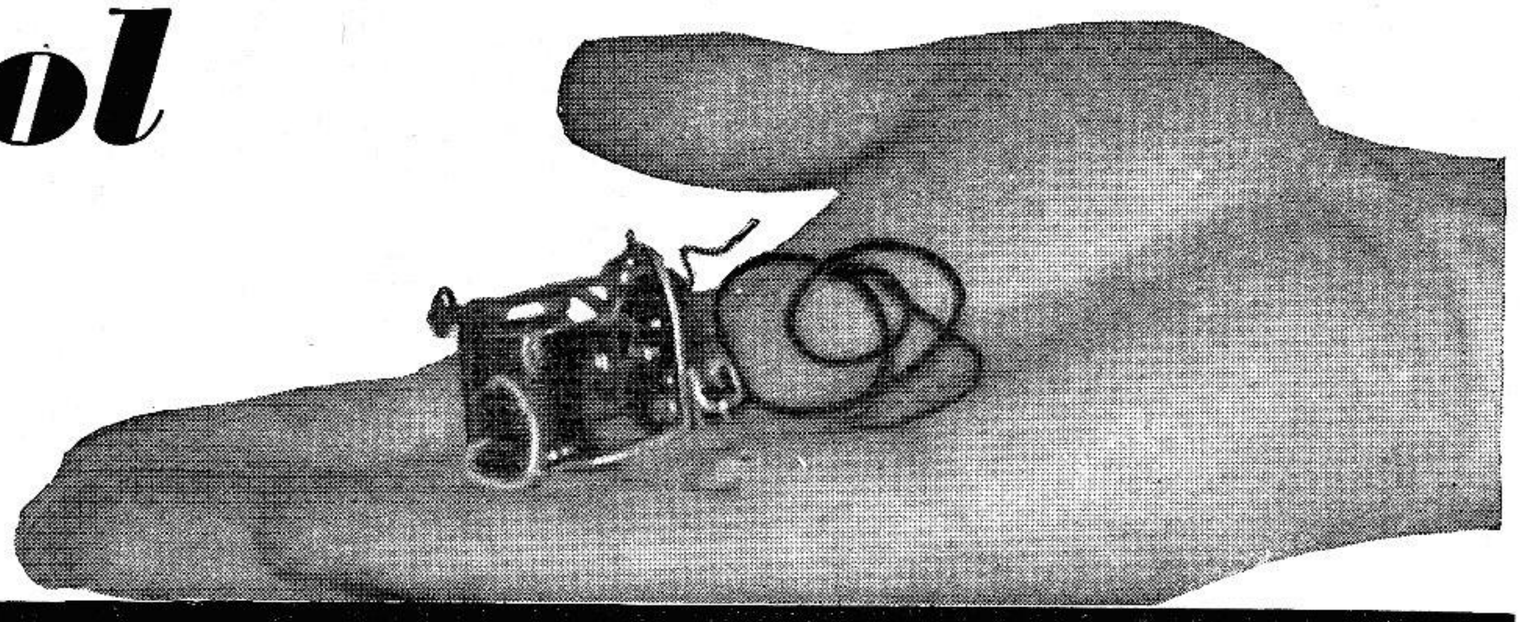
Control That Ship!



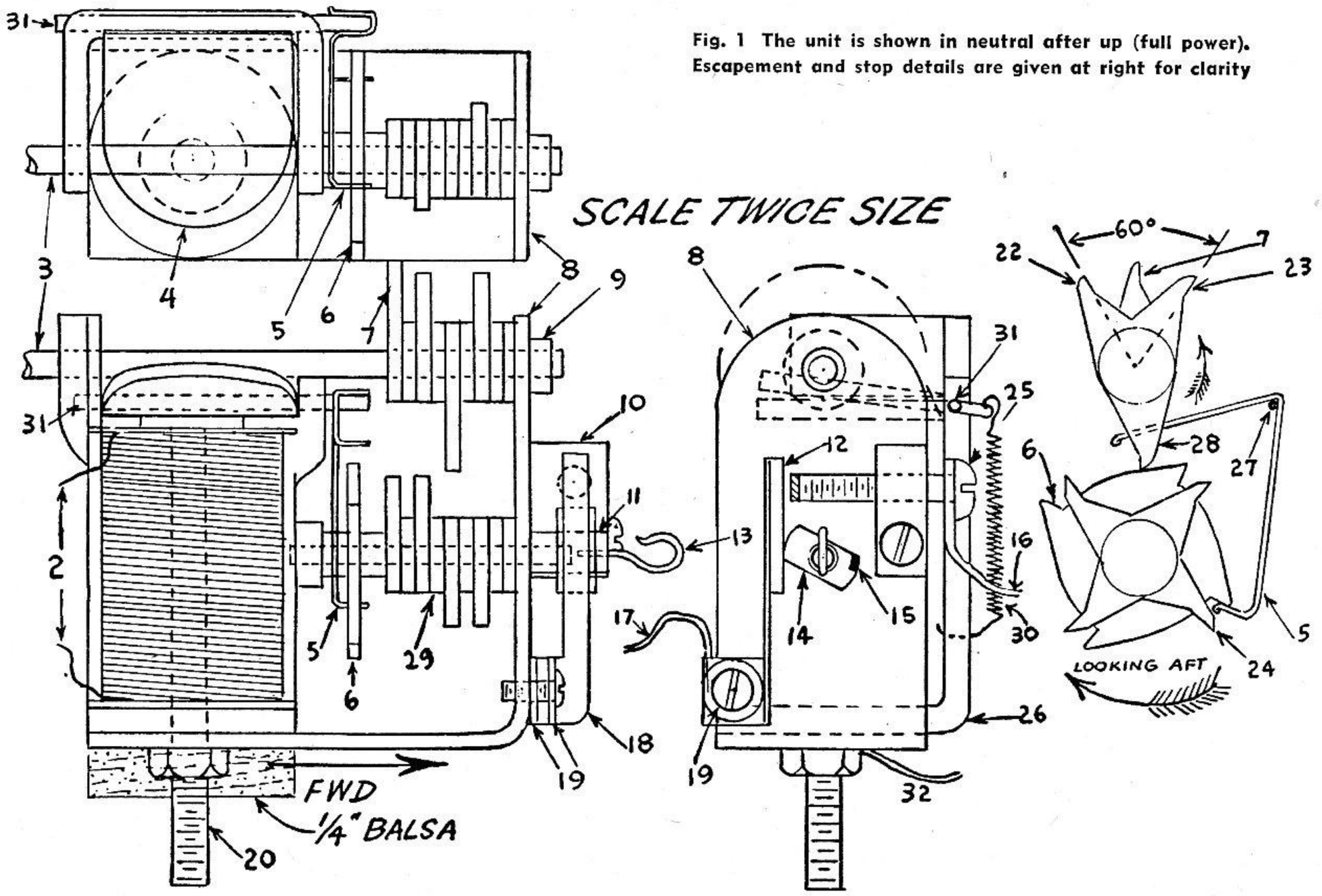


Fig. 1 The unit is shown in neutral after up (full power). Escapement and stop details are given at right for clarity

PARTS AND MATERIAL LIST

1. Coil—4 to 6 OHMS #29 or #30 wire
2. Coil leads
3. Tab shaft—1/16" brass
4. Armature .040" iron (butt solder to shaft)
5. Escapement pawl—.040" music wire
6. Escapement wheel—.032" bronze
7. "Up" spoke—.032" bronze
8. Frame—.040" aluminum
9. Thrust washer—1/8" brass tube
10. Slow speed screw block—micarta
11. Cam shaft—1/16" brass tube soldered on 21
12. Ignition switch contact—silver
13. Rubber hook—music wire
14. Advance cam—silver
15. Glue notch—(ignition cut-off)
16. Slow timer lead
17. Common switch lead (ignition)
18. Common switch arm—.006" brass
19. Common switch arm insulating washers
20. #4-40 mounting bolt
21. Escapement shaft—.042" music wire
22. "Right" spoke—.032" bronze
23. "Left" spoke—.032" bronze
24. Escapement spoke (4 needed—.032" bronze)
25. Retard contact (silver tip) No. 2-56 screw
26. Magnet frame—1/16" iron
27. Armature shaft—.042" music wire
28. "Down" spoke—.032" bronze
29. Spoke spacer (make 10)—.032" bronze
30. Armature return spring (hooked in 26)
31. Armature shaft
32. Advance timer lead (connect to 8)

"LAST Sunday's radio control contest was one of the best we've had this year. A total of 23 entrants did their best to outmaneuver each other for top score. Weather was all but perfect with a steady three mile wind. Eleven entries had their own transmitters (3 of them homemade) and the rest who were not licensed, took turns on Bill Cody's rig. Bill does a great service standing by with his transmitter, and helping the fellows shoot receiver trouble on the side. Harry Melford took first place but only by two points. Dick Schaeffer was high man in maneuvers but had less luck on the spot landings. Excitement ran high when one entry launched his ship for a test hop on what he thought was the practice frequency but discovered too late that he was on the contest frequency. The contestant flying at the time happened to be using Bill Cody's transmitter which is stronger than average. As a result, the contestant had control of both ships without knowledge of the fact. Things could have ended in a crash for the illegal ship except for the fact that it finally flew out of range and the safety timer dumped it in a plowed field; damage was minor."

If the reader has never witnessed one of these radio control contests he may have difficulty imagining the thrill that comes from competition that depends so much on flying skill in three dimensions. Those who have never seen one of these contests haven't missed much either, because such an event as described above has *never happened!* It's just an attempt to visualize what radio control could be in the near future if we could discover what is needed to shake you fellows loose from your lethargy. (All names above are fictitious and all that sort of stuff.)

Let's try to analyze why radio control today isn't at least half as popular as free

THE ORIGINAL RUDEVATOR DESCRIBED IN APRIL ISSUE HAS BEEN GREATLY IMPROVED — STUDY THE LATEST MODEL HERE

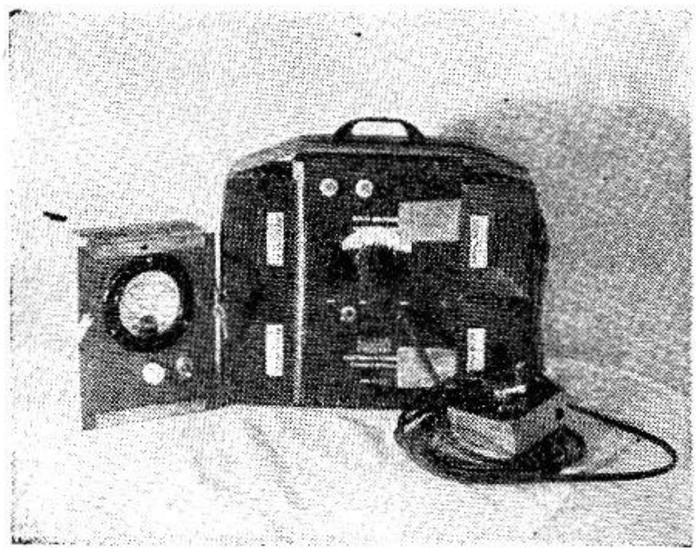


Fig. 2 Transmitter, control, and test meter

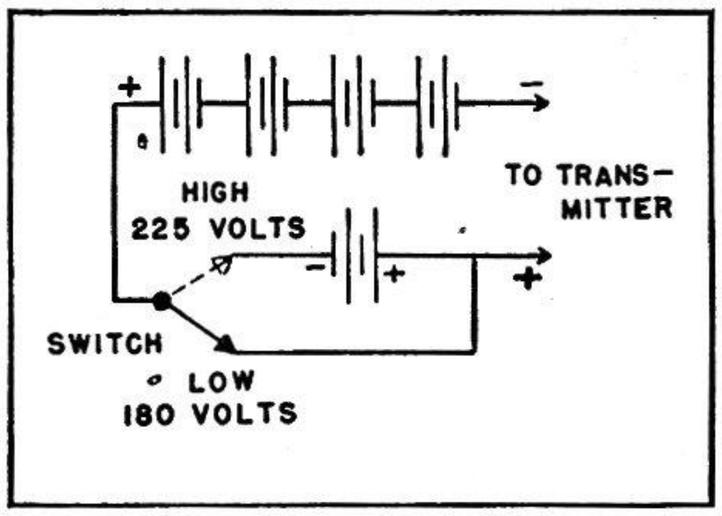


Fig. 3 Power supply circuit with "grabber"

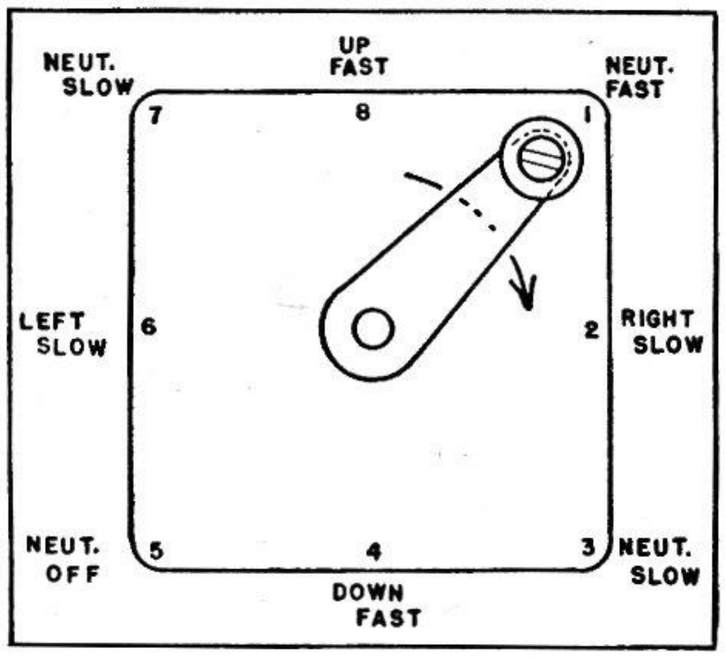


Fig. 4 Rudevator positions from control box

by H. H. Owbridge

flight. There are 3 basic problems which are more mental than physical: (1) the amateur license; (2) the equipment; (3) the knowledge.

PROBLEM 1—In two or three years the amateur license problem may well be taken care of by transmitters that are licensed at the factory so that no special operator's permit is required if used in the "as received" condition. This possibility was described in the April issue of M.A.N. by Ed Lorenz. But two or three years is a long time, and present receivers and parts of transmitters can be used on the contemplated 27.255 mc frequency when it arrives. For the present, the aid of a licensed amateur is the best solution to the problem.

Remember, all your testing and trials in getting familiar with the equipment can be done without a license if you leave the transmitter antenna disconnected. Then, when you are ready to try your first controlled flight, it should be a simple matter to find a radio ham enthusiastic enough to go out to the field with you. The honorable ham need only have (besides his operator's license) a station license for one transmitter. One transmitter can easily fill the needs of 5 "pilots" while you're getting started. The transmitter need only have 5 watts input. If it has more power than that you're using brute force, which isn't necessary. The ham, besides keeping you satisfied that you are abiding by the law, can teach you plenty about radio at first hand and help you find that loose wire in your ship. Our problem is to bring amateur radio to the model builder, not to bring model building to the amateur radio man. The ham is interested in communications; the model builder is interested in control.

PROBLEM 2—The equipment is really simple. If you are a ham that wants radio control, go ahead and build your own radio equipment and let a modeler build you an airworthy ship. But if you are (as is usually the case) a model builder with little or no knowledge of radio, there are many advantages in buying your radio equipment. It is agreed that the initial cost of present radio equipment is not low. But a good set will outlast many models. The electronics of these super-regenerative receivers is tricky. A ready made set has that extra reliability and long life that comes from well chosen components. Even if you count your time at only 50 cents an hour you can save money and discouragement and get into the air sooner where the fun really begins. The Beacon Electronics set can be recommended very highly from first hand experience. It is rugged and reliable. We mangled our receiver in a bad crash but the tube was unharmed, and when we carefully replaced the broken micarta and rewired the set, it performed better than when received from the factory. That is probably one of the most misunderstood points about radio control. The receiver (if it is the simple variety) is not delicate. It will stand a crash that will leave the ship in pretty bad shape. Both the receiver and transmitter (for all practical purposes) never wear out. By the time you are on your second set of batteries or second tube, you are a radio control operator of considerable flying time and experience.

We have also flown our ship with the Aero-Trol transmitter and receiver and can state that this equipment is also recommended as first class and a good investment. The user's choice need depend only on whether he prefers the lightweight of Aero-Trol with its more expensive and shorter life tube, or the heavier weight of Beacon Electronics with its longer life, less expensive tube.

Accidents are bound to happen. One must pay as much attention to detail as possible to avoid a crash, and even then the law of averages will determine your safety record. In 100 flights we have had one bad crash, one foolish crosswind landing, and at least 6 of those ordinary three point model builder's landings (one wheel, one wing tip and the nose). Only one accident bothered the receiver—that was the first one mentioned. Only the real crash and the crosswind landing required extensive repair which was completed by the next weekend. The snow shovel landings merely delayed operations for a few minutes.

We consider this a pretty sloppy safety record. But, then, we consider our utility factor (hours per month in the air) pretty high. There is a simple explanation for this. Our control loading (weight of radio control equipment per square inch wing area) is low. Think it over. Ours is about 0.016 oz. per square inch of area without even trying for light weight. This is what saves the ship, not our flying ability. If we had a heavy complicated control—one that required a lot of batteries to keep it going—our ship would be more nearly a total loss with every accident, minor or major.

It is easy to understand why the Good brothers stress simplicity, and why their ship is as old as it is. Get a simple radio control, operating in an airworthy ship and you have a pretty safe combination. On the other hand, if you get too original or fancy you need a junior genius badge to keep your ship in the air.

Few appreciate what radio control and its equipment will have to be in the future. It's hard to stop dreaming about a high speed job pulling out of a dive at two feet altitude, buzzing the length of the field and then pulling up into a series of vertical rolls. Yes, it's hard to stop dreaming about it, but stop we must if we are ever going to graduate from spectator to operator in quantity. Such a maneuver calls for high class proportional and simultaneous control, which will never be found this side of the military forces for less than about $500 and 15 lbs. Even if the weight of such a control could be brought down to 2 lbs., one would no more think of repairing it after a rough landing than he would think of taking apart his 21 jewel watch.

Some day this radio control business will boil down to a list of fairly well recognized procedures of a more or less standardized nature such as we now have for free flight and control line. While it is new, radio control design shows a lot of originality. That is good. It means that all possible types of controls are being investigated to determine their true worth. This process of elimination will soon evolve basic standards in the form of a few really successful controls from which the sport will develop. Originality of control types will some day all but disappear, and originality in model design and flying technique based on one or another popular type of control will take the spotlight.

PROBLEM 3—(The knowledge) is probably the largest single drawback to radio control at this time. There was a time when every gas powered model enthusiast had to look at a wiring diagram to hook up the ignition circuit on his first engine. Radio control is the same. Do it once and you know how. Simple routine tests keep your set in operating condition. Learning by doing is still the best teacher. You can learn all that is necessary about radio as you go. The radio is highly interesting, but controlled flight is the goal. One can do a lot of thinking about radio control on the sidelines and never get very far. Once you get in the air and learn what radio control really is, you start learning fast.

Our experience was like that. As prepared and ready as we thought we were, our first attempt at radio control almost turned out to be a haphazard fiasco. It's hard to keep calm on that first flight. The ship never cleared the ground on the first try because the motor was set to run too slow. On the second try it barely

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Control That Ship

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cleared the ground at the bottom of a loop because of poor trim. On the third try we had real radio control for the first time (but not until I remembered to turn on the transmitter!). Oh well, if everything worked like a push button machine you could hardly call it a hobby.

If you buy a Beacon Electronics set, watch that instruction book carefully. It took a little time to learn how to operate our set with skill. We improved the reliability of our receiver a great deal by putting an arc suppressor condenser across the relay contacts. We also improved the transmitter by going to a 180 volt external battery supply. Those little 67½ volt internal batteries are expensive for what little you get out of them. We also put a 45 volt boost on the transmitter as a "grabber" in case the ship went out of range. The "grabber" will be explained later.

Anyone with 100 radio control flights can think of lots of suggestions that a beginner will discover soon enough. The best way to handle the knowledge problem is to start in working with the equipment you need to fly. Don't take a course in radio because that will teach you to be an electronics engineer and you don't have to be one of those to handle this stuff. The simplest book on radio is all the introduction you need. Articles that have appeared in this magazine have

covered the information required.

Here's the latest Rudevator: The heading photo shows it in hand for size. We have been working hard on it since it was first introduced in the April issue and now it has acquired power control and other tricks. Rudder, elevator and engine control (including cut-off) all in a one oz. unit requiring only the turning on and off of a carrier wave to operate! You'll have to pardon our pride if we seem to brag about it a little. Thanks to the original invention of the rotary control surface by Bill Rhodes, we've got more control packed into a cubic inch than was ever thought possible.

The present version of the Rudevator came about as a result of flying experience. We became tired of seeing our ship spiral down every time we touched the rudder. We knew we were using too much power and too much rudder but were reluctant to reduce either. Less power would mean a sluggish climb, and less rudder would mean less control. We started to work on the problem by changing the position at which the Rudevator was stopped for rudder. Instead of stopping it in the vertical position we began to stop it more and more over on its side. We ended up by stopping it 60° from vertical, which gives us theoretically 66% up elevator with 33% rudder. In effect we have simultaneous rudder and elevator in turns.

Of course we had to increase the Rudevator area to get back the original amount of rudder we were using. That helped a lot, but it wasn't a complete solution. The spiral was more delayed than it was deleted. What we needed was less power in turns. This meant a 2 speed control for the engine. For some time we couldn't see how to do it without adding an extra relay. Then the light dawned. What good was high power in turns if you couldn't even complete one circle without heading for the ground? All right then, throttle back in the turns. Any flight instructor might consider this poor practice in a real airplane but it was just what we needed. So we built 2 speed points on our *Super Cyclone* (a simple matter) and designed a cam switch on the Rudevator to give us the configuration we wanted.

Now our turns are as flat as we want them and yet we can still spiral down by holding rudder for about 2 circles or going into a turn at high speed after using down elevator. But that isn't all. We were half surprised and half scared one day to find we could do snap rolls. Well, it was so fast it looked like a snap roll, but some observers may have termed it a barrel roll. Sometimes it is hard to tell where a barrel roll leaves off and a snap roll begins, but there certainly was no doubt that it was a roll. The only trouble was that we hadn't built the main beam for such a violent maneuver so we got it down in a hurry to see if there was any permanent damage. The wing looked all right from the outside but we still wonder if it didn't fail a little inside. We've been reluctant to uncover the wing to find out.

This 2 speed control comes in very handy for cross-country work. There is nothing so annoying as a radio control job that insists on climbing while you're trying to fly cross-country or practice maneuvers. The 2 speed control plus the down elevator gives pretty good altitude control without having to spiral the ship down every few minutes. Our control surface now is just twice the size it was previously, or 14 sq. in. (2 sq. in. per foot of span). The control surface is now made of 1/16" balsa sheet, paper

covered, instead of the previous celluloid. We've decided that the rotating surface looks more intelligent than expected so we've stopped trying to hide it. Also, for rotary propulsion we now use full length ailerons instead of the previous protruding tips.

The drawings of the Rudevator mechanism (Fig. 1) along with the parts and material list should be self explanatory. As noted, the unit is shown in the neutral after "up" position. The advance ignition cam (14) is touching the ignition common switch (18) and therefore completes a circuit thru the mechanism frame (which is not ground) to the advanced ignition points on the engine. If the cam (14) were away from the common switch (18) the advanced circuit would be broken and the retard circuit would be made from switch (18) to the retard screw (25) which is connected to the engine retard timer points. The glue in the notch (15) opens both circuits and cuts the engine.

The control box configuration is shown in Fig. 4. We take off and climb in position 1 (full power-neutral), cruise in either position 3 or 7 (part power-neutral), maneuver in positions 2, 4, 6 or 8 (part power in left and right, full power in up and down) and cut the motor in position 5 (neutral-off). But remember, the control box has no markings since up is up and right is right, and so forth. This way it's a simple matter to turn the box in your hand to synchronize with the Rudevator.

Back to Fig. 1. A conventional type of escapement (driven by a loop of 1/16" rubber) is used having a 4 point escapement wheel (6). Forty-five degrees of motion each time puts one and then another of the escapement spokes (24) in the path of its corresponding control spoke (7, 22, 23 or 28) on rotary tab shaft (3).

Here are three suggestions that will really improve your Beacon Electronics transmitter (or any other low power transmitter used for radio control for that matter). Our transmitter proved to be a first class item in the "as received" condition, but here is what a few dollars and a little more work and wire did to it. Fig. 2 shows the reworked stock transmitter along with our special control box (just a simple rotary switch) and our faithful test meter. The meter is a separate money-saving item that can be used for all measurements required for radio control—but that's another story.

The recommended power supply for the Beacon transmitter is 2 Burgess XX-45 "B" batteries. The only thing good about these batteries is that they fit in the transmitter box. For very near the same price one can buy batteries that will last not a matter of hours but months. These are Burgess 5308 batteries or their equivalent. Four of them stack very neatly around the transmitter box and are held thereto with a couple of shortened trunk straps. A cheap handle has been added to the top of the transmitter box as a handy grab-all. The wiring diagram for the power supply (including a "grabber" which will be explained later) is shown in Fig. 3. Two screws are left out of the rear cover of the box so that two leads can be run in to the proper connections inside.

The 45 volt batteries are connected in series so the total adds up to 180 volts. The 3A5 tube is conservatively rated at 135 volts but doesn't mind the extra pressure in the least. A spare 3A5 is stored inside the box in case the one in use should get tired some day. All the screws are removed from the front of the box

and a good grade of tape has been substituted as hinge and fastener. This way we figure it would take about 10 seconds to replace the tube if and when that fatal day arrives. We check the tube periodically by taking it down to the local radio store. After 6 months it still tests brand new! We have yet to see one blow.

The second suggestion for improving your low power transmitter is the addition of what we call a "grabber." This is merely an extra "B" battery as a reserve in case the model goes out of range. This battery is another Burgess 5308 (or equivalent) stored inside the transmitter box along with the "A" battery. Almost any type of single pole-double throw non-shorting switch can be employed.

Now let's see what this extra two dollars worth of equipment gets us. Without it we could never be sure what the actual range of our low power transmitter really was without flying the ship away until it refused to come back. With the grabber it's different. At least 4 times to date we have seen our ship set off into the blue with that unconcerned free-flight look. Obviously it had crossed the threshold of signal strength and was on its own. Normally this would mean a rush for the cars and the usual chase. Not with a grabber! A flick of a switch and your transmitter is on high. That extra 45 volts reaches out a little farther and gently but firmly swings the nose of your ship around toward home. Once it is heading home the transmitter can be switched back to normal power. The extra voltage for short periods doesn't hurt the tube or de-tune the transmitter enough to worry about. Once an extra strong thermal got our ship and we fought for it with the grabber for 10 minutes. It was a good fight but the thermal finally won. However a check on the transmitter later showed it was none the worse for the workout. One may not need a grabber for 10 or 20 flights, but when you do need if it's nice to have it there.

The third suggestion for your transmitter doesn't concern the transmitter directly but rather that all important accessory, the antenna. Take time to make it right. We should know after the many times we spent running around looking for a soft spot in the ground to push poles into. The main advantage in fastening the antenna to the transmitter lies in the fact that the area off the end of the antenna is really pretty dead. It's nice to be able to swing the antenna around when the ship gets low in the dead area. Make a "Y" frame. It doesn't have to be fancy or chrome plated. Broomsticks or one inch square pine are good enough. Block them together well at the intersection or make a folding joint to simplify the transportation problem. Make the base support from the end of an apple crate or any flat piece of wood a foot or two square. A piece of gas pipe makes a good antenna post holder. What's going to keep it from falling over? Why, the transmitter, of course. With that heavy duty power supply it makes a perfect dead weight ballast. Ask the Good brothers.

To sum up, we make the following suggestions: for those who would like to get in the air with a degree of control we have described, but who feel the Rudevator is too intricate to build by hand, here is the best advice we can offer. Get in the air with a commercial radio and rudder combination alone. This will teach you 90% of the tricks to the trade. Then, if there are enough of you who want this control bad enough we'll get it to you even if we have to build them by hand.