AUTO-PULSER

Simple add-on unit for single channel fliers who would rather fly than count.

BY DUANE HARTMAN

TECHNICAL EDITOR'S NOTE:

The RCM technical staff has tested the "auto-pulser" and recommended it for the single channel flyer who would rather fly than count. The unit tested was set up for an SH-100 — OS-104 servo and performed perfectly with a Kraft Superhet Relay receiver and Sankyo 3PN servo. The auto-pulser is capable of flawless performance if built and adjusted correctly as per the article.

The waveforms shown below were taken from the unit tested.

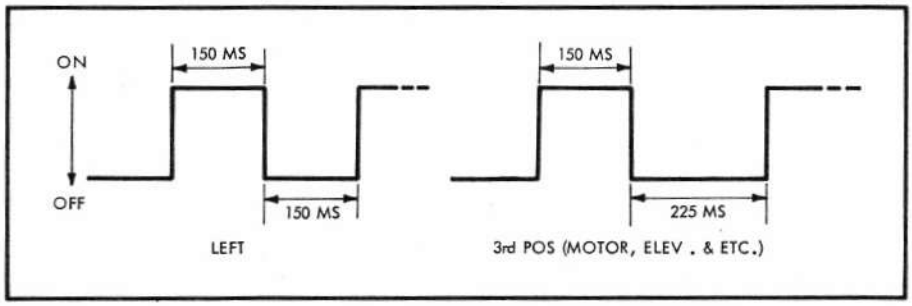
R3 and R7 could be replaced with 150K trim-type variable resistors in series with a 4.7K fixed resistor to simplify adjustment and permit later, simple changes to other receiver servo combinations.

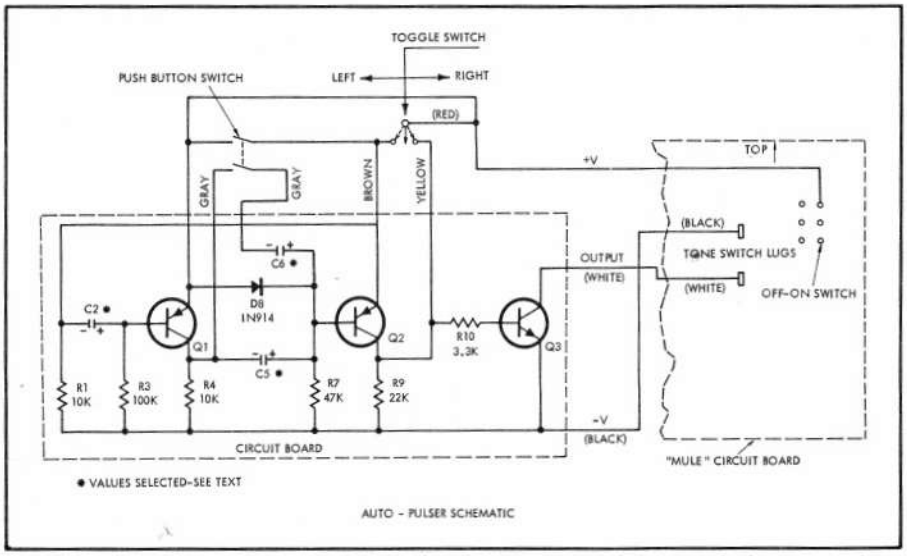
THE "Auto-Pulser" circuit was developed specifically to help the single channel flyer become adapted to the use of a stick, rather than a pushbutton, as would be encountered in the transition to some form of multi-channel control. Actually it doesn't seem that such a transition would be difficult, but in times of emergency a stick is totally unfamiliar and foreign to a "button-pusher" pilot. The circuit to be described gives the flyer practice in using a stick before he risks his new multi-channel plane. Upon pushing the stick (in this case, a toggle switch) to the right, the plane will turn to the right, and likewise, for left. The plane will continue to turn until the switch is released. Obviously, since this modification requires only very simple circuits, the controls remain as before; that is, there is no proportional control involved as the use of the term "stick" may imply. Several of the author's "dyed in the wool" single channel buddies have requested the circuit just for the advantages of having a single "stick" control. There is a certain amount of prestige and personal satisfaction in having a "stick" control on a simple single channel control system. The addition of a push-button and an additional capacitor permits the automatic selection of the third position (motor control) of a compound escapement or servo.

The original circuit was designed to be compatible with a Kraft relayless super-regen receiver, an O.S. compound escapement, and a Mark II Mule transmitter. A second circuit was designed to be used with a Controlaire SH-100 super-het, an O.S.-104 compound servo, and the Mule transmitter. Actually the circuit can be adjusted to be used with any escapement or servo of the self-neutralizing one pulse-right, two pulse-left (three pulse-auxiliary) type. Adaption to other transmitters is possible but may require certain circuit modifications to insure compatibility. This circuit automatically keys the tone twice when the "left" control circuit is energized. For the third position, the circuit again produces 2 pulses, but the duration and timing of the pulses is changed to select the third position. The circuit mounts in the Mule case and uses the standard Mule battery for power. Standby current drain (with only the carrier on) is about one milliampere, increasing to about 5 milliamperes when the tone is being transmitted, so battery life for all practical purposes is unchanged. A toggle switch mounts on the front panel of the Mule case, in the upper right corner. This switch is spring-loaded in the neutral position, and closes separate circuits when it is pushed either to the right or left. The auxiliary control push-button is mounted in the upper left corner of the case.

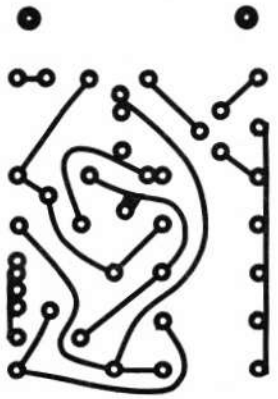
CONSTRUCTION

A full size layout for the printed circuit is shown. Note that this is a bottom, foil-side view. As an option, 16 small 1/16 diameter eyelets are used in the holes where connection wires are soldered (to prevent strain on the foil) and where the capacitors are mounted (to prevent foil





AUTO - PULSER SCHEMATIC



FULL SIZE PC BOARD

lift-off when the capacitors are repeatedly changed during the adjustment phase). Readers not desiring to make a printed circuit, may put eyelets in all the holes, and connect the specific eyelets with short pieces of buss wire insulated with sleeving. All external connecting wires should be about 5 to 6 inches in length. Follow the color code carefully, because these wires will be called out later when installing the board in the transmitter. Mount all components, except the capacitors, as shown in the sketch. Note that this sketch is a top view; the foil is not visible. Be careful to mount the diode in the proper manner. Also observe the transistor mounting tabs and the offset on the other transistor. Transistor and diode leads should be such that the component is positioned about 1/8" to 3/16" above the circuit board to prevent damage when soldering the leads. A small angle bracket is used to support the circuit board in the transmitter case.

INSTALLATION

The toggle switch (and the push-button if this portion of the circuit is to be installed) are mounted to the front of the Mule case. The circuit board bracket is mounted to the top of the transmitter case using 4-40 hardware. The circuit board should be positioned well towards the back cover to insure no interference with the antenna. Also be sure to leave side clearance so the back cover will fit properly. Now look at the circuit board of the "Mule" closely, holding the transmitter upright. Note the six eyelets corresponding to the lugs of the "ON-OFF" switch. Solder the buss wire from the circuit board to the top right eyelet. Form a cable of a brown, yellow, and red wire and route over to the toggle switch. Solder the red wire to the common terminal of the switch. Solder the yellow wire to the terminal of the switch that is connected to the common terminal when the switch is pushed to the right (as viewed from the front of the transmitter). Solder the brown wire to the remaining terminal (the LEFT position). Form another cable consisting of the two gray wires, a brown wire, and a red wire. Solder the gray wires to one set of contacts on the push-button, and the brown and red pair to the other set of contacts. Be sure both sets are the contacts that "close" when the button is pressed. That is, when the switch is depressed, the red wire will be connected to the brown wire, and the gray wires will be connected together. Twist together the black and white wires from the circuit board. Note the two protruding lugs from the tone switch on the Mule board. Solder the black wire to the UPPER lug, and the white wire to the LOWER lug. Installation is now complete.

ADJUSTMENT AND CHECKOUT

Proper operation of the circuit is dependent upon the make and type of receiver, escapement, and servo. Servos will give more reliable operation, since the operating characteristics are not dependent upon the number of turns remaining in the rubber. However, if the number of turns in the escapement is kept reasonably constant from flight to flight (as it generally is), no trouble will be experienced.

Adjustment is very simple, consisting of selecting the proper values for the capacitors. The author's original values are found on the parts listing, and will

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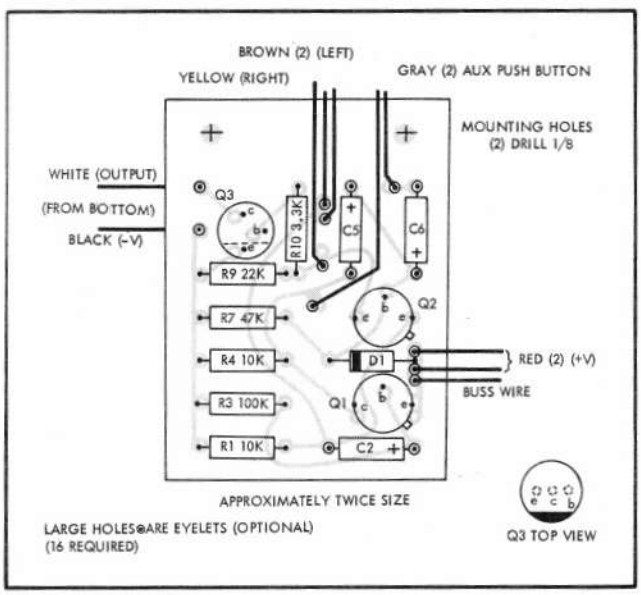

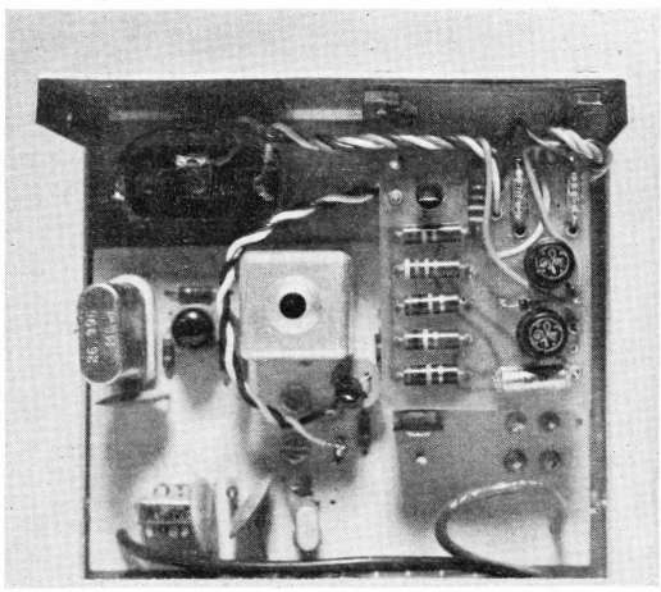

AUTO-PULSER

(Continued from Page 31)

make a good "ball-park" starting value. To properly select C2, temporarily tack solder a capacitor of about 5 to 10 mfd. in the location of C5. Note the polarity markings. Energize the transmitter, receiver, and servo or escapement. The servo or escapement should be mounted in the plane and connected to the rudder. Now actuate the toggle switch by

pushing it to the left. The rudder should move to the RIGHT, pause a very short time, and then either move to the left, 3rd position, or go to neutral. At this time we are interested only in the slight pause in the right position. Select various values of C2 until one is found that gives a barely detectable pause in the right position, each time the switch is energized. Allow about 1 second between switch activations. When this value is found, multiply it by about .75 or .8 to get the correct value for C2. The next adjustment will insure that the rudder stops in the left position. Remove the temporary C5 capacitor added earlier. While operating the switch to the left, select the minimum value of capacitance for C5 that results in correct operation. Then select the minimum value that works correctly. The proper value is right between the maximum and the minimum values. If C5 is too large, the rudder will skip the left position and stop at the 3rd position, or neutralize. If C5 is too small, the rudder will remain in the "right" position. There is no adjustment required for the right position since no timing circuits are required. Similarly, actuate the push-button, and select a value for the remaining capacitor, C6, that causes the servo or escapement to stop in the third or auxiliary control position. Obviously, if the third control is not desired, C6, and the push-button may be deleted.

THEORY OF OPERATION

This section is for those people who must know how and why things work. Therefore if you are the type who doesn't really care why things work, just skip this section, and come back later if you are interested.

When the transmitter is turned on, the circuit receives power via the wire from the "Mule" on-off switch. Transistor Q1 will be conducting since it is forward biased by R3. C2 charges to -V on the left side through R1 and almost to +V on the right side through the base emitter junction of Q1. Both Q2 and Q3 are non-conducting because the emitter of Q2 is not connected to the battery and Q3 is not forward biased. If the toggle switch is placed in the "RIGHT" position, +V volts will be applied to R10, causing Q3 to saturate (that is, conduct heavily), thus paralleling the tone switch of the "Mule" with a short circuit causing a tone to be transmitted, just as if the tone key had been depressed.

The operation for "LEFT" is more complex. When the toggle is placed in the "LEFT" position, +V volts is applied to R1/C2 junction and to the emitter of Q2. Since the base of Q2 is more negative than its emitter (because #8 is a silicon diode with a drop of about

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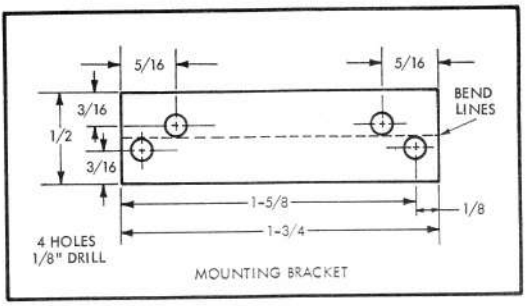

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0.6 volts, and Q2 is a germanium transistor with a turn-on voltage of about 0.25 volts), Q2 will turn on immediately, again applying positive voltage to Q3 and again causing it to saturate, and so again a tone is produced. But as the R1/C2 junction was driven to +V volts, the other end of C2, already charged to +V volts, will discharge and transfer a positive pulse to the base of Q1 causing Q1 to cutoff (stop conducting). Therefore the negative end of C5 will charge to -V volts with respect to the + end which is held + by Q2's forward biased base emitter junction. After an interval of time (determined by the time constant of C2/R3), C2 will charge sufficiently so that Q1 is turned back on. Its collector voltage rises rapidly towards +V and discharges C5. This transfers a positive pulse to Q2's base cutting off Q2, which also cuts off Q3, causing the transmitted tone to cease. After another interval of time (depending on the time constant of C5/R7), C5 will charge sufficiently (to forward voltage drop of D8) so that Q2 and Q3 will be turned on, again transmitting a tone. Thusly, the circuit has generated a BEEP-BEEP . . . EEP which will cause the escapement or servo to stop at the "LEFT" position. The escapement will stay in this position as long as the toggle switch is activated, but will immediately neutralize when the toggle switch is returned to its normal center-off position.

Activation of the push button to obtain the third or "motor" position of a compound escapement or servo accomplishes two things. It causes the "LEFT" sequence to begin, but increases the C5/R7 time constant by adding C6 in parallel with C5. The servo or escapement will then bypass the "LEFT" position and stop at the "third" position.

COMPONENTS

In general, components are not critical. Refer to the parts listing for specific recommendations. Practically any small signal PNP, germanium transistors can be used for Q1 and Q2. Q3 MUST be a silicon for best results. The diode D8 must be a silicon diode. All resistors may be either ½ or ¼ watt, and 10% tolerance is sufficient.

CAUTION

Care must be exercised when using this modified transmitter so that the palm of your hand does not accidentally depress the original tone push button on the transmitter, as this would inhibit proper operation. The author fabricated a small clip that locks the pushbutton in the off position, but the clip can easily be removed any time original "mule" operation is desired.

The recycle time of this circuit is approximately ½ second so commands should not be given closer than this or the servo will become confused.

BEST OF LUCK, AND MANY HAPPY RETURNS.

(No fly-aways, that is.)

PARTS LIST

R1, R4	Resistor, 10K ohms, 10%, ½ watt	.20
R3	Resistor, 100K ohms, 10%, ½ watt	.10
R9	Resistor, 47K ohms, 10%, ½ watt	.10
R7	Resistor, 22K ohms, 10%, ½ watt	.10
R10	Resistor, 3.3K ohms, 10%, ½ watt	.10
D8	Diode, Silicon, Type 1N914	.45*
C2, C5, C6	Capacitor, tantalum, KEMET C series (3 @ .65) (selected values — see note)	1.95*
Q1, Q2	Transistor, germanium, PNP, Type 2N404	.84*
Q3	Transistor, silicon, NPN, Type 2N2924	.53*
	Toggle Switch, Cutler-Hammer Type 8812K14, Type III contact arrangement, SPST, mom on-off-mom on	1.84*
	Pushbutton Switch, ALCOSWITCH Type 205 R, DPDT, Momentary Push Button	2.85*
	Total	$9.06

Misc. Wire, PC Board, Eyelets, 4-40 Hardware

*Available from Allied Radio, Chicago, Illinois — See 1967 Catalog.

CAPACITOR SELECTION "BALL PARK VALUES"

Kraft Receiver (Relayless) O.S. Compound Escapement		Controlaire SH-100 (Relay) O.S. Servo, Type #104	
C2	1 mfd.	C2	1.8 mfd.
C5	4.7 mfd.	C5	4.7 mfd.
C6	1 mfd.	C6	3.3 mfd.