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# NASA TECH BRIEF

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## Slow-Speed Drives for Miniature Devices

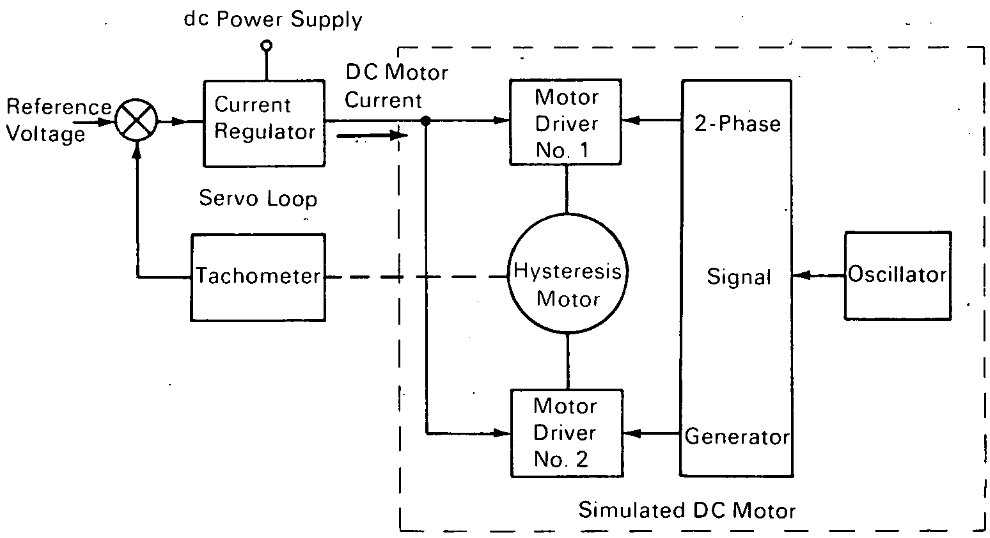


Figure 1. Slow Speed Drive

### The problem:

Generate smooth, slow-speed rotation for miniature devices, which will operate reliably for long periods of time without being serviced. This has previously been done with high-speed motors and multistage speed reducers, resulting in complex drive systems unsuitable for long, service-free operation.

### The solution:

Motor torque variations during a shaft revolution need to be minimized in order to achieve smooth, slow-speed rotation because the damping effect of the system inertia vanishes as the speed approaches zero. The hysteresis motor is known for its smooth torque at any motor speed, if it is operated at a sufficiently high frequency and with a sinusoidal motor current. It also can be built in very small sizes. Unfortunately, the speed of this motor is generally unstable, except for the very high synchronous speed. Motor speed, therefore, must be stabilized by a feedback servo.

### How it's done:

The hysteresis motor is built in such a way as to develop high acceleration torque. It is operated from a dc power supply by means of dc-to-ac inverter. If the motor and its inverter are treated as a black box, it will appear to be a brushless dc motor, having similiar characteristics in nearly every respect. The torque of this motor will increase if the dc into the inverter increases. Therefore, dc motor servo control can be applied to stabilize motor speed.

The block diagram of the drive system is shown in Figure 1. A square-wave oscillator drives a logic circuit consisting of a flip-flop and some gates for the

(continued overleaf)

generation of 2 square-wave signals with a phase difference of 90°. Each of these signals controls a motor driver circuit which performs the dual purpose of power amplification and generation of near sinusoidal motor current from the square-wave control signals. Figure 2 shows such a driver circuit.

As indicated in Figure 1, the motor carries a tachometer on its shaft, which generates a voltage proportional to motor speed. It is important that the tachometer signal be linear down to very low speeds. The tachometer signal is fed into a regular dc motor speed servo, which regulates the current from the dc power supply to the motor driver. Both drivers are identical and parallel-connected. They generate, therefore, currents in the two motor coils, which are identical at all times, except for the 90-degree phase difference. The current regulation affects only the amplitude of the rotating magnetic field in the motor, not its rate of rotation. Smooth rotation is achieved at any torque level and any speed below the high synchronous motor speed if the tachometer is capable of generating a usable output. The lowest stable speed which can be achieved is determined solely by the tachometer resolution.

## Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103.
Reference: B70-10007

## Patent status:

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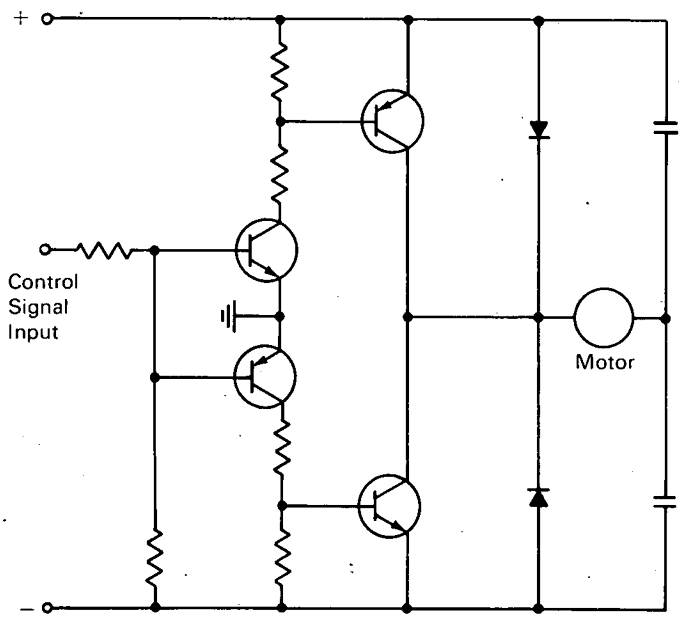


Figure 2. Motor Driver