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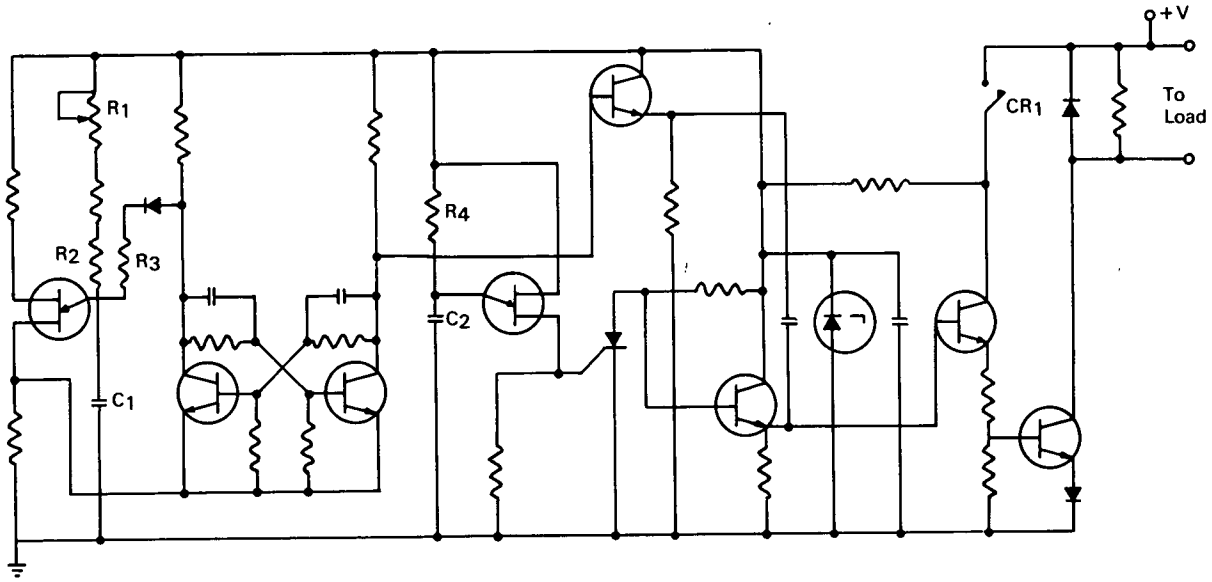
NASA TECH BRIEF

Circuit Exhibits Power Efficiency Greater Than 75 Percent



The problem:

To design a circuit having high power efficiency when operating solenoid valves.

The solution:

Use a variable duty cycle pulser, to provide a low-level holding current once a high-level current has actuated the solenoid valves.

How it's done:

Initial energizing current is provided by the "one shot" pulser that causes full power to flow to the solenoid valves for a length of time sufficient for maximum pull-in. To obtain the solenoid valve holding current, a variable duty cycle pulser turns the power switch on and off. By adjusting the pulse duration and frequency, any desired value of effective solenoid valve holding current can be set and maintained. Diode CR_1 serves a dual purpose: it suppresses the induced voltage surge when the solenoid valves are deenergized, and it circulates the decaying coil current back through the coil. This effectively increases the decay time constant, making this constant independent of other circuit parameters. Thus, the duty cycle is decreased, further increasing the efficiency of the circuit.

The variable duty cycle pulser consists of a bistable multivibrator which is symmetrically emitter triggered by a unijunction relaxation oscillator. The time constant between pulses is determined primarily by the time constant $C_1 \cdot [(R_1 + R_2)]$. The time constant of the pulse is determined primarily by the time constant $C_1 \cdot [R_3 \cdot (R_1 + R_2)]/(R_1 + R_2 + R_3)$. The output of the multivibrator is capacitively coupled, through an emitter follower, to a two-stage current amplifier. The "one shot" pulser consists of a unijunction oscillator

(continued overleaf)

which triggers a silicon-controlled rectifier, which, in turn, operates a transistor switch. This switch saturates the two-stage current amplifier until the silicon-controlled rectifier conducts. The switch on the initial pulse is determined by the time constant (C_2-R_4). The power switch consists of the two-stage current amplifier. The voltage regulator is a simple shunt zener diode with the zener output filtered by a capacitor.

Notes:

1. The circuit illustrated has successfully operated two 8.7 ohm, 0.18 henry solenoid valves simultaneously, while the valves were under an equivalent pneumatic pressure of 220 psia. The circuit demonstrated an efficiency of 77 percent.
2. For the circuit illustrated, a minimum holding current of 0.3 amp was necessary to keep the solenoid valves held in. The pulse duration was set to 0.53 ms, and time between pulses was set to 2.6 ms, which yielded a holding current of 0.5 amp.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   P.O. Box 1537
   Houston, Texas, 77001
   Reference: B66-10034

Patent status:

No patent action is contemplated by NASA.

Source: Roy J. Mankovitz of
North American Aviation, Inc.,
under contract to
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