CURRENT SAVER FOR PULSE PROPORTIONAL SERVOS

Radio control experimenter offers modified switcher circuit for less drain with triangular waves!

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If you catch a pulse proportional man in a weak moment he might admit that the current drain to his servos is much too high, especially in the neutral position. It is hoped that this report will help him to conquer this problem by providing an idea for cutting the servo current drain in half without affecting the servo torque. This scheme also gives a faster servo response.

The current saver idea is intended for those pulse systems which use spring centered servos like Bellamatics and Mighty Midgets. The description will cover the application to the Dee Bee 21 Quadruplex system.

Fig. 1 shows the Dee Bee tone detector, servo switcher and wave forms for several pulse ratios. In the standard system the wave forms at the detector (A), the switcher input (B), and the motor current (C) will all be square waves. The current used by the servo in Fig. 1.2(C) for 50/50 ratio is called 100% because it is always full plus or full minus. The same 100% is true for the 30/70 case and the 10/90 case in Fig. 1.3(C) and 1.4(C).

Now look at Fig. 2.1 which shows the modified switcher circuit. Note that two silicon diodes (D_1 and D_2) and a 30 MFD capacitor have been added and the germanium diode, D_o, has been removed. The wave forms have now taken on a different form because the square wave at Fig. 2.2(A) has been converted to a triangular wave at (B) and to a narrowed square wave at (C). These narrowed square waves show the saving in power since they exist in Fig. 2.2(C) for only half as much time as the current waves of Fig. 1.2(C). Therefore, the servo current drain in the modified circuit is only 50% of the standard one. If we compare Fig. 2.3(C) with Fig. 1.3(C) for the 30/70 case, we find the servo current is 60% instead of 100%, while in Fig. 2.4(C) and Fig. 1.4(C) it is 80% instead of 100%. Thus we find that the current saver scheme cuts the servo current to one-half around the center stick position and increases toward 100% at the ends. However, since most flying is done near the center positions, the current saving should approach the one-half value which means the battery life will be twice as long or the battery size can be cut in half.

It should be noted that ample dither current is still present and causes enough small wiggle motion to overcome the friction inherent in all servos and linkages. The diodes, D_1 and D_2 in Fig. 2.1, are of the high conductance silicon type. I used 1N482 which provide a very solid *(See pg. 110)*

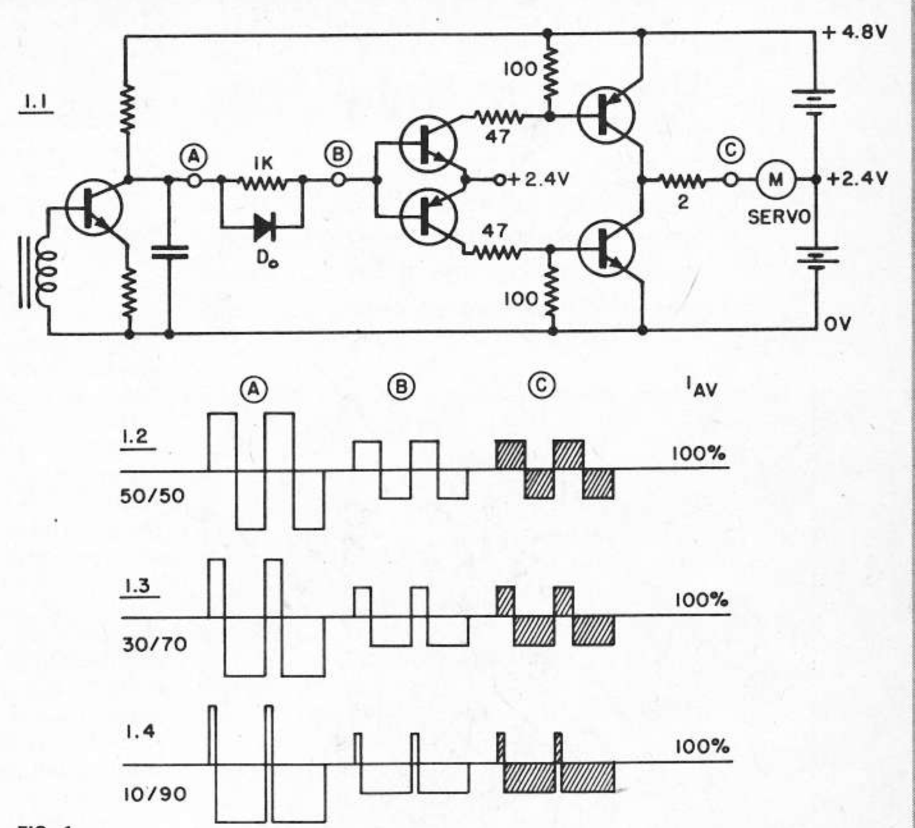

FIG. 1

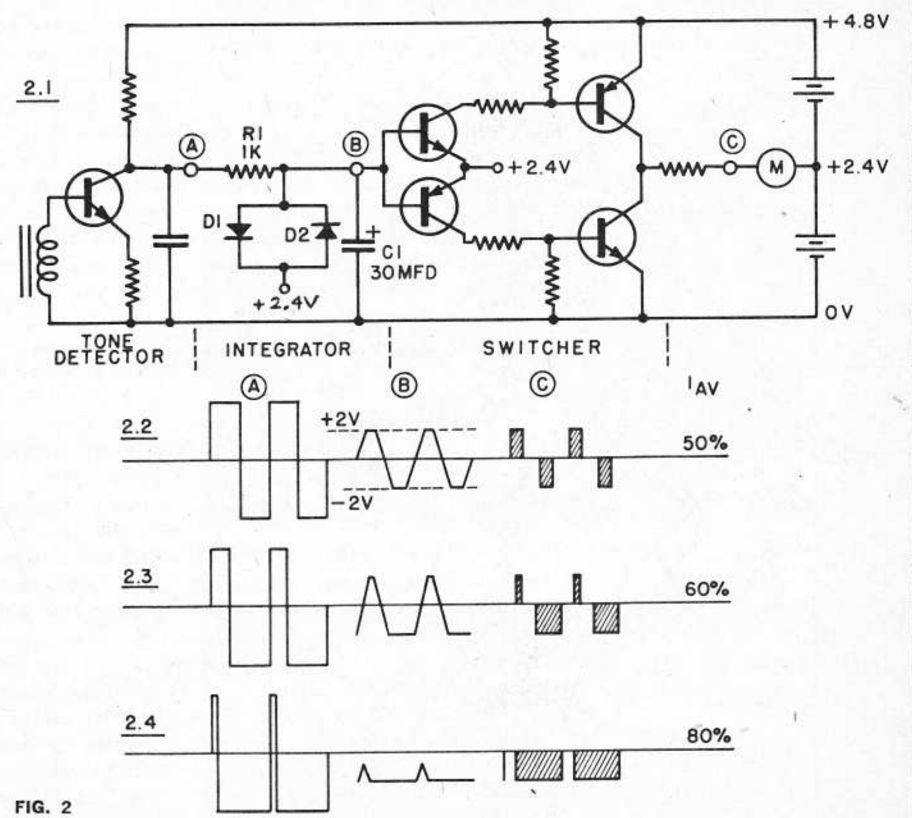

FIG. 2

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plus-or-minus 0.6 V limit to the square wave form (A). This forces the wave to be very symmetrical around the plus 2.4 reference. If this is not done, unwanted zero position shifts will result. The R_1C_1 combination acts as an integrator and determines the steepness of the triangles which in turn determines the narrowness of the servo current wave. The values of 1000 ohms and 30 MFD gave the indicated waves when using 8 cps pulse rate. A lower pulse rate will require a larger C_1 to give the same current saving effect.

Fortunately the germanium input transistors in the switcher provide a deadband of plus or minus .2 V. While the triangle wave is within the deadband, the servo current is zero. When the triangle wave tries to exceed the deadband, the switch quickly sends the servo current to its maximum value. The net effect is equivalent to a relay which has a rest position halfway between the two contacts. This type of switching is sometimes called "tristable switching" since the current has three positions: plus, minus and zero. The standard switching would be called "bistable switching" because it has two positions: plus and minus.

The torque to the servo has not been altered by the current saver because the torque depends on the *difference* between the plus and minus waves. The bench measurements showed only a minor change in servo position vs. stick position for the 50%

current saver case. Of course in the extreme case with C_1-equaling 100 MFD, it is possible to bring the 50/50 servo current to zero! But then the servo linearity is distorted with a small deadband at the center and larger than normal servo deflections at intermediate stick positions. However, there might be a number of RC applications where this nonlinearity would be acceptable when accompanied by zero servo current at neutral; perhaps in a glider or a duration model.

The response time of the spring centered servo is faster with the current wave form of Fig. 2.2(C) than with Fig. 1.2(C) because the motor is subjected to less damping. This is observed by manually pushing the servo to the stop while pulsing 50/50, and releasing it to watch the speed of return to center position. With the full wave of Fig. 1.2(C), the servo returns in a heavily damped manner, while in Fig. 2.2(C) the servo returns rapidly with a small overshoot. The reason for this is because the transistor drivers act like a short circuit to the motor during the coast period. In Fig. 1.2(C) the motor is shorted during the whole period, while in Fig. 2.2(C) the motor is shorted for only half the period. Of course in the 100 MFD case, there would be no shorting effect at 50/50 and the motor would have a large overshoot.

It should be cautioned that this current saver scheme has been worked out only on the bench thus far. It has not been test-flown at the time of this writing. However, the concept appears to be sound and it is hoped that many pulse experimenters will find it applicable to their systems.

Maybe one can soon say, "Don't use old fashion square waves. Use the new triangular waves and fly longer"!