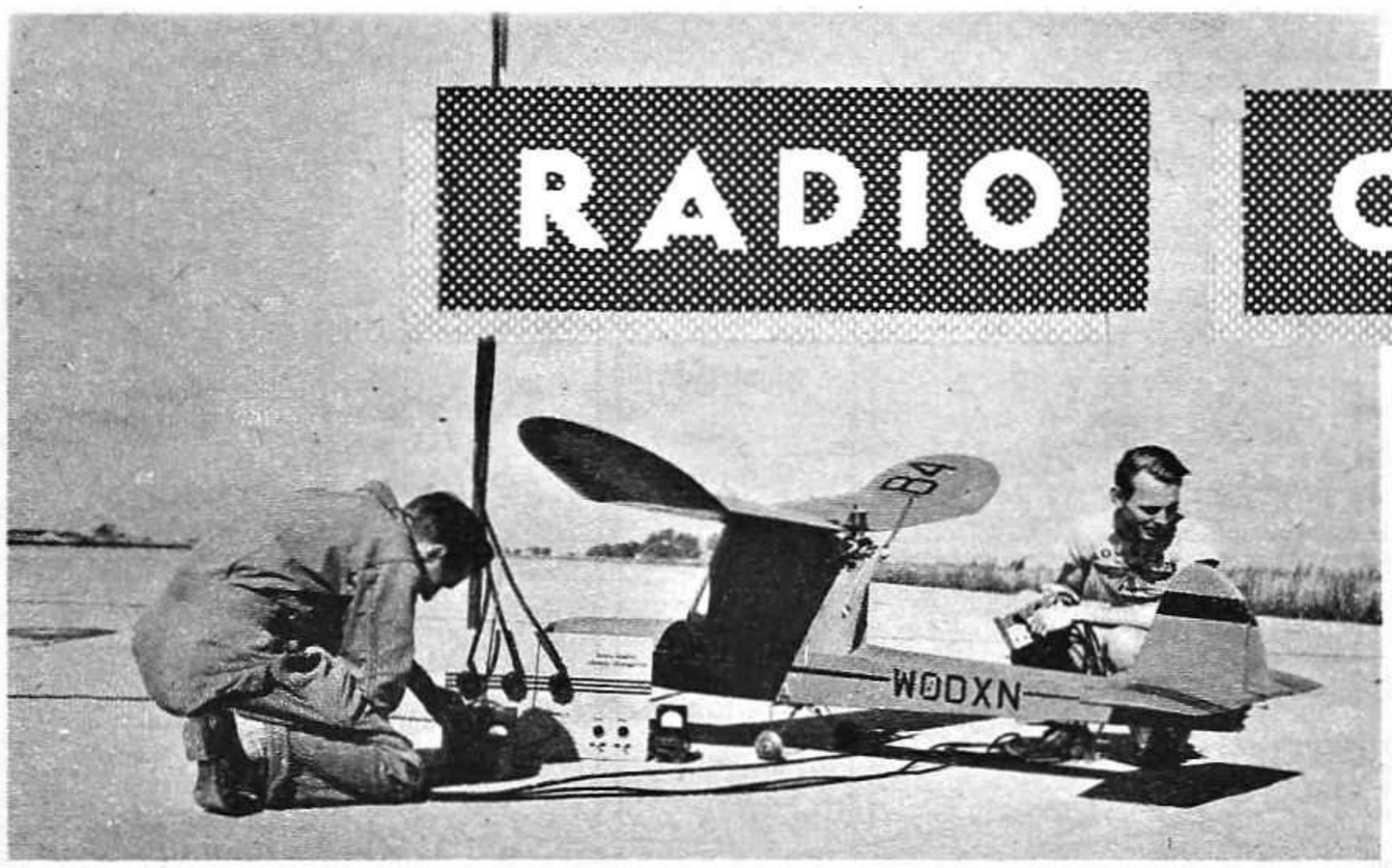
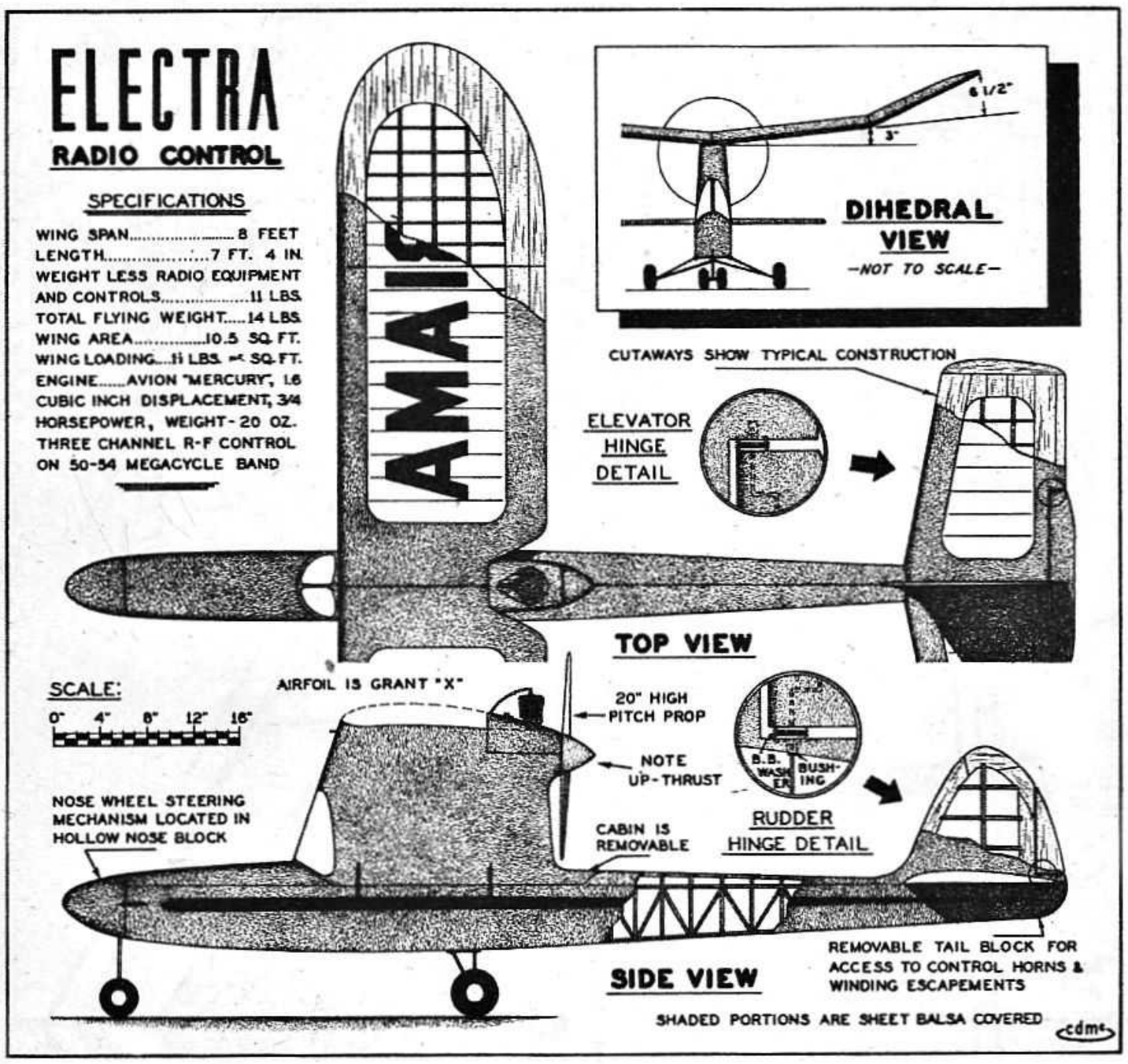
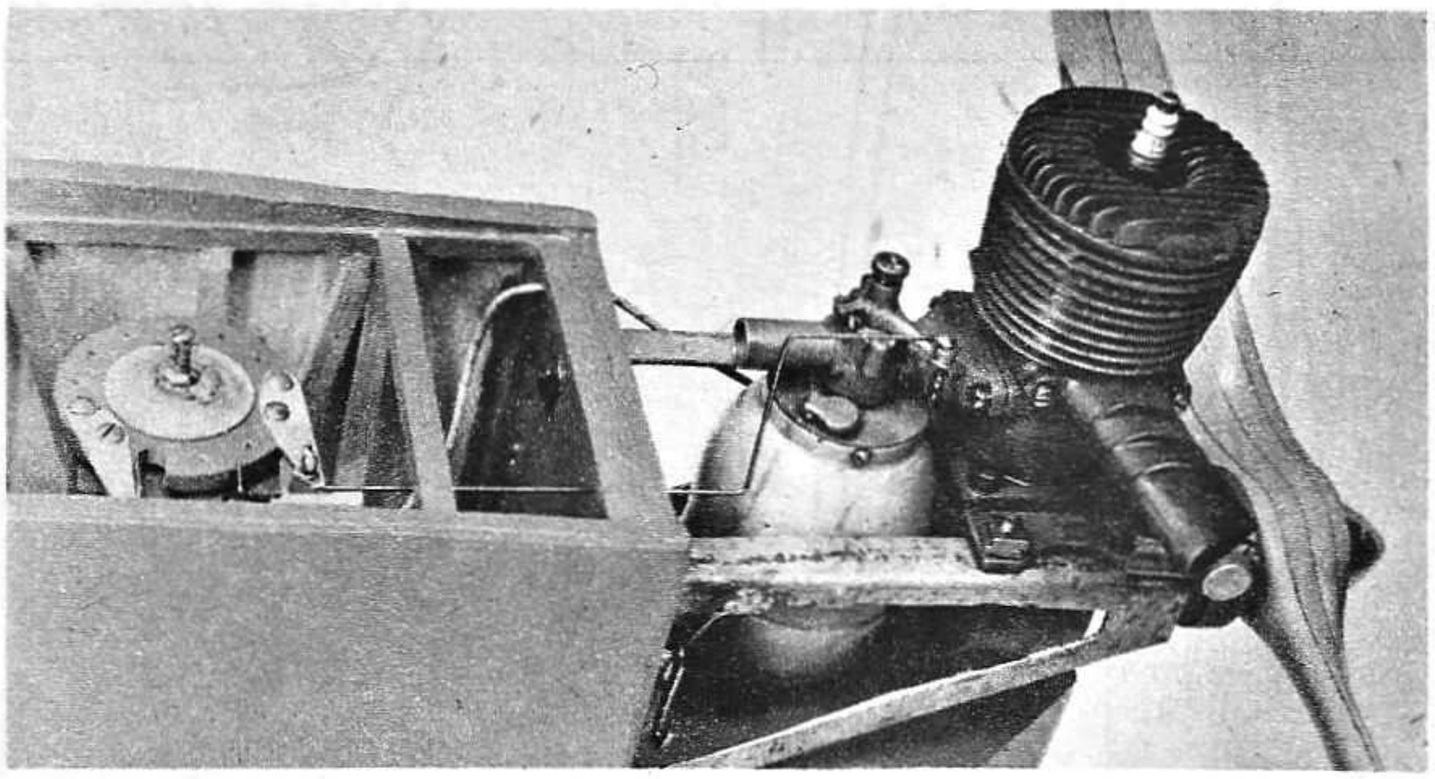
RADIO CONTROL NOTES



The radio control ship is readied for a flight . . . preliminary testing is important



Three view of the model gives an idea of its proportions and a few construction details



Closeup of mechanism used to control motor speed by movement of engine throttle

by **CLAUDE McCULLOUGH**

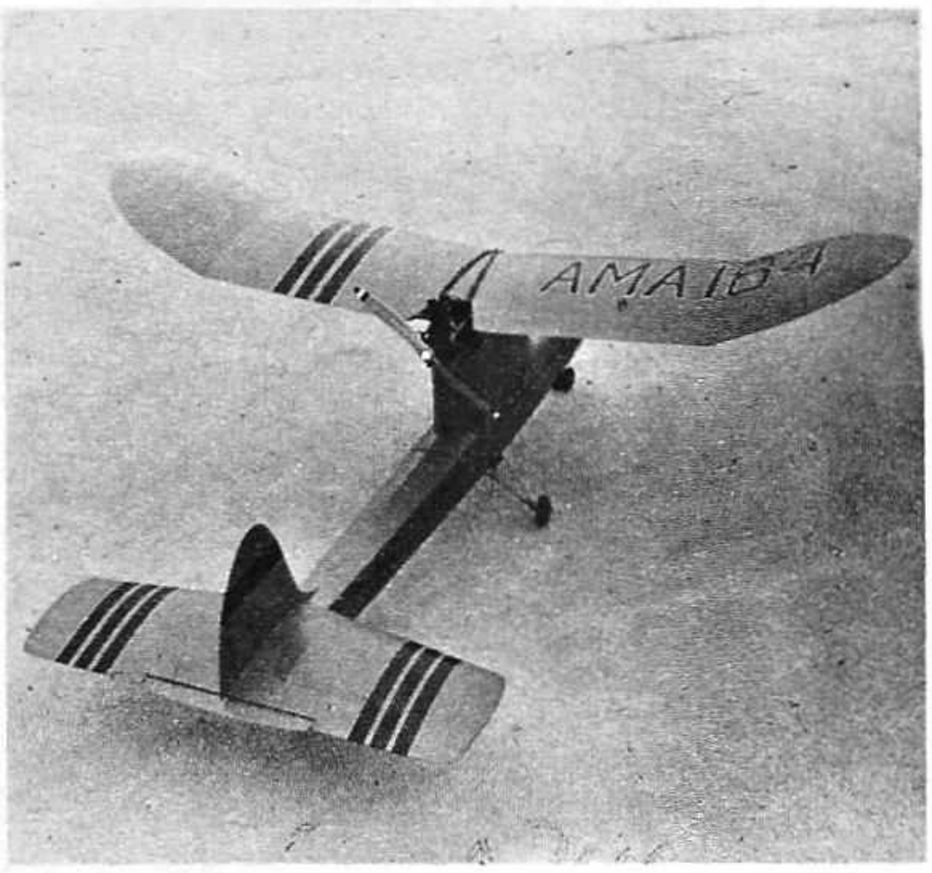
LIKE many a modeler in the service, I spent much of my spare time doodling on designs for an ultra-super radio control job and not infrequently using some of the excellent Signal Corps equipment which surrounded me to test out electronic brainstorms. Always intrigued by "R-C" and its possibilities, the flow of electrons the army subjected me to made building and flying my own remotely guided plane number one on my list of postwar projects. The resulting ship, christened the *Electra,* missed being completed for the Nationals by a few days but it otherwise proved to be a very satisfactory realization of my G.I. daydreams.

Large and heavy, it is intended as a flying test bench for various equipment and theories of procedure. In this assignment it has done yeoman service and has provided many definite conclusions on the ideal requirements for radio control.

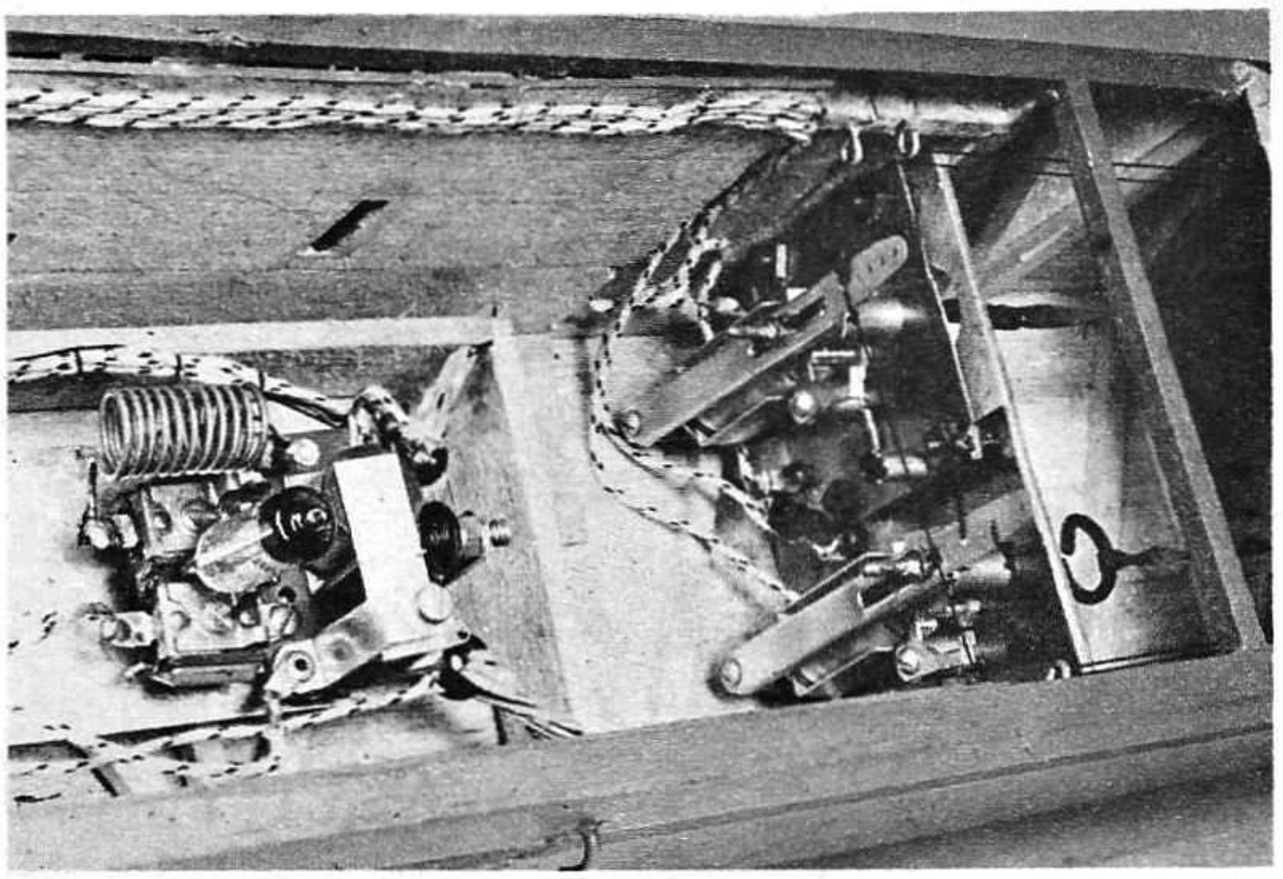
The plane's pusher design, along the lines of Jerry Stolof's *Super Yogi* (Oct. 1944 M.A.N.), was selected mainly to facilitate installation of a steerable nose wheel. Control on the ground during taxiing, takeoff and landing is given high recognition in the AMA's point system for judging R-C contests, and guiding the front gear enables an excellent variety of maneuvers. Jim Walker's 1946 Nationals-winning cabin job is equipped with this type control. Added advantage is gained in a pusher's stability and the lack of broken props, which can quickly run into money in the large sizes used on the *Electra.*

The plan is of conventional though extra-rugged construction. Body and cabin are bridge-girder style, planked with hard 3/32" sheet balsa. The wing and stabilizer have multiple spars à la Goldberg and are partially planked. Airfoil section used is Grant's X, chosen not only for its high lift qualities but for its ability to accommodate deep spars. All of the planked sections are covered with nylon and the remainder of the ship with silk.

Visions of landing gears tearing out large sections of fuselage to which they were attached in the event of a crash landing prompted their detachable design. The main gear is a separate unit, built on a sheet metal saddle which is strapped across the bottom of the fuselage with rubberbands. The nose wheel is fastened to a plywood bulkhead which is attached to the fuselage with hooks and rubberbands in much the same manner as that of a contest free flight firewall, permitting it to pull out during a rough comedown.



Note size of movable surfaces in contrast to total areas



Escapements used for rudder and elevator with one of the RK-61 receivers

The quest for structural strength was unfortunately carried a little to the extreme in building and as a result the ship has proven to be unnecessarily heavy. Its total flying weight of 14 lbs. gives it a rather high wing loading of 1⅓ lbs. per sq. ft. This in turn causes longer takeoff runs, high flying speed and pursuit-like landings. On one instance, however, this added strength paid off, when the *Electra* was inadvertently dived under power into a concrete runway, resulting in only a few cracks in the bottom planking near the nose. Such battering ram rigidity is handy, but under ordinary circumstances is a payload devourer.

The following figures are suggested as limits to follow in obtaining an efficiently operating and controllable R-C job: (1) Maximum wing loading—1 lb. per sq. ft. (2) Not more than two pounds of structural weight for every pound of radio and control equipment carried. (3) At least 1/5 hp for every 4 lbs. of flying weight. Exceeding these specifications will not produce an unflyable plane by any means, but a ship with a light wing loading and ample reserve power will be capable of a much greater degree of control than flying deadweights. In the case of the *Electra*, some 2 to 3 lbs. could easily be trimmed off the structure without seriously impairing strength.

The Avion *Mercury* engine is used to power the *Electra*—and power is an apt word in this case. With a 1.6 cu. in. displacement it is the largest model airplane engine currently available. Made mainly from magnesium, its bare weight of 20 oz. and power output of ¾ hp at moderate RPM makes it a very efficient plant. The feature most valuable in radio control is the carburetor, which gives control over a full range of motor speeds from a slow idle, accelerating to full throttle.

The *Electra's* present control setup makes use of three channel RF control on the 50-54 megacycle amateur band. The three transmitters using RK-59 tubes were patterned after those presented by M.A.N. Editor McEntee in his classic series of articles on radio control that appeared back in 1939-1940 and are just as efficient now as they were then. Their single control tuning makes them easy to operate and adjust to frequency and ample power output to give positive action response.

Using many portable "put-put" gasoline powered electric generators in the army convinced me that they were ideal for R-C work and so this transmitter was designed to operate on 110 volts. The value of such an arrangement is that a good deal of the time the put-put is not needed since you can plug into a hangar socket or any 110 volt outlet near your flying site for transmitter power. During testing and adjusting in your workshop a 110v AC power supply

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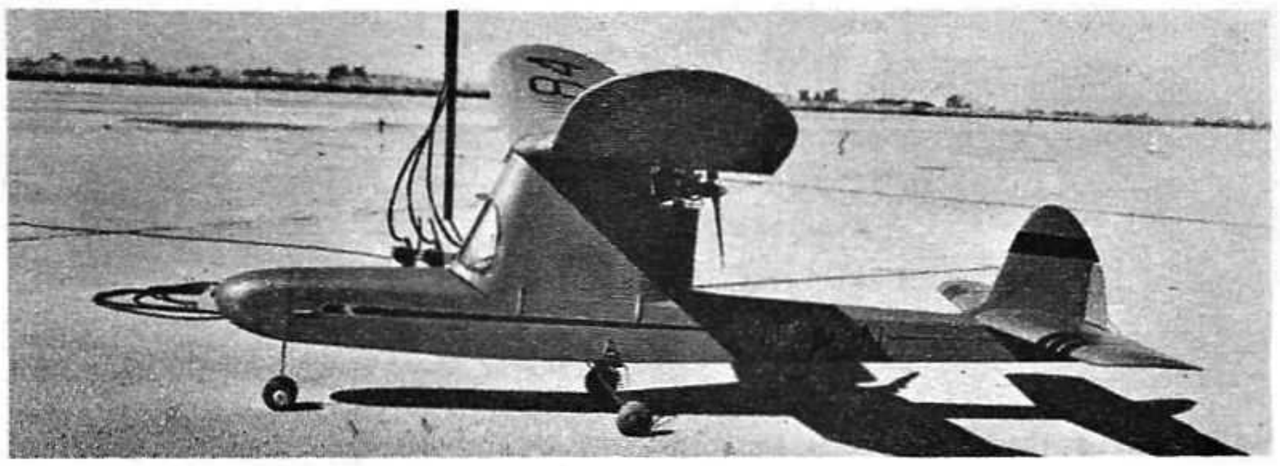
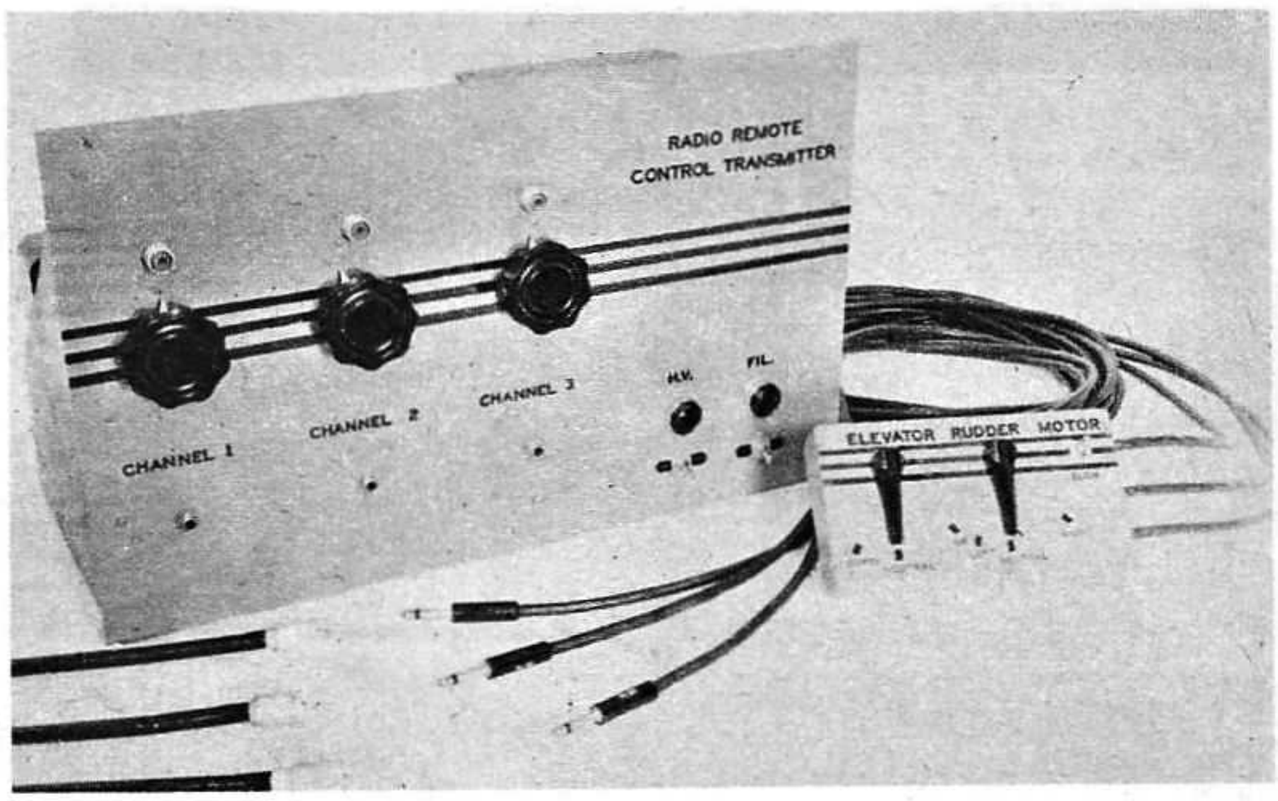
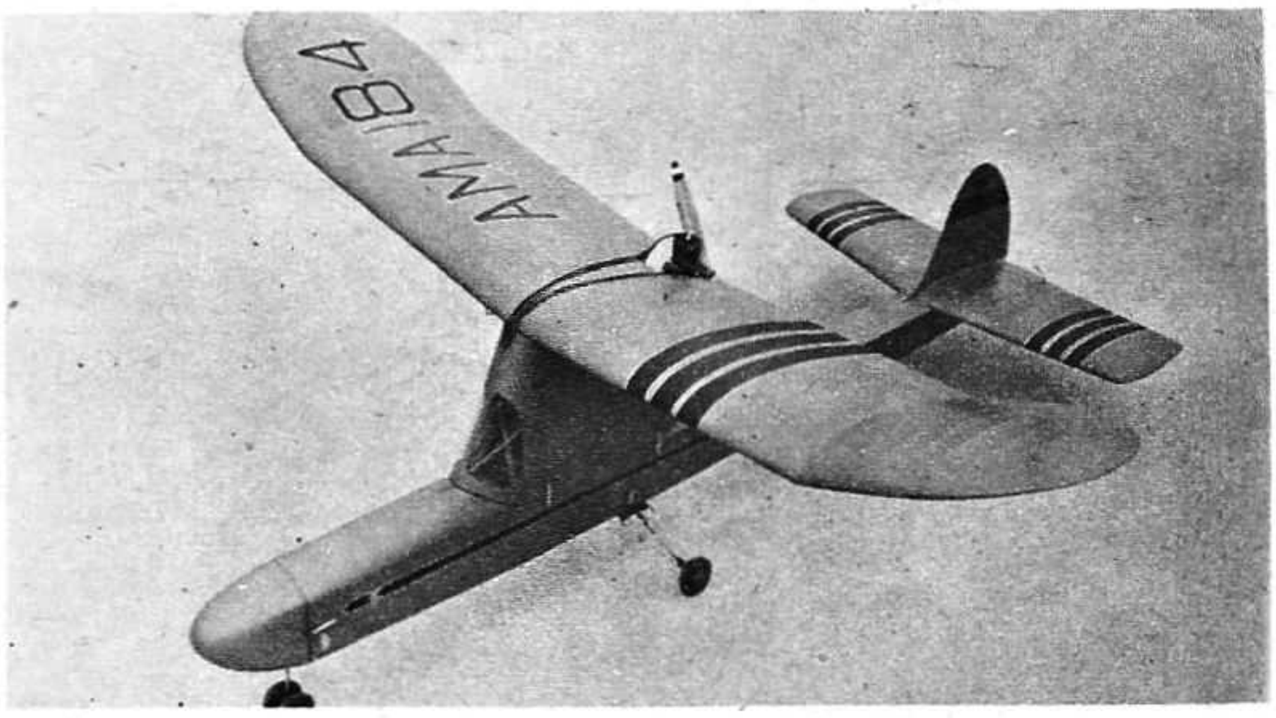


Large pylon is necessary to give clearance since the prop is 20" in diameter



Three channel transmitter allows independent control of motor, rudder and elevator



Twin nose wheels are steerable through interconnection with the rudder escapement

Radio Control Notes

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eliminates a lot of fiddling with a vibrator, dynamotor or auto battery.

My put-put, a 350 watt *Onan,* was purchased from army surplus stocks, and while heavier than many of this size has proven to deliver efficient service. When not being used for radio control these units are very handy for such situation-savers as heating electric soldering irons during a contest. At the Nationals in Wichita we used it to light our tent and burned many a gallon of midnight oil getting our ships ready for the following day's flying.

The entire radio system owes much of its extra details to the economy and quality of surplus electronic stocks, and builders contemplating an R-C job would do well to investigate this source of supply. For example, the transmitting antennas are half-wave doublets fed by coaxial cables. Ordinarily this cable and the silver plated *Amphenol* connectors and plugs used with it would run into quite a sum of money. At surplus prices they were just as economical as less efficient equipment.

With recent Congressional urging, the enormous surplus electronic stocks have begun to reach the market in greater quantity. Especially attractive are some of the types of equipment now being offered. My eye has been particularly taken by the appearance on the market of brand-new SCR-522 sets on sale at around $60.00. Familiar to all G.I.'s as the VHF set carried by just about every Allied aircraft, these beautiful transmitters and receivers cost the government about $2,500. Four crystal-controlled frequencies in the 100-156 mc. range are available at the flick of a switch. Needless to say, such an arrangement is tailor-made for R-C work.

The receivers carried by the *Electra* are conventional super-regeneratives using the Raytheon RK-61, hearing aid size of the popular prewar RK-62 radio control tube. (See articles by E. J. Lorenz in September and October 1946 M.A.N.) They are built around a standard RCH 1.1-A relay. Weighing only 3.5 oz. each, they are mounted on an aluminum chassis slung in a balsa frame with rubber-bands to absorb vibration.

One of the receivers is attached to a RCH 134 reversible geared electric motor equipped with limit switches and used to control the engine carburetor. When a signal is sent the motor pulls the throttle arm back to the idling position and holds it there as long as the transmitter is on. Turning off the signal reverses the motor and the throttle arm returns to high speed position. A toggle switch on the control box serves to operate the throttle control transmitter.

The rudder and elevator are operated by RCH self-neutralizing escapements which are attached to the other two receivers. These escapements are rubber powered and are mounted in the fuselage near the rear of the opening made by the removal of the cabin. The rubber motor runs back to the tail where it can be conveniently wound through the end of the fuselage. Nylon fish line is used for control cables. This is tough and strong and lessens friction at points where the cables pass through eyelets. At first radio dial springs were installed in the cables to maintain tension, but it was found that they tended to bind against each other and make control operation difficult. No trouble has been encountered with slack-

ening of the nylon cables and the springs were found to be unnecessary.

Nose wheel steering is accomplished without addition of another control channel by hooking the steering motor to the rudder receiver relay. A switch with a wiper arm that completes contact when the plane is on the ground turns off the steering motor when in the air. It makes little difference whether the rudder tracks with the wheel because it has little effect while taxiing and returns to neutral whenever the nose wheel is neutralized.

These self-neutralizing escapements used on the rudder and elevator give one control upon receipt of a signal and return to neutral automatically when the signal is turned off. The opposite control is obtained by sending a short signal followed by a continuous pulse, neutral automatically being obtained when the transmitter is no longer keyed. In the control box these signals are keyed by a rotary tap switch. Turning the switch to one control turns the transmitter on and off when returning to neutral. The other control has an intermittent on point followed by a continuous on as the switch reaches the end of the movement. Such an arrangement is simple and does not involve the use of complicated sequence mechanisms. Best of all, transmitter failure does not leave you holding the bag in the middle of a power dive, since all controls return to neutral upon interruption of the signals.

The receivers use Eveready Mini-Max 455 Batteries (weight 7 oz.) for the B supply and medium flashlight cells for the filaments. The little plastic-case wet cells used for U-control and race cars were found to be especially suited to the requirements of the escapements and the motors. They allow heavy current drains without much voltage drop when several of the controls are being operated consecutively and in being easily rechargeable represent a saving in battery costs.

Ball bearing washers are used on the control surfaces for frictionless operation, and the elevator was counterbalanced to lighten the load on the escapement.

Although many esoteric and algebraic formulas have previously been proposed for computing the area necessary for control surfaces, I would hesitate to recommend any definite percentage. The amount required depends mainly on the design and flying trim of the particular ship and is best determined by experimentation. For this reason the control surfaces of the *Electra* were made from solid balsa to facilitate changing the area in accordance with the outcome of tests. The rudder area proved to be just about correct. The elevator shown is sufficient for the amount of control necessary for takeoff and landing maneuvers but is too small for more violent acrobatics such as loops. As a general rule to follow, a slightly small area with a large arc of movement is less sensitive to adjustment than vice versa.

The pasture from which our club generally flies is not very smooth and, faced with the prospect of decapitation by the prop if we tried handlaunching, it was decided that a smooth takeoff surface was essential for test flights. Accordingly we obtained permission to fly from some of the acres of concrete in the possession of the local naval air station. The first flights were notable for the high speed attained —on the ground. The ship scooted about with modelers in hot pursuit, but refused to get off. Blaming at first the landing gear (it taxied in wide circles) we spent the rest of our allotted time getting it to track properly.

Appalled by the reams of red tape with which the Navy still joyfully occupied itself, we retired to an auxiliary landing field, that we had discovered was not being used and, free from brasshats, continued the tests. Some time was spent and quite a few miles were put on the plane before we eventually puzzled out that the ship was definitely nosing down and this was traced to the stabilizer. Designed along free flight lines, the ample lifting tail had sufficient leverage to overcome not only the 60% of chord balance point, but also further movement of the C.G. rearward. It was finally necessary to increase incidence and add upthrust to get the ship into flying trim. This experience suggests that it might be advisable to use a non-lifting symmetrical section stab on large size controlled ships.

No further trouble was encountered, and before winter weather discouraged further trials we were pretty well acquainted with the *Electra's* flying characteristics. Acrobatics, loops, etc., have not yet been attempted because the up and down controlling made it evident that the elevators were too small for these maneuvers. The three channel simultaneous operation certainly proves worthwhile in precision flying. In spot landings you can use combinations of the controls to really set it down on a dime and get a nickel change.

The RK-61's have been operated from distances of a mile without a miss, sometimes with obstructions in the way. Further control is certainly possible but it's no fun flying out into the next county even if your transmitter is powerful enough. Occasionally when you don't click the pulses just right the self-neutralizing escapements will miss a beat and give you the single pulse side of the control instead of the double pulse and the operator must be alert to this possibility. A quick flip of the switch back to neutral will remedy this situation. One thing can be said for this type escapement—loss of control never causes a crash and when the put-put ceases to put, the worst you can have is a cross country chase after a controlled ship that has suddenly become a free-flight.

At the present time experimentation is proceeding on an audio tone control system. This method, in which the receiver differentiates between audio tones by means of filters, is the basic method used by the armed forces in their radio-controlled target craft and other remotely guided planes. In my opinion this will eventually prove to be the only worthwhile system of control for a really responsive plane. Sooner or later the number of ships flying at the Nationals and other large contests will definitely obsolete the present practice of spreading the control channels for one plane from one side to the other of an amateur band and flying one at a time. The advantage offered by audio control is that only one transmitting frequency is required and a large number of controls may be operated over it. Even if not-notably-selective super regenerative type receivers are used in the planes it will be possible for 4 or 5 to operate at once, more if audio channels are regulated, on a single band. If such intriguing possibilities as races and dog fights are ever to become a reality then something along the lines of audio control must be developed.

Radio control still remains a field in which a lot of pioneering may be done. The war set back experimentation considerably and the turnout in the R-C contest at the Nats was disappointing. But

a successful radio control job is something that cannot be whipped up in a month or two, and the number of builders I ran across who were contemplating R-C is indicative of what is coming in the sport.

Certain it is that one of the greatest stumbling blocks for many would-be radio controllers is the necessity of possessing an amateur radio operator's license. The hobbyist is rare who can devote maximum enthusiasm to an absorbing interest and still find the time and energy required in beating 13 w.p.m. of Morse code into his head. The most complex problems of electrical theory can be mastered with study, but to some unfortunates radio code is a devious gibberish that absolutely defies them regardless of the effort applied.

The AMA's radio control committee, headed by Walt Good, tackled this problem but was unable to get any satisfaction from the Federal Communications Commission. The only group who might be able to secure such a concession is the ham radio American Radio Relay League. They recently withdrew their request that had been placed with the F.C.C. for issuance of Class D licenses, requiring no code and limiting operation to the very high frequencies. This action very probably stemmed from the understandable reaction of the some 60,000 U. S. hams to this letting-down-the-bars proposal; their bands already being veritable bedlams. Solution to this objection could be found, however, in restricting Class D licenses to a band of their own. Until the A.R.R.L. is solidly behind such a proposition, though, it has little chance of fruition.

There is some possibility that the proposed Citizens Radio Band of 460 to 470 mc. may be the answer to the modeler's prayer. License requirements on this band would be very simple and further information should be available from the F.C.C. soon. The opening of such a service would be a greatly beneficial stimulus to "R-C"—a fascinating angle to a fascinating hobby.