leg and several small holes on the other leg.

(11) Fasten the "L" shaped piece to

the base plate with a 2-56 screw and nut.

(12) Wind the centering spring from .008 control line wire — about 8 turns around a $\frac{1}{16}$ " form should do it.

(13) The spring should now be installed and adjusted in tension until the motor will just barely overcome the spring and begin to spin when 1.2V is applied.

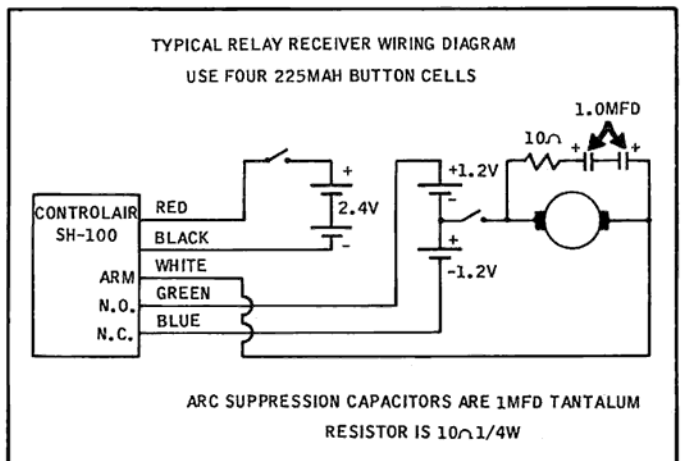
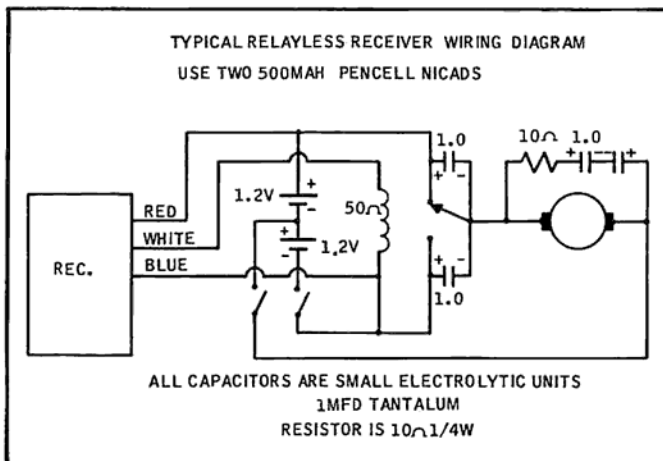
(14) Install the two 1 mfd. capacitors and 10 ohm resistor and fasten to the base with a good adhesive. (Walther's "Goo" is excellent.)

(15) Install a wire from each brush terminal about 6" long and the actuator is complete.

Construction Of The Model

Start construction with the wing. Cut all parts to size as if you were going to make a kit. Place a piece of waxed paper over the plans and pin down the leading edge, trailing edge and bottom spar. At this time, the center section planking on the bottom should be cut to size and cemented in place. (Do not cement along center seam.) Cement all of the ribs in place, tilting the two center ribs inward slightly to accommodate the dihedral angle. Cement the top spar in place and let entire assembly dry overnight. When structure is dry, take the two wing halves and sand the correct dihedral angle into each

(Continued on Page 53)



panel, taking care not to sand in any sweepback (or sweep forward). This operation is best performed by placing each wing half on a wooden board with the center rib flush with the edge of the board. Prop the tip rib up $1\frac{1}{8}$ " to get the proper angle, and then sand along the edge of the board with a flat sanding block until the center rib has a smooth, true angle along its entire length. After both halves of the wing have been sanded, trial fit them together to test for correct dihedral and a good fit with each other. Proceed slowly during this step, as much of the wing strength at the center depends on a good fit at this joint. When the two panels fit, they should be cemented together. This joint should be pre-glued — that is, put a thin coat of glue on each rib and let dry, then put on a second coat and join together. The wing should be pinned with one panel flat on a work-board and the other tip propped up $2\frac{1}{4}$ " until dry. Now, cut $\frac{1}{16}$ " off of each end of the center ribs and cement the leading and trailing edge braces in place.

The top planking may now be applied as well as cementing the tip blocks in place. When all is dry, remove the wing from the work surface and give all accessible joints a second coat of cement. The leading edge and tip blocks may now be carved to rough shape and the entire wing structure sanded to a smooth shape. The wing should be given two coats of clear dope, sanding lightly between coats to remove any fuzz.

The wing is covered with colored Japanese tissue. The bottom surface first, using the tissue dry. Attach to wing perimeter framework with thick, clear dope. When the entire wing is covered, spray with a light mist of water from a Windex bottle or similar type sprayer in order to remove all wrinkles. When the water has dried, the wing may be doped with thin, clear dope — about six coats will give a nice finish. Avoid the use of color dope as the weight-building factor will be excessive. The wing should now be set aside to cure while construction of the rest of the model commences.

Begin the fuselage by cutting the sides, bulkheads, firewall, and $\frac{1}{4}$ " square tail post to size. This is a good time to put the blind mounting nuts in the firewall, and sand the top and bottom taper to the angle indicated. The nose doublers and cabin framing should be cut to size. Cement the doublers to the fuselage sides, being certain to make one left and one right side. Contact cement is excellent for this operation — I use Weldwood. Cement all of the framing to each side. If an escapement is being used, it should be mounted on bulkhead F2 at this point. Use small

scraps of $\frac{1}{32}$ " plywood where the mounting screws bear against the balsa bulkhead, and glue a scrap of this to the front side of the bulkhead where the torque rod will pass through. This piece of plywood may be used as the torque rod bearing by punching a small hole in it with a pin.

If the model is being built for Galloping Ghost, simply drill a hole in F2 to clear the torque rod. Bulkheads F1 and F2 may now be glued to the fuselage sides, pre-cementing all joints. The fuselage should be allowed to dry, checking constantly for proper alignment.

When dry, the sides should be pulled together at the rear and the tail post glued in place. The firewall may be installed, using a good epoxy glue such as HobbyPox. If the model is being built for escapement flying, this is the time to install the torque rod and rubber motor. A very satisfactory torque rod can be made from $\frac{1}{32}$ " wire. Splice it in the middle with a scrap of brass tubing — this makes bending of the ends much easier. A small eyelet makes a good bearing at the tail post. Use the same location for escapement or GG.

The stabilizer should now be cut to shape and cemented in the two slots in the fuselage sides. If the model is being built for dual proportional, cut the elevators free and hinge them. I prefer clot hinges, but whatever you use, keep it free from any stiffness or binding. When the stabilizer is glued in place, be certain that it will line up well with the wing when viewed from the front and is square with the fuselage.

Plank the bottom of the fuselage, using $\frac{1}{32}$ " plywood from the firewall back to the point indicated, and $\frac{1}{32}$ " balsa for the remainder. The grain in the balsa planking should always run across the fuselage, top and bottom. If the model is being built for GG, this is the time to install the actuator and torque rod. The actuator should be glued in place on a pad of $\frac{1}{8}$ " foam. (Dr. Scholl's brand, available in all drug stores.) Bend the torque rod to shape from $\frac{1}{32}$ " music wire — be careful to get the correct shape from the side view. Use a small eyelet in the tail post for a bearing and solder into the $\frac{1}{16}$ " O.D. tubing shaft on the actuator. Be careful to get a good alignment between the crank on the torque rod and the centering pin on the large gear of the actuator. When satisfied that all is free and working well, the top may be planked with $\frac{1}{32}$ " balsa. Plank the area from the firewall to the cabin bulkhead also (don't forget those blind mounting nuts!). The front and rear cabin fairing blocks should be carved and hollowed from soft balsa and cemented in place.

At this time the entire fuselage should be sanded smooth and the corners rounded slightly. Make the fin and rudder from $\frac{1}{16}$ " balsa, noting the grain direction on the fin and dorsal. Hinge the rudder and make certain that it is quite free, then sand this assembly smooth. The fin should be glued on with some cement that does not shrink. I feel that HobbyPox is superior here.

Install the strip of $\frac{1}{32}$ " plywood that serves as a stop for the landing gear and temporarily mount engine in place. An extension for the needle valve will have to be made and the fuselage side notched to clear it. Take the engine off and put it back in its dust free box.

The fuselage and tail should be given three coats of thin butyrate sanding sealer (I use Aero-Gloss), sanding well after each coat with 400 paper. The stab may be covered with Japanese tissue to match the wing, using the same technique of doping it down around the edges, then lightly water shrinking it. Clear dope the stab to match the wing, being careful to apply dope evenly to avoid warps.

The wing and landing gear dowels are installed now, gluing in place with HobbyPox glue. This will not react with the finish. The fuselage and fin should be color dope if desired — use thin dope and just enough to cover evenly. A nice shine may be obtained by brushing on several thin coats of clear dope. Yellow Japanese tissue was used on the wing and stab of the prototype with Aero Gloss metallic blue on the fuselage and fin.

After the dope is dry, the engine should be mounted in place and the landing gear bent from $\frac{1}{32}$ " aluminum. The wheels on the original model came from a "Fire-Baby" control line trainer. Use any wheels that are very light — avoid heavy rubber tired wheels. The tail wheel should have been installed earlier, before color doping. Use a $\frac{1}{2}$ " diameter wheel and bend a strut from $\frac{1}{32}$ " wire. This should be fastened to the bottom with HobbyPox cement. The tail wheel is quite important if the model is being used for Galloping Ghost — it prevents the plane from resting on the linkage at the tail.

Speaking of linkages, let's bend up the rudder and elevator followers from .020 wire at this point. The rudder follower should be bent first. Follow the plans closely and install in the exact location shown. Rotate the torque rod 360 degrees and make sure no binding occurs at the extreme rudder position. Cement in place with a good grade of model cement. (I use Ambroid.) The elevator linkage should be bent at this point, again following the plan exactly. Solder in the cross bridge to form a slot. No wire wrapping should be necessary if good soldering techniques are used.

I installed the unit on the elevator, slipping it over the end of the torque rod and punching small holes in the elevator with a straight pin for the small prongs to stick into. The elevator follower should be adjusted by gradual and slight bending to give approximately 10 degrees down elevator at neutral rudder and 40-45 degrees up at the top of the crank arc. Make sure, before cementing, that both elevators line up with each other and that everything works smoothly.

The final test, after cementing, is to hook up a 1.2V nicad cell across the motor and make sure that it will spin freely. If there are any tight spots, take the time now to free them up properly. The entire system should provide little or no resistance to the actuator. If an escapement is installed, the hairpin on the rudder should be positioned initially to give + or - $\frac{1}{8}$ " movement. Again, carefully check for proper operation with no binding. Use the thinnest rubber strand that will operate the escapement — this will give more turns of operation.

The receiver and batteries should be installed and wired up. Be just as neat as possible and twist all wires together into smooth cables. A little planning beforehand will make a very neat installation. The Pipsqueak prototype has the antenna strung to the top of the fin with a tiny rubber band cut from a penny balloon to provide some antenna tension. With this tiny model, most equipment will have plenty of range on this length of antenna.

Test Flying And Trimming

The model should be carefully inspected before leaving home. Check for correct C.G. location and correct with ballast if necessary. Be sure all flying surfaces are warp-free. If you find any, use a tea kettle to steam them out. After you have assured yourself that the model is completely true, try to find a flying buddy who will double check it for you — he might spot something you had missed. If your model is the escapement version, find a patch of tall, soft grass and proceed to hand glide the model, noting its glide tendencies. If it is built true and the weight is correct, the glide should be smooth and fairly fast. If, during these initial tosses, the model veers or turns consistently in one direction, bend the torque rod to adjust the rudder in the opposite direction. When the model glides nice and straight, it is time to observe the pitch trim more carefully.

If the model is not overweight and the C.G. is definitely correct, the model should appear to want to make a swift, two-wheel landing. Do not trim the glide to get a pretty, flared landing — this will give a horrible stall under

power! When satisfied with the glide, it is time to fire it up and test under power.

Before flying the model, power-on, make a thorough range check of the equipment and operate the controls with the engine running to make certain there are no vibration troubles. When satisfied, put in enough fuel to run about one minute, set the needle valve for a rich, slow run, and have a friend launch the model.

Observe the attitude of the model and try to send the minimum of signals until the ship is at a safe altitude. Try to maneuver the model so that it will have enough altitude for you to closely watch the glide pattern. Any adjustments to the glide should be made by shimming the wing in small increments. Power-on flight adjustments are restricted to adjusting the down thrust of the motor.

Trimming the Galloping Ghost version of the model is very similar. After making sure there are no mis-alignments, proceed to the glide tests. Turn the equipment on and set the elevator trim so that the crank on the tail is revolving about 90 degrees to either side of center-down and set the rudder trim so that the crank action is symmetrical about neutral. Now glide the model into soft, tall grass and watch closely. Do this a number of times to make sure of the results you have obtained. If the model has a consistent turn in one direction, set the rudder trim in the opposite and glide again. When the model is gliding satisfactorily, observe the glide angle. It should be smooth with no tendency to stall or dive. If the model stalls consistently, shim the trailing edge of the wing up a little — do not change the elevator trim. If the plane is diving, shim the leading edge up a little at a time until the flight path is smooth. When the glide looks good, check the radio range and run the engine with everything pulsing. Hold the model lightly by the wingtips to avoid damping the vibration with your hands. If everything is still working, you have used up all of your excuses!

For the Galloping Ghost version of the Pipsqueak, set the engine for a fast, lean setting and put enough fuel in for about one minute. Have a buddy launch the model and try to hold the nose up slightly to climb to altitude. When the model has gained some height, gently feel out the controls — they should be responsive, so go easy at first.

The Pipsqueak is capable of precision flying and some pretty fancy maneuvers for a plane of its small size — such as excellent spins, loops, full power touch and go's, etc. The control is very pre-

cise, as evidenced by Don's photos as he, Bill Welker of Citizen-Ship, Ed Thompson, and Bill O'Brien flew the Pipsqueak from the roof of Don's house one afternoon — making each landing approach around the power and telephone poles, TV antennas, and dropping it in on a 15' x 20' area!

I hope that you have half as much fun with your Pipsqueak as we have with ours!