

Al Doig's remarkable "ULTI" MULTI radio control system

■ In the May issue of American Modeler, a single channel proportional system was described. The principles used in the single channel version are directly applicable to multi-channel use. For prototype field trials a three channel simultaneous receiver was installed in Howard Bonner's old Smog Hog plane. Rudder, elevator, and motor were controlled for a start. It was decided to leave aileron control until more flying experience was gained. Several flights were made with the old maestro Bonner on the stick.

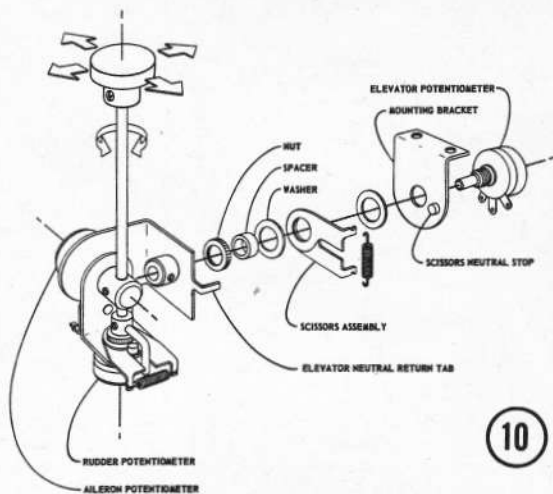
The first thing found lacking was the absence of a positive neutral. Spring loading of the control stick seemed inadequate because it was difficult to apply one control without getting a little of the other. The result of this experience was a very nice stick control designed by Bonner. The design allows a very positive neutral and gives a good "feel" to the control.

Two errors on the part of the writer eventually caused the demise of the Smog Hog. First, the transistors were assembled in the prototype receiver using sockets for ease of experimentation. And second, the plane was sent off on its last flight with a bit of right trim in the neutral position. Midway

in the flight, a transistor fell out of the socket and the servo returned to neutral.

With the right trim . . . "the flying field" to quote Bonner, "tilted up and I ran right into the side of it." As the Hog was somewhat "bent," no attempt was made to fix it. The receiver survived the crash without damage and went on to further tests. The extent of these tests, however, has not been as great as those made with the single channel receiver.

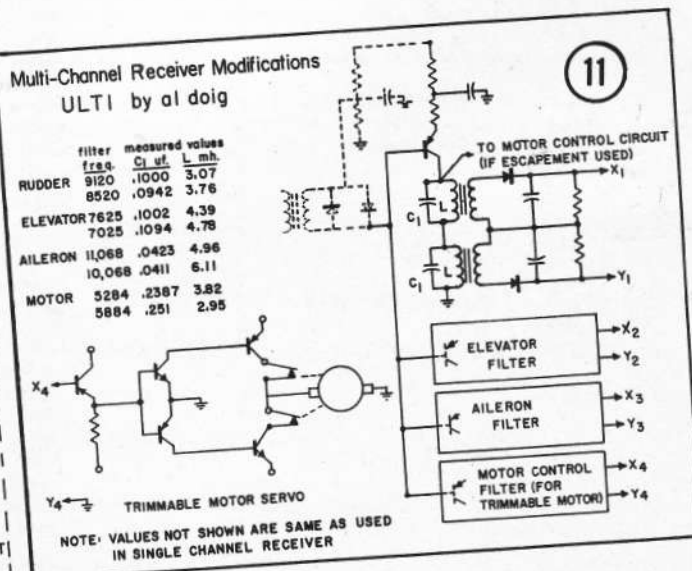
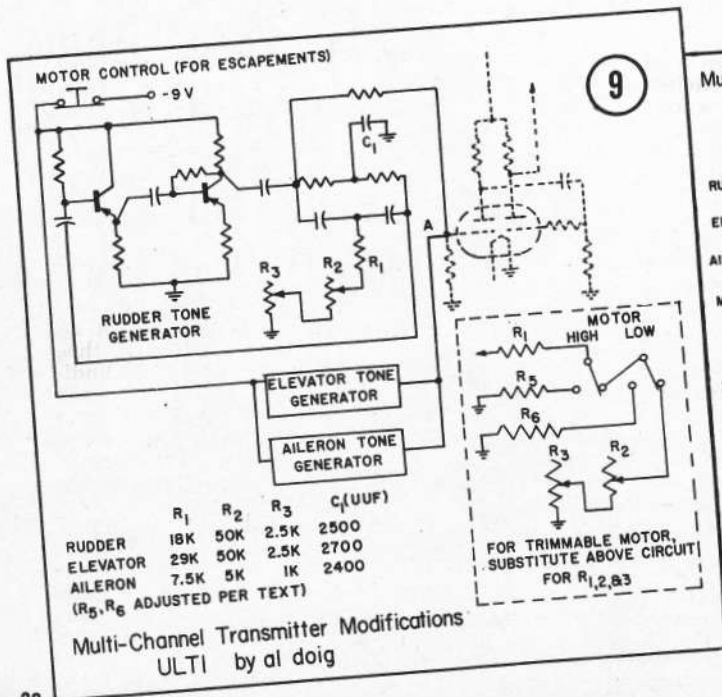
The only difference in the multi-channel as opposed to the single-channel receiver is that there is more of it. A comparison of fig. 9 with fig. 2 on pg. 24 of the May issue shows the additions necessary to convert the single-channel transmitter to multi. Additional tone generators, which are identical—except for certain circuit constants—to the single-channel units, are added. The additions are tied to point A of the mixer-amplifier stage as shown in fig. 9. The stick control used to control rudder, elevator, and aileron is shown in breakdown form in fig. 10. One control is shown in an exploded view. The mounting bracket shown is the only piece mounting directly on the transmitter case.



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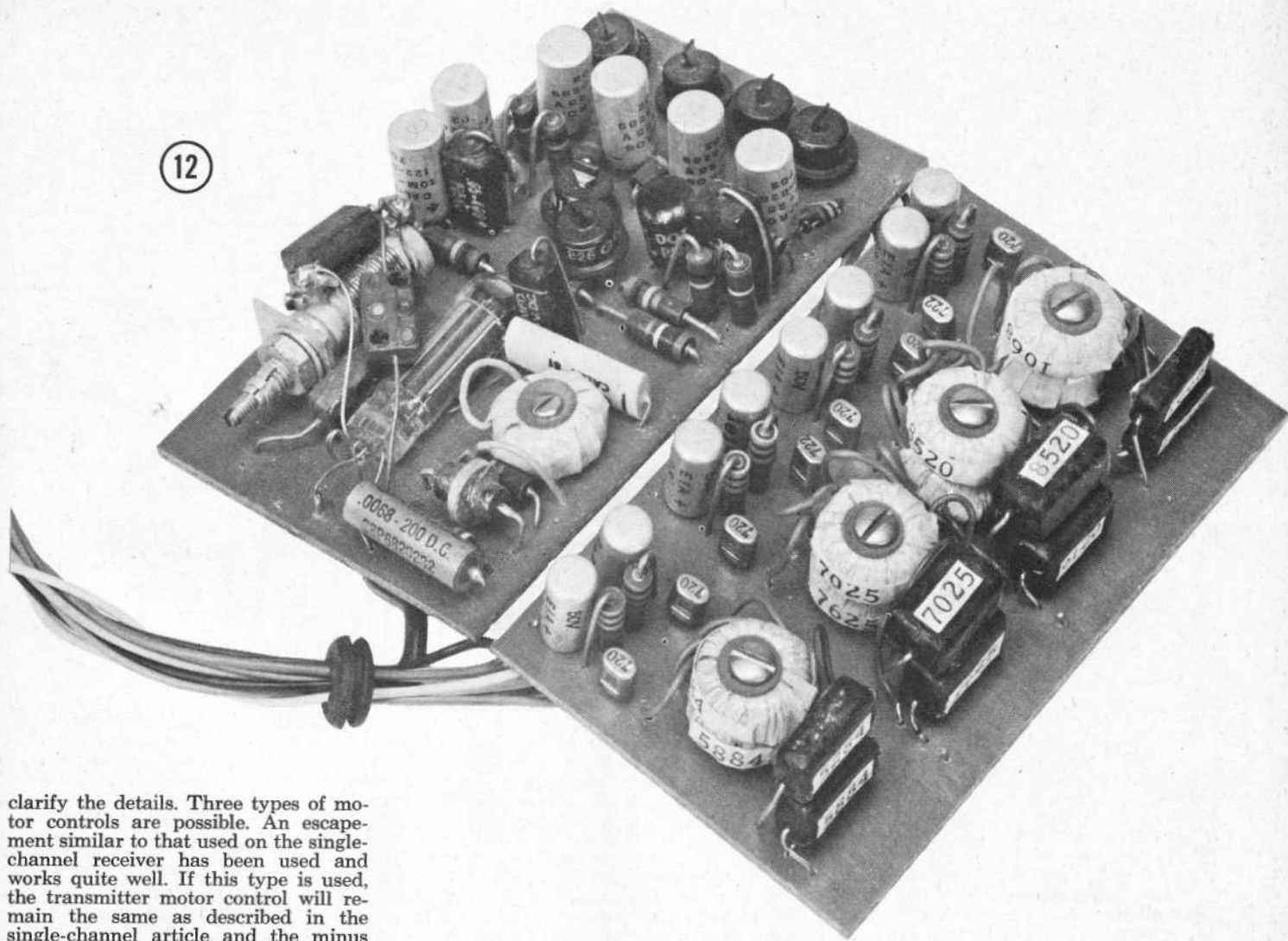
As shown in fig. 10, the potentiometer assemblies solidly to the mounting bracket. Two washers, a spacer, and a nut hold the "pot" tightly yet allowing the scissors to rotate easily. The scissors assembly is held normally closed by a spring. It is held in position by the scissors neutral stop. The elevator pot shaft is screwed solidly to the aileron pot bracket, so that rotation of this bracket will cause rotation of the elevator pot shaft. A neutral return tab on the aileron bracket fits snugly into the scissors slot. The scissors assembly will then provide a spring return and positive neutral to the elevator pot. The same type of assembly is provided for the aileron pot. A side movement of the stick assembly will only move the aileron pot. Similar treatment is given the rudder pot except that the stick shaft is free to rotate through the aileron shaft bushing.

Rotation of the control stick rotates the rudder pot. Neutral return is provided in the same manner as on the other controls. The three degrees of freedom given the stick make the operation confusing and somewhat difficult to describe and a little thought and study of fig. 10 is necessary to



These circuit drawings should be studied along with those appearing in May issue of AM. Three-function control stick (top); triple-simul receiver, upper right.

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clarify the details. Three types of motor controls are possible. An escapement similar to that used on the single-channel receiver has been used and works quite well. If this type is used, the transmitter motor control will remain the same as described in the single-channel article and the minus 9 volts to all tone generators is interrupted to provide motor control.

A fourth simultaneous tone channel could probably be transmitted to provide proportional motor control. This has not been tried and is not advised. It actually would have little advantage over a trimmable motor control. To control a trimmable motor control it is proposed that the aileron audio tone be changed from its normal neutral tone to one of two lower-frequency tones by means of the motor control buttons shown in fig. 9. This system would assure that three tones are always being sent, providing a more uniform modulation level. Upon loss of its tone, the aileron would return to neutral.

TRANSMITTER ADJUSTMENTS of the multi-channel unit are exactly the same as for the single-channel unit. The tones used are as follows: Rudder, 9120 to 8520 cps; Elevator, 7625 to 7025 cps; Aileron, 11,068 to 10,068 cps; High speed motor, 5884; Low speed motor, 5284. Again these frequencies are by no means sacred and like Topsy, just grew. It is noticed that the low speed motor frequency is one-half the aileron neutral frequency. This was chosen for bandwidth considerations and is adjusted so that when the low-speed motor button is depressed, no aileron movement occurs.

RECEIVER MODIFICATIONS. Shown in fig. 11 are the modifications necessary for triple simultaneous operation of the single-channel receiver

described in fig. 1 of the May issue. As can be seen, the only change is one of addition. Fig. 12 is a photograph of the completed receiver. This receiver was constructed on two etched boards. Everything except the toroid filters, discriminators, and servo amplifiers was put on the top board. The servo amplifiers were again mounted in the servo boxes, leaving the toroids and the discriminators for the back receiver board. The two receiver boards were assembled back-to-back. The assembled receiver will fit in an Orbit or CG 8 channel receiver box with room to spare.

RECEIVER ADJUSTMENTS. The batteries used are exactly as described for the single-channel unit. The servos are connected one at a time and all adjustments made as previously described. One difference is noticed. With the three simultaneous tones being transmitted, the servos will constantly "dither" a small amount due to the modulation products. This agitation is not enough to move the control surfaces and actually helps the servo action by decreasing break-away friction of the motor. However, it is annoying because it increased the no-signal drain on the servo batteries from 5 milliamperes (for the signal-channel receiver) to about 50 milliamperes per servo for the multi-channel unit. This aspect is being investigated but time has not permitted a solution.

CURRENT WORK. Several versions of the ULTI system are being flown around the country. The writer is getting ready to install a triple simultaneous with escapement motor control in an Astro Hog. California has long been a holdout against proportional control. Many California flyers have been flying "nervous proportion" (beeping) for some time. This shows up poorly only on elevator control. To this end, a standard 8 channel reed receiver is being experimentally fitted with one proportional channel for elevator and seems to hold good chance for success with easy modification.

There is some objection to the multi-function control stick. In a panic situation it takes a cool head to give corrective control without pulling in an unwanted control. To correct this, some thought is being given to individual proportional controls for each channel. This would be flown in a manner similar to the current 8 channel reed transmitters with proportional stick controls replacing the switch handles.

As was originally stated, this proportional program is in a development stage. It is strictly experimental at the moment but maybe with more hands doing the work, correcting the mistakes, simplifying the design, and contributing new ideas, we will soon have the ultimate in multi.