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

PART ONE

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 (½ to ¾ 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.

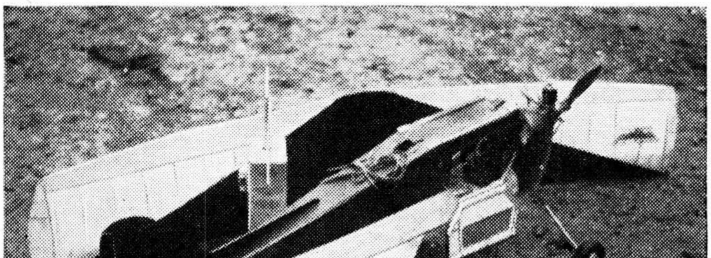
Experience over a year's flying with an *Ohlsson 60,* 6½-foot semi-scale job (wing loading 18 oz.) had indicated a number of musts for this smaller design. An analysis was made of the *Rudderbug* which (with Gene Foxworthy's very excellent twin-tailed job) is the best all-round R.C. ship in the country 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.

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.

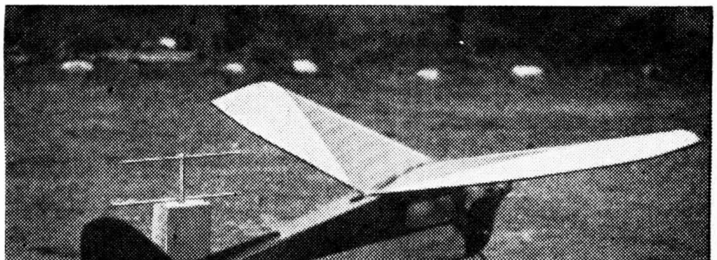
The first question in designing a new radio control model is "how big?" Since the *Rudderbug* weighed 74 oz. gross, it was felt that the minimum weight we could hope to attain with a sturdy small airplane, capable of toting a heavy B battery and not hearing aids, would be 60 oz. (Actually, the finished 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



Wings can be removed for easier handling and transportation



Trap door near tail allows access to escapement rudder hook

The Citizen

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

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.

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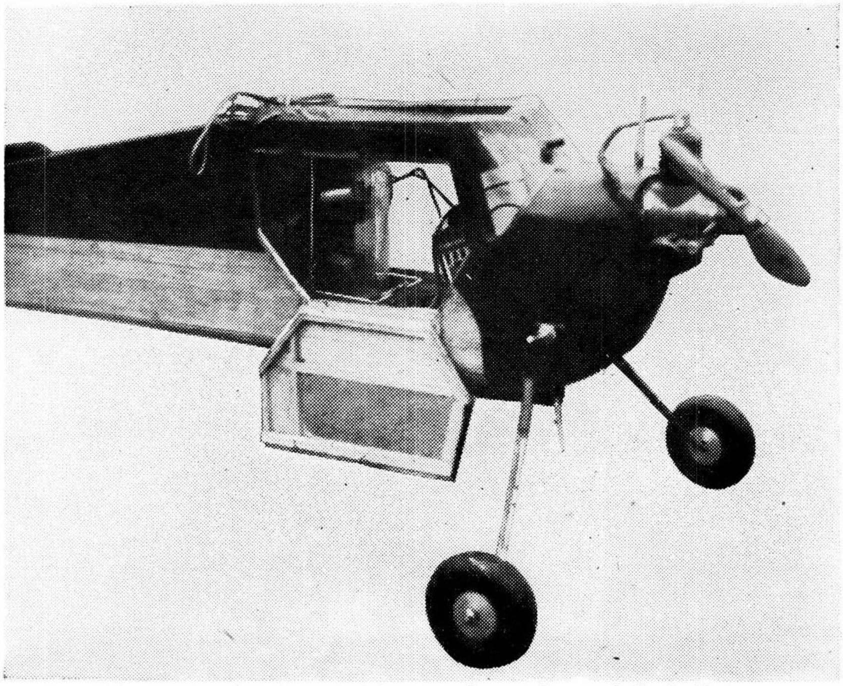
PART TWO


The receiver is mounted with square loop antenna at the bottom

IN THE writings of the Good Brothers, Owbridge, Lorenz and others, radio model aviation has a kind of ground course which every new "student" should read. The Goods, interestingly enough, bear down heavily on the flying of the airplane. This is highly significant. Even on rudder alone, steering a gas job where you want it to go is far more of an art than tossing the highest-powered pylon into the air. This is something the writer learned the hard way. Despite an appreciation of the radio man's point of view, it took nearly a year of on-and-off flying to reasonably master the technique of rudder alone.

This technique, from the writer's point of view, consists purely of getting back the airplane after every launch, without recourse to field glasses, bicycles, foot races, and automobiles. It is primarily a matter of experience. Not experience in adjusting a relay or reading batteries, but in knowing from past disasters what is happening when an airplane threatens to get away. Experience in knowing what is overcontrol or undercontrol, and what each can do to you. Experience in knowing how fast to fly and climb and how to do it precisely the same way *every time*, and what the variations can do to you. And, as it is with real planes, your second ship may vary from the first in subtle ways, which, after cases of overshooting and undershooting, and other startling changes, will gradually teach you to judge quickly from the way the ship first responds and handles, what may be expected all down the line. This, to us, is a fascinating new world of modeling.

First, however, some details remain from last month, on the *Citizen*, its construction, and especially on use of the *Citizenship* radio supplied by Vernon C. Macnabb. Since this radio vitally affects both the testing of the *Citizen* and the rigging of the plane, let's examine this particular "electronic co-pilot." Now it will be noticed from the plans that a severe amount of decalage, or longitudinal dihedral, (positive incidence in the wing, negative in the tail), has been used, he experienced model designer may assume, because of the rearward position of the center of gravity, plus this rigging, that the ship is on the borderline of being too heavily loaded. This is a half truth. At the relatively low flying speed under power which has been found necessary to give reasonable alikeness of rudder responses under power and in the glide, the ship has to fly at larger angles-of-attack. This is the equivalent of "slow flight" in a lightplane where, with engine throttled back, and stick partly back to hold up the nose, you cruise easily along at, say, 50 mph. You see, the *Citizen* differs from the real big radio jobs in that the *Arden .199* has a remarkable margin of reserve power for the job on hand. And, if too much power is drawn, and transmitted into forward speed and/or climb, the high speed of the plane immediately steps up rudder effectiveness to the point where the man on the ground can't do more than flip it from side to side to avoid spirals and spins. Painstaking effort was required to learn the speeds, the trim, and the props that give correct results.

This trim is also required because of the unique problems in battery distribution arising with the Macnabb radio. If the Beacon radio was used (the ship was originally designed for such equipment, with the use of large batteries), it would be advisable to move the C.G. more to the rear, removing some incidence from the wing. The plans show removable packing to permit the proper change in incidence. With the *Aerotrol* and its lighter weight, especially in batteries, the wing would be set at a still smaller angle, or the negative removed from the tail. With the latter equipment it should be possible to fly the *Citizen* on a glow plug .09 engine, and remove all risk of improper flight speeds and climb. The combination would be ideal in every respect for the tyro.

In the installation of the test radio, it became necessary to mount the radio well to the rear of the cabin, taking care to keep its very sensitive antenna away from surrounding objects (at least 1/2"), such as wires, switches, etc. At the time it was believed inadvisable—and this has not been definitely cleared up at the time of writing—to place batteries directly beneath the receiver. Most radios use a long antenna running along the fuselage, or back, to the fin; but the small antenna of this radio is no larger than a cluster of batteries. When the ship was directly overhead, it was feared the control might suffer. On the *Citizen*, the cramped experimental vertical mounting of the receiver would not permit such installation of current supply. For these reasons, the batteries were grouped at the front of the cabin, whereas, ordinarily they would be spread out on the floor.

This balance problem was rendered more acute with the discovery (by the manufacturer, our guinea-pig difficulties confirming what was found at the plant) that the original 6-volt A battery made up of four pen cells as a commercial unit, was not reliable, was too difficult to obtain in some localities, and, at best, gave but a few flights. Eventually, it was found that, while flights could be made with four pen cells for A, four intermediate flashlight cells gave reasonable performance. At present, the writer gets somewhat better than one hour continuous operation on these batteries, while the manufacturer finds two hours is the limit before voltage makes reception critical. It was also found that ignition interfered with reception under some conditions, so the coil and ignition battery had to be moved as far away from the radio batteries as the ship design permitted. (The manufacturer supplied a resistor for use in the high tension which eliminated the interference problem.) Actually, these are not real problems. They are known factors to be considered in designing the plane; the resultant C.G. location, in this case, requires the trim shown on the plans when the *Citizen* is flown with the Macnabb radio. Results are perfectly satisfactory.

As the reader probably knows, this particular radio was developed with the aim of obtaining FCC approval of a transmitter that would not require a ham license. The significance of this is obvious. However, the Macnabb radio has so many unique advantages that far outweigh disadvantages, that it would be a desirable unit, regardless of FCC approval or disapproval for license-free operation.

Compensating many times over for its high A power drain is the extremely low B drain, which enables hearing aid B batteries to last practically the equivalent of their shelf life. In the *Citizen*, one set has gone a busy 10 weeks and still reads 60 volts. (For the initiated, milliamp readings are about .1 idle, and 1.2 with transmitter signal switch on.) The total weight, including the four flashlight cell A's, is about the same as when a big B is used along with small A's. It is unnecessary to touch either the relay adjustment or the tuning. There is no adjusting of antenna length. The radio is manufactured ready to operate; and when it doesn't, return it to the factory. The small antenna on the transmitter eliminates awkward field setups and makes possible the chasing of a plane, perhaps on purpose, for cross country with a car. The transmitter is a small affair that is aimed in the general direction of the ship. All this means that the radio end is reduced to turning on switches, and pre-session checks of batteries and escapement power.

Space last month did not permit a discussion of some of the crucial points in the construction of the *Citizen*. For example, the first step in assembling the fuselage, once the sheet sides and formers have been cut, is to position the formers at the front and back of the cabin portion, gluing them to the sides. The floor of the cabin goes on next. If these parts are drawn with a square and triangle, alignment is automatic. After this has been done, the sides are pulled in at the rear as usual; and from there on, the builder requires no special information. The four corner posts of the cabin (1/2" sq. front—1/4" x 1/2" rear) are dropped in, followed by the cabin top pieces and the V-shaped cabin roof. The nose itself is made by putting on the side blocks first, then the top and bottom blocks, followed by the ply firewall or engine mounting. Before closing in the nose, position coil, tank, etc. with the aid of balsa sheet supports, and complete the wiring. Note that the two corner blocks behind the firewall close in the crevices that show at the bottom of the nose at either side of the firewall. These blocks can be glued onto the two big side blocks before assembly begins. Be careful that coil leads, especially the high tension, is not close to, say, the timer body.

Another point to watch is the escapement rubber-driven motor, which comes forward through holes in the bulkheads. These holes should be made before the fuselage is closed in on the bottom. On the original ship the holes were reinforced with washer-shaped pieces of sheet. The rubber can be replaced at any time with a long music wire hook pushed to the rear from the left side cabin door. An inspection door on the right rear of the fuselage facilitates reaching the escapement hook.

The landing gear is very sturdy; the rear strut extends for about 4" along the fuselage side, fitting into a groove made in the belly block, after the nylon covering is completed. When the gear wire is pushed into position and cemented, a strip of nylon is cemented over it. All joints are double-cemented; that is, the parts are first coated on the intended joints then, when that dries, more cement is applied and the parts are pressed together. This has a very great effect on the strength of the ship and it takes pliers to remove some of the pieces afterwards, although the joints never yield. The nylon covering extends over all wood surfaces and is a design factor in the use of the light sheet sides. *Do not forget this!*

The testing of a radio model is always a problem. Usually, the experts start by telling us the model must fly and glide in equal size circles both in power and the glide. Pride prevents our telling you how long it took the writer to reach such a point. (Incidentally, Walt Good says his *Rudderbug* now flies the way he wants it to, after 110 flights!) The beginner wonders what to do from the instant the airplane is done. Well, what is needed?

The ideal is an open field and a windless day. Given these conditions and you may get to controlled flying in one session. The greatest psychological hurdle is that first hand glide, followed by the first power flight. Fortunately, the *Citizen* is small and tough enough to dive on its nose if the glide trim is bad. This isn't recommended, but since we've done it stupidly a couple of times, the strength of the ship can be vouched for.

As a beginning, remove the prop and prepare for some test glides without radio or batteries. In the event that the ship is rigged for the Macnabb radio, removal of forward batteries will make the machine tail heavy. This means that less flying speed is needed in the glide, a less forceful heave is required, and that the descent probably will be a kind of shallow swoop landing nicely on the wheels. The first glide can be made from an on-the-knees position. How fast to throw it? Imagine that you have an equivalent-sized free flight that is trimmed a trifle fast and that it can be heaved dead ahead with plenty of muscle, nose pointed down a trifle, and aimed at a spot about 25' away, or about 40' if standing. If the *Citizen* glides at all at this stage, you have no worries. If tail heavy, those batteries will bring down the nose. Do not trim but, having gained a little confidence, fasten in the cabin some object of about the equivalent weight of the radio. Also put in about half the battery weight forward. If the model is launched from a standing position, more severely due to the added weight, it should still display a slight floating tendency as its flight path or glide path curves for a pretty landing. Now, if the glide seems dangerously fast, add incidence to the wing. (This may come out later, if needs be, as you get further with the testing.) If it is slightly tail heavy, it is perfectly safe to add all the batteries. It will be reassuring to know that the original was glided with all weights in place with the most nose heavy trim and that the landing gear merely bounced the ship a couple of feet into the air.

If possible, hand glide the machine from a slight rise so that the glide can be studied for distances of, say, 75 to 100'. If you can get this advantage, you will be far ahead on the flight testing, possibly eliminating stalls on short motor runs. To power test, first run up your motor trying to estimate from experience what power would be enough to merely drag the machine through the air. On the original, a timer setting of eight o'clock, with an 11-6 *Pow-OR* prop (other props may give climb so look out), and *Sky Ranger* gas-oil mix, provided level, slow flight. If you have the room, set the flight timer for 15 secs. And running with the plane, supporting it near the rear of the cabin, launch it as nearly in level flight as you can estimate. Do not point the nose up! Try to feel the ship leave your hand; as you push the ship forward from you while running there is a second or so when the machine is in between flying and resting on your hand. It is usually possible at this point to guide the strength of the heave accordingly. Launches depending on pure forward motion of the hand are not recommended on any but small models that become airborne right from the hand. Hard arm-launches frequently result in banked flights one way or the other.

If you estimated things correctly, the model will either drag itself across the field at the height of launch or will descend to the ground with the motor still running, taxiing harmlessly about. The writer prefers the latter condition because it permits gradual addition of throttle to get level flight. Of course, the model might dive too abruptly or it might climb, getting into mushy stall approaches on its low power. If the ship seemed to dive rather than descend in a straight line, increase the incidence in the wing until the short power flights indicate that the right power has been found for preliminary testing. At this stage, the only correction for tail heaviness is downthrust. *Unless you see the glide* it is unsafe to assume that the glide is too slow. If it proves so later, remove the downthrust and take out some of the wing incidence. If downthrust of a maximum of 3/32" (behind the top of the engine mounting ring) does not eliminate the stall tendency, remove incidence from the wing. In the end, your ship probably will require 3/32" downthrust, as measured behind the top of the mount, and 1/32" right thrust.

Now that we have the throttle setting to get short level flights across the field, what are we looking for? Just one thing: is the model flying straight? At this point we can accept a very slight turning tendency of about 25-35' from straight after 250' or so of flight. If the ship tends to turn badly, check the rudder position to see if it is really neutral in "neutral." The flying surfaces, of course, should not be warped and it is assumed that any warps that showed up in construction were removed. A warp is not a disgrace, but it *must* be *removed* before flying! If the rudder is true, and the alignment is correct (a slanted tail will turn the plane toward the high side of the tail; a wing resting with one tip lower than the other will bank a plane), this turn in power flight is corrected by placing a washer behind the engine mount to provide side thrust. When more power is added later, this may have to be altered again. Continue the short low-power flights until you know the ship is sticking reasonably close to the desired straight course and is

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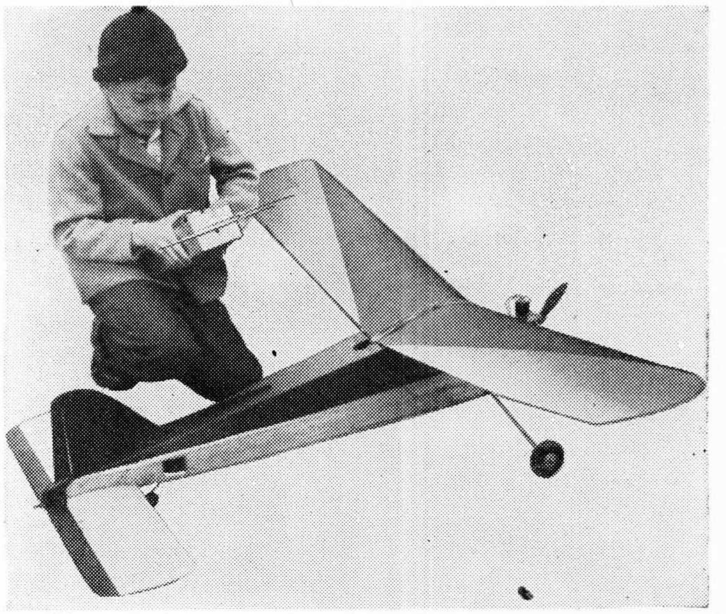

The simple but pleasing lines of the *Citizen* are apparent here

The Citizen

carrying through from power to glide in what looks like a reasonably good, but not necessarily a perfect, transition.

With the same 15-second timer setting, increase the power by moving the engine timer arm about 1/8″ to a more advanced position. This should give sufficient climb to check many things. First, did the plane fly straight, turn slightly, or turn too tight, under power; second, did it show any stalling tendencies under power; third, was the glide fast, slow, straight or banked? These conditions frequently have to be analyzed in combinations. Here are some common examples:

1. Stalls both in power and glide. Probably due to too much incidence. However, be sure that the glide stalls were not the direct result of a complete stall that resulted when the engine died with the plane in a normal-climb nose high condition. It is safe to remove 1/16″ incidence at a time from the wing; but only 1/32″ at a time from the tail (though the tail is not concerned in this case).

2. Mushy or stally climb followed by fast glide. Ship needs more incidence; engine more downthrust. If the glide is not dangerously fast, correct the thrust first and observe the result. Whereas combinations are involved, it is better to make single corrections and establish clear-cut effects.

3. Straight power flight, but banked glide. The rudder must be moved with its neutral position actually killing the turn tendency. This, of course, will make the power flight bank in the other direction, and thrust corrections will have to be made accordingly. In this case it would be safe to anticipate the power turn by making a slight thrust offset beforehand.

4. Straight glide but banked power flight. Lucky you! Add engine offset to straighten out power flight.

5. Good glide but mushy or stally climb. Assuming straight flight, add downthrust. If turn is involved, remove it first, for removal of a turn tends to make a ship more stally on straight flight.

6. Fast power flight but slow glide. Too much downthrust. After removing downthrust and checking results, the glide should be corrected separately.

Keep in mind that straight flight is a matter of obtaining straight glide first; then straight power flight by means of offset thrust. Reasonably straight power flight is obtained in the same rough kind of way that a sculptor chisels out a statue. It is not vital that flight be arrow true at this stage; very moderate departures from the straight can still be permitted. The aim is to arrive at the radio stage with a ship that can respond well enough to give you control over the whole flight. Turning tendencies in one direction always built up control response on one side, and weaken it on the other. As a beginner, you can be rattled out of control by an unexpected spin. Okay, you recover it by using opposite rudder. So there is the ship, stalled nose high on recovery 15′ off the ground. We've done it!

Now, the plane is approximately adjusted and you are ready for radio control. If you had been experienced, this flying might have been assisted with the radio in place, though this is tricky with a new, original design. In your case, the radio is put in and the simulated radio ballast removed. What do you do now?

In the writer's experience an engine run of 30 secs. is good for first R.C. tests. If the open area is really large, 45 secs. is better because you can wait longer before initial use of the rudder. While the experienced man might use rudder close to the ground —since he can react more quickly and do the proper thing if something goes wrong —it is better to wait until the ship is out about 15-20 secs. before trying rudder. Most often, the flier leaves his rudder in neutral with the right-rudder position coming up on first use of the button.

The kind of response you might get depends entirely on the amount of rudder area, its degree of movement, the speed of the plane, and even the amount of slipstream, which depends on the prop. A plane with mild response may come on around a full turn without losing altitude, while one with extreme response will flip over and be in a power spiral in less than half a turn. If the plane is being flown with too much throttle, this wind-in can occur as quickly as a thunderclap. This is particularly true of new designs being tested for the first time; in the case of the *Citizen*, one-third of the original rudder area was removed and about half its movement was eliminated, therefore it is very unlikely that anything dangerous will result.

So, you press the transmitter button. The ship begins to turn to the right. What you can do now depends on how much cleared area you have. You can press the button immediately to get back to neutral, then tentatively try a very short turn to the left, etc., until power dies. You probably won't put the ship down anywhere nearby. If you have only a small cleared area, leave the plane in the turn until you see it is beginning to head back toward you (unless it begins to dive), then press the button once to get back in neutral. The ship may not fly exactly straight—for your adjustments are perfected from here on over many dozens of flights—so anticipate the unexpected. The plane probably will begin a mild turn on its own. Remember that the rudder is in neutral with left rudder next. If the ship begins to turn to the left, you can't keep left rudder on, so you have to send your rudder quickly through left, back through neutral, then to the right. If the ship turns right, your rudder can go to the next position which is left. To tell you what to do all through a mythical flight is impossible, but the above is the typical beginning.

Now we'll let you in on something. After many months of R.C. flying, during which there always was a terrible feeling of panic and desperation when the sequence slipped in our "think box," we caught wise to the fact that the plane could be flown without attention to sequence, in an emergency. You can never make a mistake by pressing the button once. For example, suppose the plane being tested flips over in the bank and begins to wind down. Press the button once and the neutral rudder will permit a gradual recovery. If that isn't enough, press it again and the ship will come round and climb. If the plane is flying straight and you don't know which way it will turn, and you fear doing anything, press the button. It will begin to turn. You'll always know that after a turn, neutral is next. Any time the sequence is forgotten fool around 'til the plane goes straight, then press the button to see which way the next turn goes and you are in business again. The cure, actually, is a forced relaxation. In all emergencies now, we follow the do-anything school of thought.

Make at least a dozen of those short 30- and 45-second power flights, getting the feel of things, building up confidence. One minute under power is a long time in the air, and 2-1/2 min. is a century to the "intermediate" pilot. Five minutes is king size and only the adventurous or the practiced venture on for 10 and 15 min. Properly adjusted and flown on low power, the *Citizen* will gain about 50′ of altitude a minute. When its tank empties it will be at least 350′ in the air.

Something they don't warn you about is the strategy of each flight which begins to cook as soon as the ship is airborne. You will find yourself wondering at all times how to keep the plane near you; how to get it back from wherever the engine dies; how to keep it headed into the wind, if any, without striking obstacles by falling short or overshooting. These short flights will give you that sense and, at the same time, will permit final adjustments to get a straight-as-a-die glide, straight power, moderate climb, and the correct control response. You may decide later to increase or decrease rudder effect. Trimmed and equipped as described the *Citizen* will not spin, but will spiral in tight circles; even in full rudder in the glide going through several turns of a spiral, it will not hit steeply enough to smash the plane. It will cartwheel but the wing surfaces detach; and it is doubtful if damage will result. The original has spiraled into woods, fences, and bare ground with little damage. Rudder effect is increased by bending down the wire arm attached to the rudder where it enters the linkage. Do not exceed the eight o'clock position on the ignition spark arm unless the ship refuses to climb as built, or because of a worn engine.

No one can teach you how to fly radio control. It is suggested that you get a friend to help you indoors with a pre-flight routine some evening. You take the transmitter and with your eyes shut try to control the plane as he describes its maneuvers. Have him call a maneuver to you, then as he sees the rudder move he can pick up your errors or go on to say what the machine probably is doing as a result; then you struggle with that situation. We spent our first evening after the ship was finished doing this (and once spun into the kitchen floor!)

It is from the out-of-control flights that experience can be passed on. All our out-of-control flights — which have averaged about a mile — have occurred because of faults in adjustments and very infrequently due to malfunctioning in the model.

After our first three successful 30-second motor run flights, the timer was set for four minutes on our first R.C. airplane. In the enthusiasm, the engine timer probably was advanced. Anyway, the ship climbed in tight left circles and made a beautiful duration flight as a free flight job. What had we done? First, we had varied the power drastically—when the success of this kind of flying depends on not varying *anything* unless adjustments dictate it. Second, we had not waited until we had had adequate experience. It looked so simple. The engine run was long enough for an expert. Excess climb, resulting from the slow trim of the plane for that power, made it impossible for the rudder to get the plane out of a left turn in the climb. This happened on two other occasions before we even realized that the radio wasn't failing, as we had supposed!

After we had progressed to being able to steer the ship around a pattern without losing it on a windy day, an out-of-control flight occurred with shocking suddenness. The plane was gliding across wind, from which position we attempted to turn it upwind for the approach and landing. The rudder was applied but nothing happened. After the plane continued straight across wind for about 100′, it was assumed that a mistake had been made in sequence. Gliding straight—the rudder must be neutral! So we gave it one rudder pulse to come over to what we thought would be left rudder, and the plane instantly banked the opposite way and sped down wind like a bullet out of a gun. It was a quarter mile away before we remembered to do anything, pressed the button once, and the ship headed back for an "in-sight" landing.

In a wind, more rudder action is required. Even with sufficient rudder area there can be a delay of many seconds before a plane will turn from cross wind into the wind. Not realizing this, we had called for left rudder, when actually it was already in left, so that the control surface then went to neutral. This was not enough to hold the plane cross wind and it turned away. When we pressed the button with the ship a quarter mile out, the rudder went to right and she headed back.

Winds are dangerous. Not only do they pick up as the model ascends—we had that happen with no wind on the ground after the wind died at sunset—but a ship can do strange things in the wind. For instance, a turn under power into the wind may be half completed when the engine dies. The plane is apt then to whip off in a wild down-wind turn in the opposite direction. Once we passed between trees, under wires, hit in a road and bounced over a fence—and the plane had been only seconds from safety. *Stay out of the wind*. Any sequence difficulties or missed signals at altitude in a wind may get the plane so far down wind that you have trouble telling what it is doing. You have to see a plane clearly to tell what it is really doing on every signal. Keep it up wind if possible and spin or spiral down whenever altitude gets excessive.

Virtually all our lost flights resulted from poor turn adjustment or poor longitudinal trim. You must have rather flat power flights with gradual climb, and altitude increasing slowly because of time in the air. The typical free flight adjuster is apt to try a climb at too high a nose angle. The ship gets too high, is hard to see clearly, and it may "stick" in a left climbing turn, due to inability of the rudder to overcome torque at the low flight speed. We muffed many flights before catching on to this. Poor turn adjustment, with a strong turn to one side and a weak turn to the other is too often accepted until some wind is encountered. Then it becomes impossible to hold the plane into the wind and the ship gets further away on every circle. The strong turn will whip it around quickly into the wind but the opposite rudder proves too weak to keep the heading and eventually the plane begins another turn. Make it a habit to observe the kind of turns you are getting on every flight. Note: if the ship is flying straight in neutral, and if it glides straight. Begin to worry any time the model seems sluggish in coming around to one side or the other. That's a built-in out-of-control flight waiting to happen.

One fault in our *Citizen*—not necessary in yours—is a slight bit of whip in the rudder linkage. This is due to too much play in the parts. As a result, the plane has the odd characteristic of stopping its rudder at different places for neutral, depending on which way the rudder was last moved. The plane holds neutral when right rudder is coming up, but when left rudder is next, the "neutral" position permits a barely perceptible turn away from straight toward the left.

* * *

In one important respect the design of a radio control model closely resembles full scale. While an R.C. ship will perform well, it is always possible with time to make further improvements in maneuvering characteristics so that the model undergoes continual refinements. Conversely, after some 75 or 100 flights, shortcomings of any particular design are revealed. Because radio models will come into their own before long the writer would like to pass along the results of further experiments with the *Citizen.*

It has been found that the ideal power plant for easy handling is an .099, rather than a .199. It was also discovered that, whereas the .099 failed to produce climb on a flat pitch prop at high revs, it is capable of forcing zooms, and stalls and steady climb to about 500′ over 5 to 7 min. of flying (which is more than enough) when equipped with a *Tornado Sport* 9-4 propeller. *Power Mist* is being used in a rather small *Anyway* stunt tank set on edge and giving about a five- to six-minute engine run. An *Austin* timer and fuel shut-off has been attached to the firewall beneath the engine.

Removal of coil and battery, etc., has resulted in startling changes. First, due to nose light trim, all the packing for incidence has been removed (about 3/16″) and 1/16″ negative has been removed from the stab. The over-all drag is thus greatly reduced permitting the smaller engine to do a most satisfactory job. The .099, due to higher rpm requires double the right thrust shown for the .199 and, due to less power, requires almost double the downthrust of the .199. The rudder has been reduced to ⅞″ width at the base, and has about ¼″ movement to right and left.

Since the ship tends to overbank in the turns (from the standpoint of the ideal contest machine)—without, at the same time, spiralling tightly—this overbanking and dive in a 180 to 360° turn always followed by a slight zoom on recovery, is the result of the profile of the fuselage and could be improved by raising the rear of the fuselage with the stab about 2″ higher than at present; by lengthening the moment arm to one-half span. Also, while the *Citizen* flies well in the wind its ability to glide straight into the wind from far out might be improved. This will result from a longer moment arm and the addition of vertical tail area, up to 15% total of the wing area.

Present loadings with the .099 have worked out to 16½ oz. for the wing per square foot and 565 power loading. The machine is ideal now from the point of view of power and its glide is as slow as one dares use without risking thermals (due to the thick Gottingen section). With *Aerotrol*, or any equipment using light batteries, these loadings will be sizeably reduced. *Rudevator* would produce perfect turns without design changes.

These things usually remain designers secrets but to further R.C. design, the writer would like to suggest that twin rudders placed outside the slipstream, but well above the ground, would cut down on annoying differences (on most models) in rudder action between power-on and power-off. For automatic take-offs, a trike gear with plenty of shock absorbing action on the nose wheel would be desirable. Lastly, a number of radio control fliers have found that the addition of a belly fin has corrected bad banking tendencies. This indicates the desirability of low bellied designs in keeping with the CLA theory. While CLA is unimportant in contest free flights it is vital where smooth turns and banks are required.