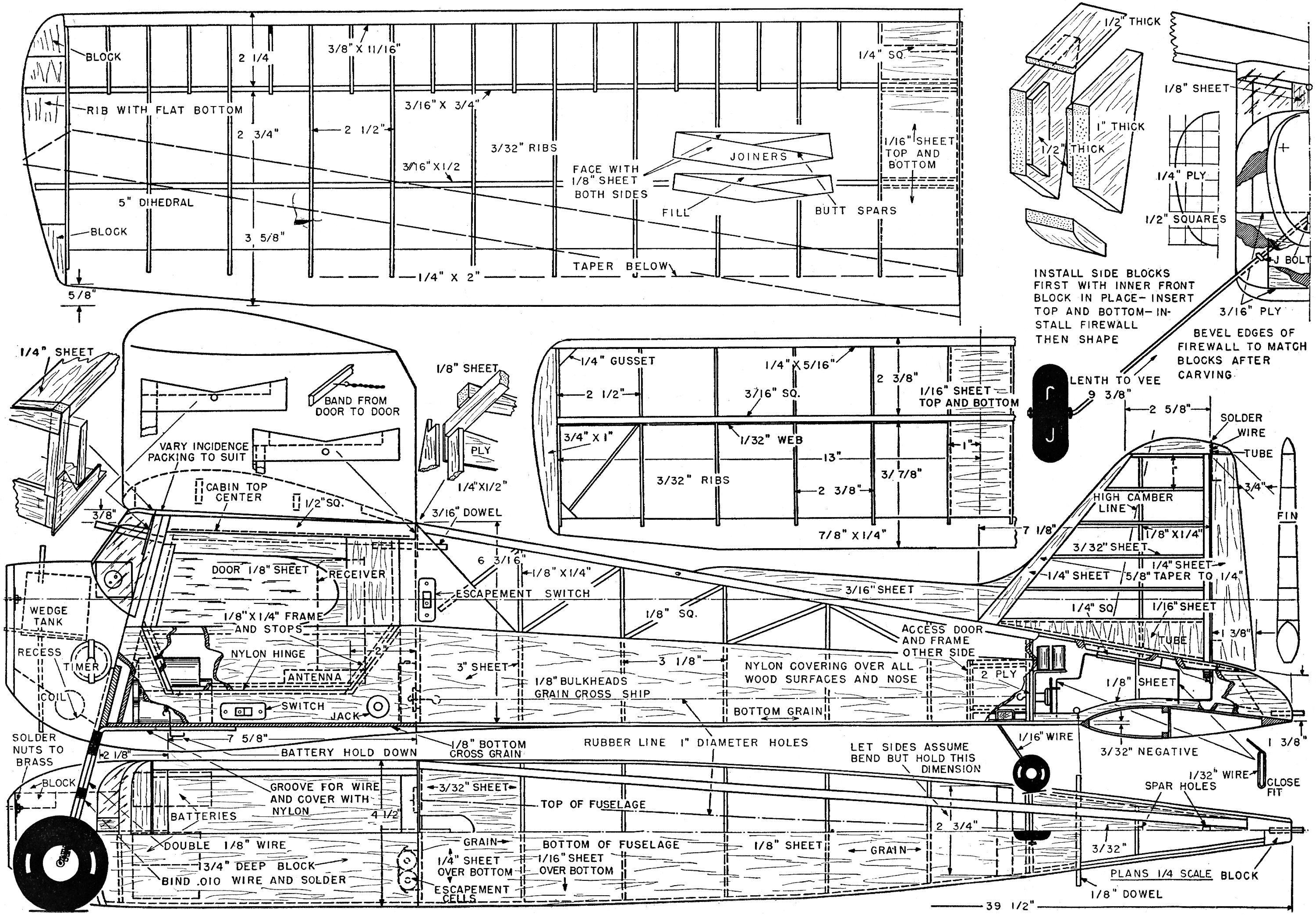
BLOCK
2 1/4
3/8" X 11/16"
1/4" SQ.
RIB WITH FLAT BOTTOM
3/16" X 3/4"
2 3/4"
2 1/2"
3/32" RIBS
1/16" SHEET TOP AND BOTTOM
JOINERS
3/16" X 1/2
FACE WITH 1/8" SHEET BOTH SIDES
5" DIHEDRAL
FILL
BUTT SPARS
BLOCK
3 5/8"
TAPER BELOW
1/4" X 2"
5/8"
1/2" THICK
1" THICK
1/2" THICK
1/8" SHEET
1/4" PLY
1/2" SQUARES
J BOLT
3/16" PLY
INSTALL SIDE BLOCKS FIRST WITH INNER FRONT BLOCK IN PLACE- INSERT TOP AND BOTTOM- INSTALL FIREWALL THEN SHAPE
BEVEL EDGES OF FIREWALL TO MATCH BLOCKS AFTER CARVING
1/4" SHEET
1/8" SHEET
BAND FROM DOOR TO DOOR
PLY
1/4"X1/2"
VARY INCIDENCE PACKING TO SUIT
CABIN TOP CENTER
1/2"SQ.
3/16" DOWEL
3/8"
1/4" GUSSET
1/4" X 5/16"
2 3/8"
2 1/2"
3/16" SQ.
1/16" SHEET TOP AND BOTTOM
3/4" X 1"
1/32" WEB
13"
1"
3/32" RIBS
2 3/8"
3 7/8"
7/8" X 1/4"
7 1/8"
LENTH TO VEE 9 3/8"
2 5/8"
SOLDER WIRE
TUBE
3/4"
FIN
HIGH CAMBER LINE
1/8" X 1/4"
3/32" SHEET
1/4" SHEET
1/4" SHEET
5/8" TAPER TO 1/4"
1/4" SQ
1/16" SHEET
1 3/8"
TUBE
6 3/16"
1/8" X 1/4"
DOOR 1/8" SHEET
RECEIVER
ESCAPEMENT SWITCH
3/16" SHEET
WEDGE TANK
1/8" X 1/4" FRAME AND STOPS
1/8" SQ.
ACCESS DOOR AND FRAME OTHER SIDE
RECESS
TIMER
NYLON HINGE
2"
3" SHEET
3 1/8"
NYLON COVERING OVER ALL WOOD SURFACES AND NOSE
2 PLY
ANTENNA
1/8" BULKHEADS GRAIN CROSS SHIP
1/8" SHEET
COIL
SWITCH
JACK
BOTTOM GRAIN
7 5/8"
1/16" WIRE
SOLDER NUTS TO BRASS
2 1/8"
BATTERY HOLD DOWN
1/8" BOTTOM CROSS GRAIN
RUBBER LINE 1" DIAMETER HOLES
LET SIDES ASSUME BEND BUT HOLD THIS DIMENSION
3/32" NEGATIVE
1 3/8"
1/32" WIRE
CLOSE FIT
BLOCK
GROOVE FOR WIRE AND COVER WITH NYLON
3/32" SHEET
TOP OF FUSELAGE
SPAR HOLES
BATTERIES
4 1/2"
2 3/4"
DOUBLE 1/8" WIRE
GRAIN
BOTTOM OF FUSELAGE
1/8" SHEET
GRAIN
3/32"
3/4" DEEP BLOCK
1/4" SHEET OVER BOTTOM
1/16" SHEET OVER BOTTOM
PLANS 1/4 SCALE
BLOCK
BIND .010 WIRE AND SOLDER
ESCAPEMENT CELLS
1/8" DOWEL
39 1/2"

The Citizen

by William Winter

Clean simple lines are a feature of this small R. C. model

You won't need a truck to transport this compact radio control plane

THE *Citizen* is an attempt at a minimum-size airplane that would utilize the heavier, long lasting batteries (desirable for the use of a tube having long life, as in the Good Brothers receiver) which commonly are carried by planes 6' and larger. Primary considerations were smallest size consistent with the above, and with plane visibility at a distance (1/2 to 3/4 mile), and construction that would survive the rugged flying typical of western New England. While the *Citizen-Ship* radio we used does employ hearing aid B batteries, the weight of the required A's balances things out.

Experience over a year's flying with an *Ohlsson 60*, 6½-foot semi-scale job (wing loading 18 oz.) had indicated a number of musts for this smaller design. An analysis was made of the *Rudderbug* which (with Gene Foxworthy's very excellent twin-tailed job) is the best all-round R.C. ship in the country today. If the *Citizen* seems to have been impressed by Walt Good's *'Bug*, it is because any serious effort to design an ideally practical ship keeps bringing you back to the same general layout. However, despite the *Rudderbug* motif, the *Citizen* is a rugged individualist and contributes some worthwhile data on performance and control characteristics at various power and wing loadings to be described.

PART ONE

As the ship's name implies, the receiver and transmitter operate on the Citizens Radio band; Vernon C. Macnabb kindly supplied one of his three original test radios for our use. As this is being written a transmitter is before the FCC for possible approval which, if granted, would mean license-free (or more correctly, *examination-free*) operation. However the *Citizen* was designed also to take *Beacon, Aerotrol, RCH,* and similar equipment, and is not limited to any one make of radio.

The first question in designing a new radio control model is "how big?" Since the *Rudderbug* weighed 74 oz. gross, it was felt that the minimum weight we could hope to attain with a sturdy small airplane, capable of toting a heavy B battery and not hearing aids, would be 60 oz. (Actually, the finished machine came in at 59 oz.) The *'Bug* has a wing loading of 12.3 oz. a square foot. Probably one failing of the *'Bug* is that it is *too* good and can vanish on a thermal. At the Nationals we had noted the remarkable glide of the Good design and had observed Dick Gelvin's job spinning in a thermal in a nearly unsuccessful attempt to get back to mother earth. Presumably, a smaller airplane would have less thermal riding ability but it was decided nonetheless to increase wing loading over the *'Bug* by about 2 oz. This gave a 56" wing with a 9" chord. (Consideration had been given to low aspect ratio to increase the rate of sink but too rapid a roll on use of the rudder soon killed the idea.)

A higher power loading was also decided upon. Most radio control jobs now perform with engines throttled well back, which means, of course, that the ships are overpowered or, more aptly, there is more power than can be successfully controlled. The *Rudderbug* has a power loading of about 247 oz. per cubic inch of displacement. This may sound like a lot to the average free flight man but it actually is a low figure. R.C. models are performing successfully with loadings up to and beyond 600 oz. A perfectly arbitrary figure of 300 oz. power loading was selected. This determined the use of the *Arden .199*. It was feared that glow ignition would result in too much power and a speed inflexibility that would prevent adequate adjustment, so spark ignition was installed.

When the *Citizen* at first exhibited a high flying speed, extreme control response under power that threw the ship

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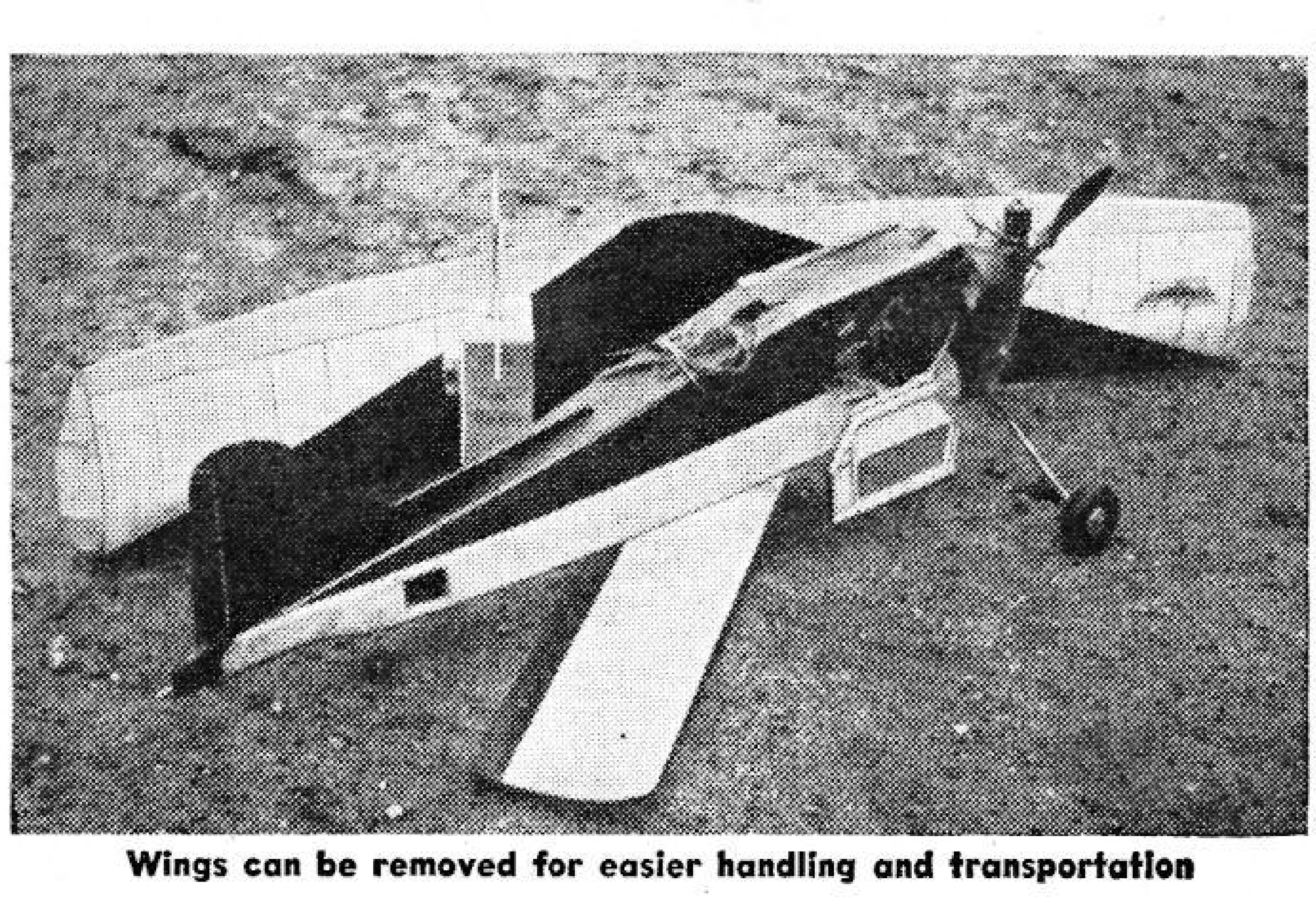

Wings can be removed for easier handling and transportation

Trap door near tail allows access to escapement rudder hook

The Citizen

(*Continued from page 23*)

from one spin into another and back again, and a rate of climb that would have put the plane far too high after a long run, an interesting experiment was made with an *Arden .099* for power, still on ignition. With the .09 winding up a low-pitch propeller, the *Citizen* still flew fast for R. C., but was incapable of more than a barely discernible climb. Quite obviously, 600 oz. of power loading, generally speaking, would permit maneuvering speed without excess altitude. Had glow ignition been used the climb with the small engine unquestionably would have increased to an amount acceptable for open area flying where high obstacles did not have to be cleared. Bear in mind that the wing loading was 14 oz. Each ounce that could be pared off this figure would increase the climb on an .09. At 10 oz. of wing loading, a very nice slow flying machine would have resulted, though light construction would be required at power loadings of around 500 oz. At 12 oz. a passable machine can be designed for an .09. It is suggested that Aerotrol (etc.) owners can operate the *Citizen* successfully on a glow-plugged .09. Weight saved in radio batteries, and ignition equipment, will result in proper climb and gentle control response.

If the size of airplane, and its workable wing and power loadings, are known in advance from experience, so that the glow engine can be used at its natural running speed with a specific prop, then a glow engine proves desirable. The *Citizen*, when equipped with heavy batteries, apparently would fly and climb slightly with an .09 on glow; if its .199 was glow-operated we shudder to think of the wild performance that would result.

During tests to find a prop that would be "sufficiently inefficient" for the .199 so that the plane could be controlled with a good engine speed, the *Citizen* had been adjusted for straight power flight with some wide-blade 12-5's, cut down from old 14-4 *Invaders*. This, we found, was barking up the wrong tree. Anyway, a further switch was made to *Ohlsson* 11-4's. The timer arm had been locked in a well-retarded position (in fact, it was the starting position with the *Invader* props) and the needle valve was tuned to one turn open. Expecting more thrust, the timer was further retarded. The ship raced around in a wide left power turn, and soon began a progressive nosing up through the minute or two following. With torque taking an effect, left rudder action was dangerously increased, but right rudder affect was so weak that the ship could not be held into the wind encountered at high altitude, and an out-of-control flight resulted. So, if you are impatient with the radio boys as stick-in-the-mud's, consider this incident just one of several things that could happen as a result of too much speed and/or control. We got the ship back, though other possibilities could have washed it out. But more of these anon.

What shape should the plane take? How should it be built? Of what materials? Taking first things first, it is well known that a very high thrust line is desirable. This decreases nosing up tendencies under power and minimizes the down thrust required to offset such tendencies. It also means more prop clearance and fewer snapped blades in inadvertent nose overs. Walt Good demonstrated an important feature when he placed the vertical tail of the *Rudderbug* in such a position that it was roughly bisected by the thrust line. Walt long ago had told us his observation that a low fin area seemed to result in straight ahead power flights, while a high tail had a turning tendency due to the slip-stream from the propeller. Thus, placing the fin half above and half below the thrust line automatically produces the swept down fuselage profile, from the wing to the stabilizer.

Since we had had several out-of-control flights on the old machine due to a shifting tail giving too much control one way, and none the other way, Good's use of a separate fin built integral with the fuselage is now a must. While talking of tail surfaces, there seemed no better way of mounting the stabilizer than with rubber, in a recess in the bottom of the fuselage, where it would knock loose in a crash, or could be removed to reach the escapement which should be permanently mounted within the fuselage.

The wing location should not be excessively high if a high thrust line was to be adhered to. For quick fly-off in a crack-up it was decided to attach the wing as it is usually fastened on a pylon mounting, by means of two dowels, one in front and one in back of the wing. Side pegs protruding through a cabin have wrecked as many ships as they have saved (some of ours among them). The cabin itself is determined by the size of the receiver, plus batteries, allowing adequate clearance for all.

The present landing gear, while only a monostrut, works like a charm on a 60-ounce machine. Originally, double 1/8" wires had been led down to the axle position (wire-bound and soldered together), with one wire continuing around a curve toward the rear of the fuselage, then breaking out at a right angle to take the wheel. This gear should have been placed at least 2" further forward to permit the shock absorbing shape of the gear to function without nose overs. The gear on the plan appears to give just as much shock absorbing action without nose-overs and is adequately strong and simple. Double strut gears fold the rear strut on every hard impact, unless the struts are on the short side. On Frank Ehling's suggestion we tried *Davis* semi-pneumatic air wheels and have had fine results, even after a barbed wire fence punctured one tire. These wheels are a good compromise between light weight and sturdiness.

The wing features the same washed-out tips used by Good in the *Rudderbug*. Such tips prevent falling off on a wing and tend to permit the airplane to pull its tail up from a stall in power flight without sliding off. Their action is to delay tip stalls—just the opposite to polyhedral free flights design. Since they do depart from the desired airfoil section of the main part of the wing, and toward the symmetrical side at that, they certainly add to flying speed and possibly lower the L/D of the airplane. However, the only alternate is the use of tip slots which have proved out excellently on Foxworthy's airplanes. A Gottingen 549 airfoil is used on the *Citizen* because of success with the same section on earlier airplanes. It has beautiful stall characteristics and seems to give excellent performance at slow flight speeds. It is deep (about 13%), making easy the placement of deep spars through the ribs which, in turn, puts the nylon covering to work in absorbing both down and up stresses. The heavy sheet trailing edge which fits flush with the top surface of the wing is a la the *'Bug* and is traceable to a *Berkeley* kit. The false ribs proved superior to sheeting of the edges in taking collisions with sharp narrow objects.

The fuselage is of fairly unique design for a radio model, in that fairly soft and thin sheet balsa is relied upon for sides. This sheet is not full depth, and leaves a built-up superstructure behind the wing. The bottom is sheet-covered cross grain to the long dimension of the fuselage. A large soft block is used as a belly fairing; this block, together with the top cabin members, carries all the cabin loads. No primary construction exists on the sides between the front of the cabin and the rear, beneath the trailing edge. Rectangular sheet formers, grain across the ship, are used between the sheet sides from the rear of the cabin on back. The nose consists of four blocks, top, sides, and bottom, carved to shape after assembly, and then faced with a 3/16" ply firewall. The engine mounts externally with two bolts and is instantly and fully accessible. Downthrust and offset adjustments are easy to make.

The condenser is mounted on the engine for easy replacement when necessary. A medium sized wedge tank, thin edge down, and slightly tipped toward the rear, provides up to 7 min. of running time on the

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11-6 Pow-OR *Props* recommended for this airplane. Other props will work as well, of course, but adjustments and setting may prove slightly different. Flight adjustments on any airplane can be discussed only with one make as well as one size propeller. Whatever make prop you start with, stick with it.

Perhaps something should be said about the durability of the construction described. It is estimated that at least a dozen flights were hung up in trees or bushes. Several of these accidents were severe, with the ship in level flight under power and the trees large and bare of leaves. In one case a tree on a mountain side had to be chopped down with the plane still in the topmost branches. Several other times the wings and tail detached with the plane falling to the ground. On one flight the ship got out of radio range quickly due to low A batteries and glided through three turns of a tight spiral into the woods with full left rudder. (An Aerotrol self-neutralizing escapement is now being tried!) During its early tests it spun in one full turn under power with rudder jammed left. This particular crash threw mud from the pasture, and the wing was tumbled several feet in the air when it detached. The engine dug a shallow "trench" about 1-1/2' long. This particular crash bent the landing gear back along the fuselage on the one side, but no damage beyond broken props (once a crushed but not broken leading edge) and occasionally punctured covering was suffered in any crash.

On one occasion the motor stopped about 30' up, in a steep climb into the wind after a bad launch, and the ship simply fell out of the sky, finally diving into the ground so hard that it bounced into the air and fell on its back; no damage except to the prop. On another flight, with too much rudder action, the ship was banked very close to the ground to avoid a bush and, turning before the wind, dived in before recovery could be made. This time the stab was tied on too tight and opened cracks in the rear of the fuselage. Much of this remarkable durability is due to the less than 5-foot size of the machine but a large measure of credit must go to the sheet construction. Another helpful item follows a valuable tip from Jim Walker (who, when he crashes, hits harder than anyone in the business! This is the use of light plywood reinforcement at the crucial cabin corner joints. In the *Citizen*, one piece of ply runs across the front of the cabin by the windshield, and another similar piece across the back of the cabin. The wind hold-on dowels extend through holes in these plywood pieces. Further ply gussets back up the joints of fore-and-aft cabin members at the top of the cabin. By using four heavy uprights of the hardest balsa at the cabin corners, and filling in the cabin roof with 1/4" thick sheet, the entire cabin (remember the belly block) is a box of great strength. The nose is virtually unbreakable since there is nothing to break. The remaining construction is designed with lightness as well as strength in mind.

Complete details on construction will not be given. First, essential information is shown on the plans. Secondly, a large amount of material remains to be presented in the second installment, concerning the radio, adjustment, flight testing procedures, and the kind of thing they never tell us R. C. dubs about.

We should like to add our observations on nylon covering. It is *wonderful!* Light weight nylon was obtained from *Jasco*, and Frank Ehling has briefed us on the art of applying it successfully. It definitely is not hard to cover with. First, all wood members to which it was to be applied were given a coat of dope to fill the pores. Then, after this coating dried, the nylon was applied wet, exactly like silk. A half-and-half mixture of dope and cement was used for attaching. Simply pull out the wrinkles and when you like what you see, dope it down. If wrinkles appear anywhere you can always soften up the nearest edge with dope and again pull out the wrinkles. One interesting observation is that the material dries at a fabulous rate. By working at top speed it was unnecessary to re-wet any panels. If the material dries out before it is completely attached, it may be re-wet on the job. To trim neatly, run your dope brush along the material outside the frame. When this doped portion dries it will be stiff so that the razor blade cuts neatly without snags and pulls.

About six coats of good clear dope will fill the pores. While we have seen heavy nylon take on an opaque milky appearance when doped, this lightweight stuff was semi-transparent when the pores had been filled. Visitors slyly keep trying to blow through it, or see if cigar smoke would work through; it won't, and the covering is stronger than silk!

It would be nice to say that an airplane has no weak points; such is never the case. The *Citizen's* big headache proved to be rudder response. It is strange that everyone thinks one must be a radio expert, but that flying is like falling off a log—the opposite is more nearly true. Before it will perform successfully, every radio model must be trimmed, by means of offset and downthrust, to fly absolutely straight under power. Not only that but its glide must be straight. Circles in both directions, right or left, should be the same size. There is some tolerance here but don't mistake "evidences of control" (as Harry Geyer calls them) for control. A tight circle on one side and a wide open circle on the other, sooner or later will end in an out of control flight, probably the first time you get the ship up in a breeze. And—this may happen though a breath is not stirring on the ground. Fore and aft trim must be on the ball with no tendency to hang on the prop, for that can spell loss of control (you'll blame the radio, when the fault really is with flight adjustments), most likely in left climbing turns, growing tighter and steeper. But this much is fundamental. The real tough problem, the one you don't hear much about, is rudder area and rudder movement or, expressed as a result, "rudder power."

Every plane has a margin between its cruising and glide speeds and must be trimmed differently for each speed. On both a real ship and the model, differences in nose-up or nose-down tendencies are taken care of by trimming. In the big ship you crank a tab to keep the nose down; in the model, you adjust (by downthrust) for a certain power speed. This speed, naturally, can't be deviated from without excess climb or loss of altitude, as the case may be. In most big ships, rudder adjustment is made by holding more or less rudder and, brother, this is what licks us R. C. modelers.

Under power, less rudder action is needed than in the glide. If you use the ideal rudder action for power flight, glide turns are sluggish and slow, especially in a wind. If strong control is used in the glide, the rudder action under power can spin the airplane, rolling it over and down if rudder is held. Twin rudders to keep these controls out of the slipstream are some help but the biggest factor is holding down the power-on speed, thus minimizing the difference between glide and cruise speeds.

Proper flying of the *Citizen* compels use of no more throttle than will give climb adequate to move the plane up wind, or to get over obstacles near the launching spot. With the timer arm in the nine o'clock position and the needle valve open one turn on an 11-6 *Pow-OR Prop*, the *Citizen* will climb slightly. More thrust may be added by slight advances of the timer arm, after you have adjustments well under control and have decided that more power is vital.

Open the engine wide, and the ship will climb high and fast, taxing the mind to the utmost to maintain control without a completely disastrous power wind-in. At high flight speeds the rudder is capable of almost snap rolling the airplane. Don't worry, though, your plane will behave. These facts are given to show the impatient critics of the learn-by-doing radio boys what manner of problems face the experimenter. Rudder movement that will flip a ship over at high speed, is the same movement that is needed to give a minimum of steering during the glide. At higher speeds, one must neutralize controls the instant a turn is begun, and must end a diving turn before it builds up, for the recovery is a zoom into a stall or loop. At reasonable speeds the ship sails around and you have no worries. If a wide range *must* be had between glide and power-on cruise, then some automatic device (such as a vane in the windstream) must be used to reduce rudder action under power, or to increase it when gliding. The wise pilot takes it easy at first. Later, if more power is used, the response of the ship can be stepped up for more spectacular flying. The *Citizen* has the combined virtues of both a primary and an advanced trainer. Outside of Walker, however, no one today is maneuvering at high flight speeds.

Don't ask us about more than one control, or proportional control. The latter proved too much for Walker who flies three *Fireballs* at once. He states he couldn't manage the ship when it got more than a few hundred feet from him. After one year, embracing more than 100 flights on two airplanes, the writer still makes too many mistakes on rudder alone! Eventually, he'll get to the *Rudevator*, the logical step ahead, which gives elevator and rudder action on a single channel.

For the beginner, an .09 glow version of the *Citizen* could do no wrong. And don't be tempted to open up the .199! Full directions on the complete flight testing procedure will be given next month.