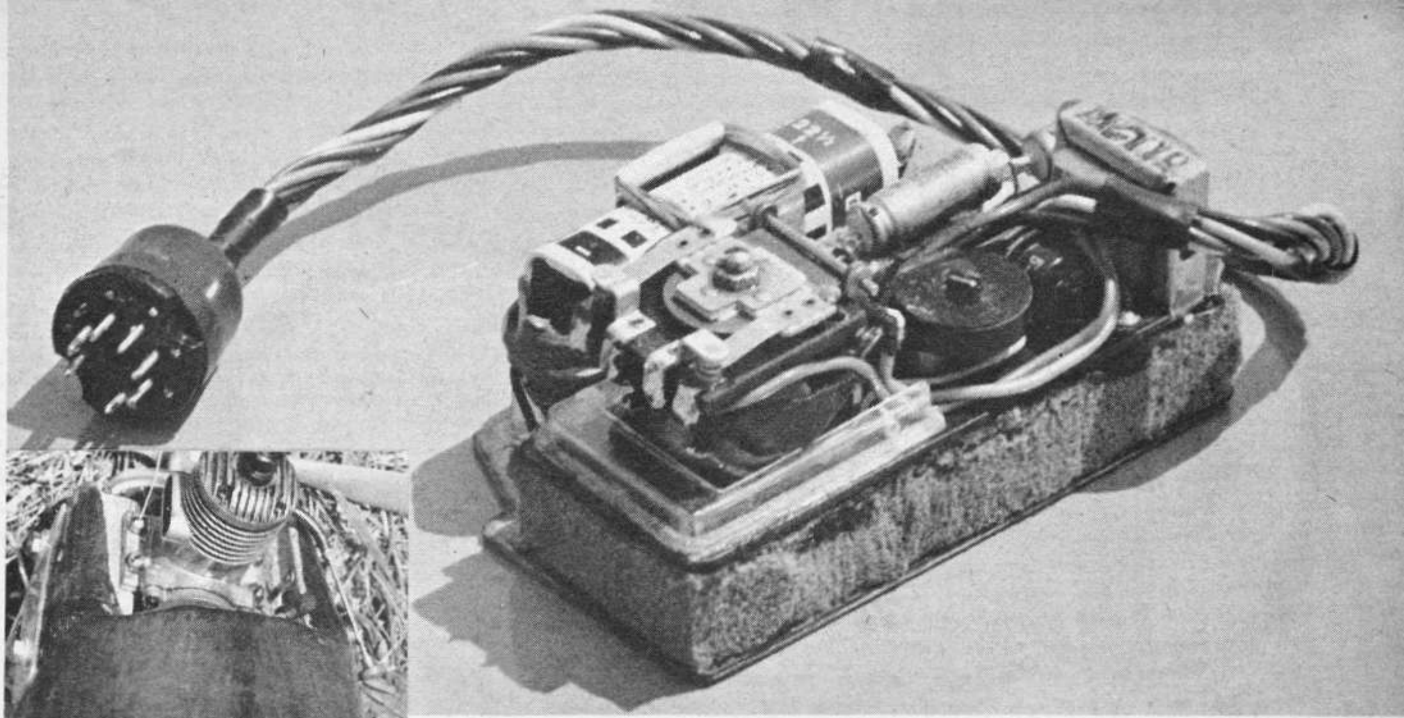
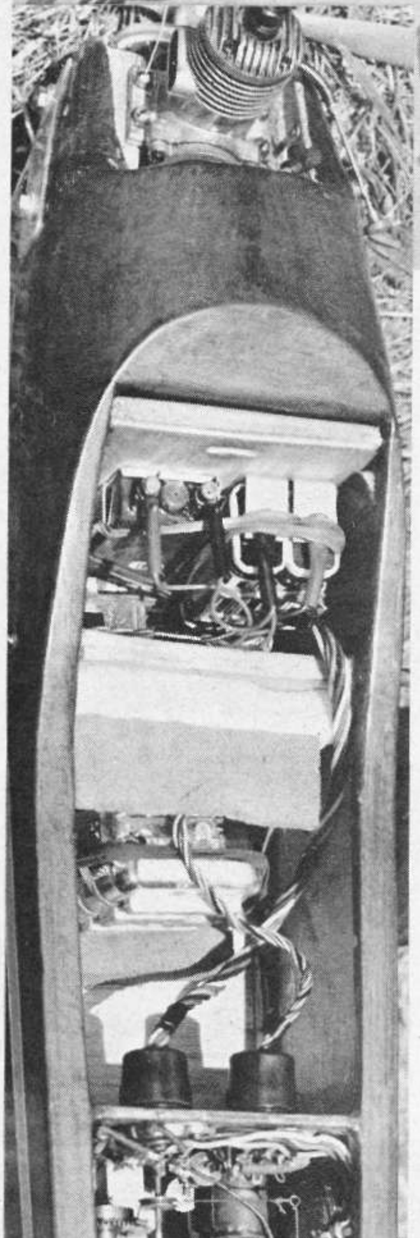




Radio Control S-D-S-P-S by McEntee

"Kickin' Duck"

■ "What — *another* simplified dual simultaneous proportional system?"

Yep, but this one has advantages very useful to model plane fliers. "Inductive kick" is not new; several arrangements have been shown in S&S magazines in the past (see reference 1, 2). It is a relatively simple way to get dual proportional control. While it can never come up to what you get with something like the WAG TTPW system, still we can *approach* such results—and most inductive kick systems can be used with conventional receivers and transmitters.

Add a pulser to your transmitter, the kick circuit in the model and you're in business—within limitations that will be covered fully. AMA R/C contest rules place inductive kick systems in the Intermediate Class. Dual simultaneous control of rudder and elevator there can get you up in the well-above-100-points scoring category if you practice.

How does the system differ from others? In the past since all took the kick from a magnetic actuator, you *had* to use such a unit to move your rudder. While an actuator will handle a rudder nicely, it doesn't do much with a steerable tail wheel. With the premium placed in contest rules on ground maneuvers, steering is almost mandatory.

Our "Kickin' Duck" system does fine with an actuator. But it works just as well with an electric motor to drive the rudder. Reason? Since the "kick" is taken from another part of the circuit, it makes little difference what sort of unit is used on the rudder.

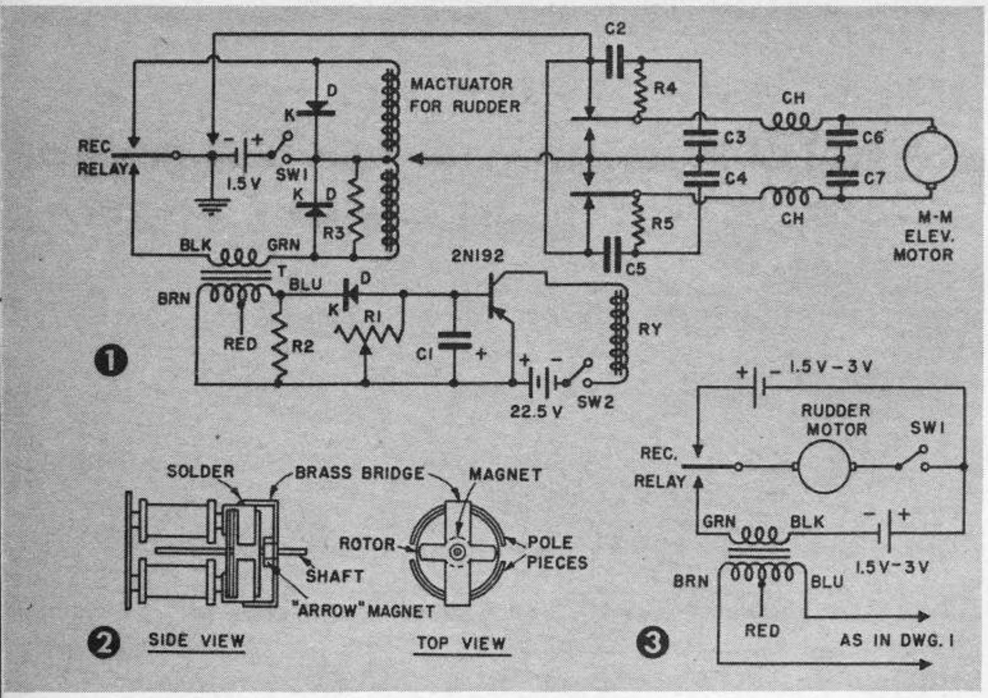
Another big advantage comes in the actual control reactions. All inductive-kick arrangements depend on pulse length and pulse rate for the two control functions of rudder and elevator; normally, slow pulse rate is used for "up" elevator. Up is used a lot, and thus the model wags its tail a great deal during flight. It has been possible to tailor parts in the circuit so that full up elevator may be had with no movement of the flippers. This, together with the fairly high pulse rate on full up, gives a very smooth flying plane.

As the stick is moved from full up toward full down, the elevator will start to flap, but at a higher and higher rate; result is the plane unable to follow the individual "flaps" simply reacts to the average elevator position. On the down side of neutral the pulse rate is rather high; at full down, the elevator is also solid without wiggle.

One reason for the system's smooth performance is the fairly high pulse rate range, about 3-12 cycles per second. The higher the pulse rate range, the smoother your plane will fly, especially in the up-elevator maneuvers. But there is a limit here; many receivers can't handle too high a pulse rate; in fact, neither can many relays. The 3-12 cps range is a compromise . . . high enough to give pretty smooth elevator action, not so high as to encourage receiver and relay failures.

Before you even start to work with *any* proportional control system which depends on pulse rate and length change, almost a necessity is a zero-center test meter as described in the past (3). An ohmmeter can be used but it's subject to rather large and

Top ply panel holds two 22½ B batts, 1 LR-1 Silvercel (latter for lo-voltage circuits & rcvr filaments). Under these is elevator control circuit panel with 22½ V batt for elevator relay. Rcvr in middle on ½" foam rubber, ½" polyfoam ahead. Mactuator at rear right for rudder, double-geared Mighty Midget for elevator.



unpredictable error. Furthermore, the ohmmeter works on only one relay contact, while the zero-center meter works on both—as does the control circuit you are testing. The zero-center unit will give you true indications of how your receiver or relays work under various pulse rates.

As to receivers that can be used with this system, most single-hard tubers are okay; so are circuits which use a second tube or transistor following a normal single-hard tuber. Some gas tube circuits will work nicely, others won't. There are so many different gas tube receivers with their detector followed by another tube or a transistor (and often with from one to four diodes coupling them), they will just have to be tested for fast pulsing. Now in use are a large number of audio tone receivers designed along the lines of the WAG (4). While most will *not* follow fast pulsing, some successful modifications have been given (5).

Since it is the present "ultimate" in dual proportional equipment, other DP systems are naturally compared to the TTPW. While it may seem that simpler systems than the latter might be easier to get going properly, such is not always the case. We set out to make Kickin' Duck perform as near the TTPW as possible; our most important goal was to get control action without any airplane tail-wagging, especially at the low pulse rates (the rudder and elevator do wiggle most of the time, of course, as in most proportional systems, but the wiggles are of such rate and amplitude that the plane cannot follow them). Tied in with this goal was another—enough control surface movement so the plane could be tossed around in most of the AMA stunt maneuvers. These goals, unfortunately, are in direct opposition! It was in effecting the necessary compromises that we encountered most of the development difficulties.

Kickin' Duck has been flying for over a year in a very heavy mid-wing plane much like Dale Root's Little Freq (6), but with 58" span and other dimensions enlarged accordingly. The plane was overweight to start with and repairs along the way haven't helped —like most multi-control planes this one has seen its share of bugs and pilot trouble! Wing-loading is now 23 oz. per square foot (ridiculous in a job with only 415 sq. in. wing area). However, powered by a Cameron "19," the plane will do nice inside loops, slow and snap rolls, upside-down flight, Split-S's and Immelmann's, frightening vertical dives and true spins.

How does Kickin' Duck work? Look at the complete circuit. To save weight the whole plane works from a single LR-1 Silvercel. This has proven very satisfactory, but separate battery supplies may be used for the various controls and receiver filaments if you desire. Average current drain on the Silvercel is about 450 ma; a single charge is good for a lot of flying.

The two windings of the Mactuator are shunted by 1N91 diodes, killing almost all the inductive kick they produce. This bars the kick from the elevator circuit and keeps the receiver relay contacts perfectly clean. The little transformer couples the rudder and elevator circuits and provides the kick for the latter. With a very low primary resistance of 0.3 ohms, it has little effect on the Mactuator winding on its side of the circuits. Kick which comes when the relay *opens* that side of the circuit, is about the same strength regardless of pulse rate or length.

Following the transformer is a "pulse-stretcher" circuit which averages out the kicks; at the slowest pulse rate (3 cps) the pulses applied to the transistor are just low enough so the elevator relay does not pull in at all, and the elevator gives solid up.

To use a single low voltage supply for the elevator it was necessary to employ a DPDT relay. On hand was a Price surplus unit of 6,500 ohms; these are no longer available, but other DPDT units such as the Gem may be utilized. A double-pole relay requires considerably heavier current to operate reliably than the more widely-used SPDT style. However, unlike tube circuits, the transistor gives practically no voltage drop—figure the relay to draw about the same current in this circuit as it would if connected directly to the battery. So the 6,500 ohm relay receives about 3 ma. It has been set to operate at 1.7 ma, open at 1.4. Transistor battery circuit must be opened when the equipment is not in use; there is a slight leakage even with no pulses coming through.

We advise using the *exact* parts specified. While they are not exactly critical, we know they work well. This is especially true of the diodes, transformer and transistor. There is quite a bit of leeway in the elevator relay, but make sure the one you choose will work reliably at the current it receives.

Some centering should be used on both rudder and elevator servos or your plane will tend to "wander" and flying will be erratic. The Mactuator has a fair amount of built-in centering, if well made, and the rudder linkage is free; however, we have added "magnetic centering" as shown in Dwg. 2. This has the virtue of giving greatest centering action near neutral where it is needed most—just the opposite of spring centering.

The elevator is operated by torque rod from a Mighty-Midget motor. Considerable work was done on the latter to free it so it would run smoothly on 1½ volts. A second set of gears was added, with a centering arrangement similar to that shown in a past R/C Column (7). The total gear ratio is about 18-1 and the linkage used gives another 2-1, so we have an overall ratio of 36-1. After much flying, we feel this could be raised to 50-1 without slowing down the elevator action too much. This higher ratio would also give more power at the elevator. Spring centering on the motor is rather weak (another concession to the 1½ volt operation); heavier centering would afford smoother flying.

The receiver in the plane is the high speed version of the Tech-Two (8); an even "faster" receiver would be preferable since our pulsing starts to go a bit sour at the top rate. This receiver is rather sensitive to electrical noise in the plane, hence the RF chokes in the M-M leads; also, a careful bonding of all moving parts of the control system has been done.

The transmitter is keyed by the Compact Pulser used exactly as shown in the original article (9). Since real care was taken to match parts of this pulser when it was made, it is free of "lopsided" pulse action and interaction between the pulse rate and length functions. Those who intend to use an electronic pulser might check directions that have been given (10) for assuring satisfactory action. A suitable mechanical pulser has also been described in the past (11).

First thing to tackle when setting up the system is the pulser itself. Hook a zero-center meter circuit across the relay contacts; make sure pulsing is even both sides of center at all pulse rates. You can count the lowest rate required for the Kickin' Duck (3 pps); get your foot tapping at this rate, then slowly increase the rate and you will pass the second and third "harmonics" —that is, the 6 and 9 pps rates, when you will be able to hear two and three pulses for each tap of your foot. If you can also reach four pulses per foot tap, you are in business. The Compact Pulser will give just this range as it was shown.

Most satisfactory way to get the elevator circuit adjusted is to hook the pulser relay direct to rudder circuit; connect it in place of the receiver relay shown in Dwg. 1. Close Sw-1 and make sure the rudder follows the pulse length correctly. With the pulser turned off, close Sw-2; a meter connected temporarily in series with the 22½ volt battery and the relay winding should show practically zero. Now start the pulser and vary R-1. You should be able to reach a point where the elevator motor (or the elevator itself, if you have the linkage connected) stays close to zero, with the stick centered. Shove the stick forward and the elevator should go to full down. Pull it back; if the elevator comes to full up without flipping, when your stick is all the way back, you've got it made. Chances are it won't, though. If it goes toward up, but still pulses with full up on the stick, you must lower the value of R-2. In our plane, this is a 120 ohm resistor, but it could very well be a small variable of about 0-200 ohms range (see parts list). Once this one is adjusted it will seldom need change, but R-1 must be variable since occasional readjustment may be needed.

As with all transistor circuits, this one changes a bit when it gets hot; what happens is that the transistor draws a small current (perhaps 0.5 ma or so) with no pulsing. R-1 and R-2 should be set when the plane has been resting in a hot place—like in the trunk of your car under the summer sun. When it is cooled off, you will still have full control, but the control stick range of movement will be a little less, to go from full up to full down. All specified transistors tested drew barely perceptible current on an 0-5 ma meter in the relay coil circuit with no pulsing. If yours draws more than 0.2 ma, get another.

Final test is with the receiver and transmitter in the circuit and the whole works operating as in the field. You don't have to go this far, though, to find out if the receiver is suitable for high pulse rates; just connect the zero-center meter to its relay and watch how it follows as the pulser at the transmitter is varied.

As mentioned at the start, most inductive kick circuits won't work with a motor on the elevator . . . but this one will. Motor should be connected as in Dwg. 3. Two batteries are needed unless you use a DPDT relay in the receiver. We found this circuit to work just as well as that using the Mactuator. Hook it up exactly as shown, following the battery polarities and transformer connections carefully. Resistance-capacity arc suppression shown is normally used on such motor circuits. However, diodes can be used with good results (12). This circuit was tried with various motors, and with 1.5 and 3 volts; R-1 and R-2 must be adjusted to match the voltage and motor.

Old proportional users might wonder why we show R-3 in Dwg. 1. After the plane had been flown quite a while and we adjusted for more and more elevator action, we noticed a slight irregularity in elevator action near the mid-stick position. Hunting down this bug with an oscilloscope showed a very faint "spike" of the inductive kick from the Mactuator sneaking past the two diodes and into the elevator circuit. R-3, about the same value as the actuator winding, is needed only on the one coil shown. It about doubles the current drain on that side, but works so well that this current waste is worthwhile.

No engine control has been fitted to the plane carrying the Kickin' Duck system—a look at that wing loading will show why! Actually, several ways to operate engine control have been shown (2) (13), any of which would do the job nicely. Of course, a duplicate of the K-D could be placed in the other actuator (or motor) leg of the rudder circuit, and adjusted to close a relay for motor control when pulsing was stopped momentarily. The same relay could have the battery circuits for the rudder and elevator run through its contacts, so that when the motor control button was pushed (to cut all pulsing) rudder and elevator would go to neutral—a valuable fail-safe provision.

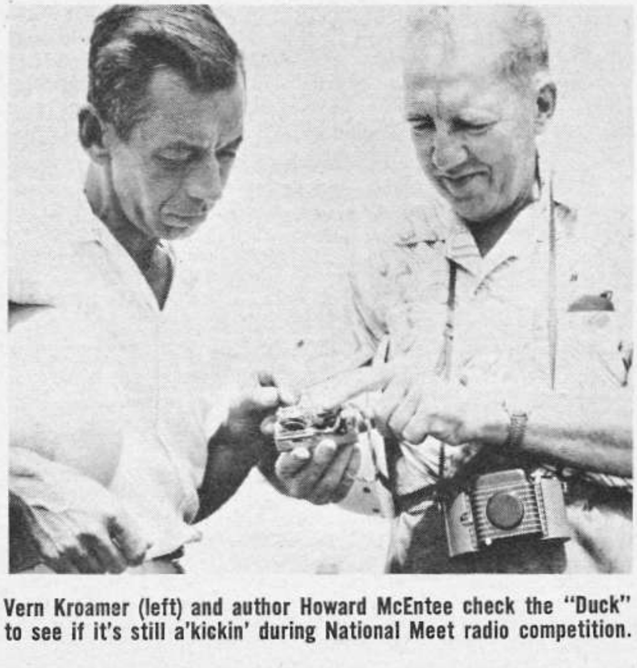
One last word. Our entire elevator circuit, including the 22.5 volt battery and its holder is attached to a small chassis which weighs about 5 oz (the Price relay and a plastic dust cover for it account for 1.75 oz and the chassis has 0.5 inch thick foam rubber shock mounting). Battery has been found to last a long time, much longer than those used for the receiver. A change of two or three volts does not bother the system too much; it will make it necessary to hold the stick somewhat off center to get neutral elevator, but you can still get almost full up and down. Same is true with respect to a drop in the low voltage battery.

Why not try this system? When you get used to it you will be able to give the other Intermediate and Mickey Mouse boys a hard time—and you can push a lot of the Multi boys pretty hard too!

To keep up with the latest in radio control model developments, read Howard McEntee's informative "Everything Under Control" column in each monthly issue of "American Modeler" magazine. "Mac" covers all phases of R/C including model planes, boats and cars, special circuits,

References: 1) ATH April 55 p. 52; 2) YM Oct 56 p. 33 also Nov 56 p. 33; 3) YM June 56 p. 54; 4) ATH May 54 p. 90; 5) AM May 57 p. 31; 6) AT Model Annual 1954 p. 34; 7) YM Nov 56 p. 52; 8) AM Jan 58 p. 20; 9) ATH Oct 55 p. 36; 10) AM Dec 56 p. 48; 11) YM July 56 p. 52; 12) AM July 57 p. 27; 13) AM Aug 57 p. 36 also AM July 57 p. 26.

Parts List: D, 1N91 diodes; T, Argonne AR-119 (Lafayette Radio); RY sensitive relay, SPDT or DPDT, see text; Sw-1 and Sw-2, DPST on-off switch; R-1, sub-min variable resistor, 5,000 ohms, Lafayette VC-27; R-2, see text, may be Clarostat type 39-200 (Lafayette); R-3, value according to actuator winding, 0.5 W carbon resistor; R-4 and R-5, 0.5 W carbon, 10 ohms; C1, 200 mf electrolytic, 3 volt, Sprague TE-1064 (Lafayette); C2-C7 .01 mf ceramic; CH, RF chokes to suppress elevator motor noise in receiver, value according to rec. frequency.



Vern Kroamer (left) and author Howard McEntee check the "Duck" to see if it's still a'kickin' during National Meet radio competition.

Mrs. McEntee holds the shoulder wing plane in which Howard checked out the simplified dual simultaneous proportional system