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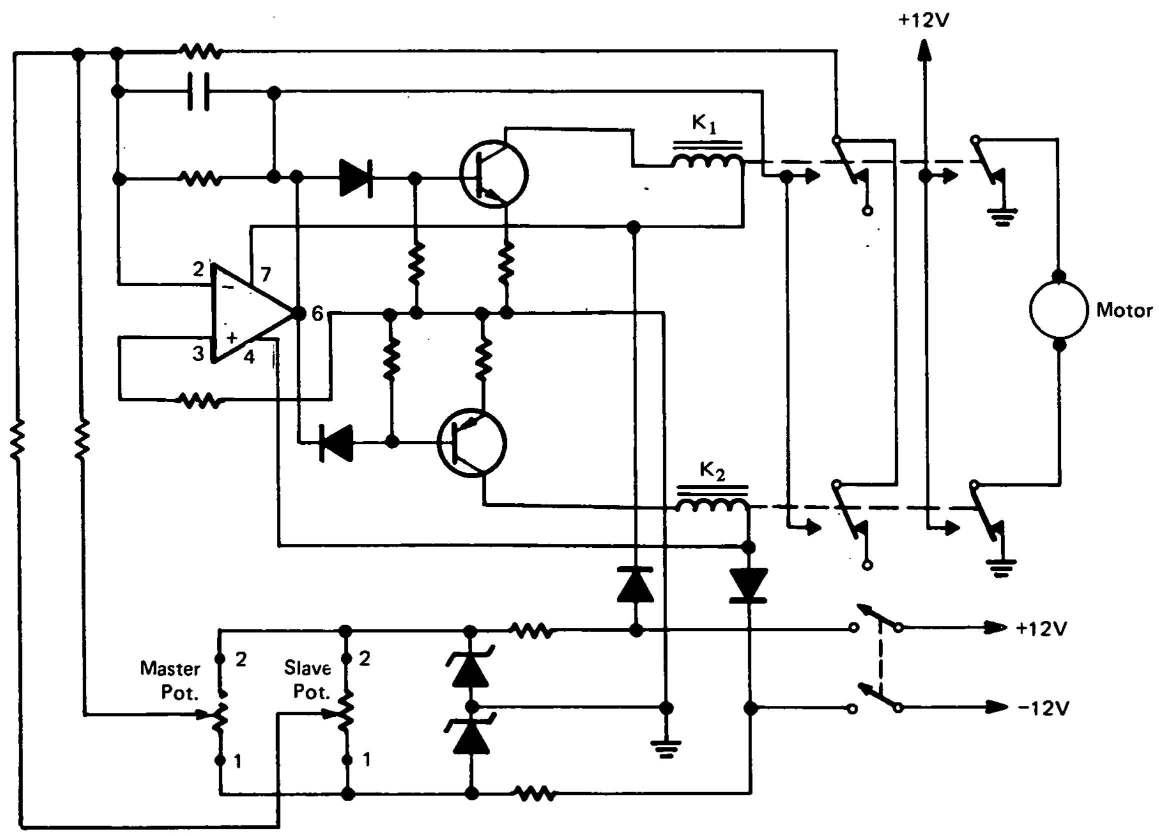
NASA TECH BRIEF

Marshall Space Flight Center

DC Motor Proportional Control System for Orthotic Devices

A multi-channel proportional control system used for operation of dc motors has been applied to the operation of externally-powered orthotic arm braces. The original system was produced to operate remote manipulators located at two NASA facilities, the first two prototypes having the desirable feature of very accurately controlling the shaft positions of the motors that drive the remote manipulators. The units have been reduced in size from 0.23 to 0.004m^3 (8 ft^3 to 220 in^3) for application to the orthotic braces and also include velocity proportionality capability.

The most convenient and best method of controlling the velocity of permanent-magnet dc motors is by pulse frequency modulation. These motors have linear speed/torque/voltage characteristics which seem to suggest that a simple analog control signal would be adequate. However, they do not respond favorably to an amplitude-modulated signal during the first instant of acceleration. Because of the static friction of the motor and other conditions, a substantial amount of current is required just to start the motor, and it tends to "leap" forward before settling into its governable pattern of operation.



Since the first increment of motion is most important in the powered orthotic devices, this velocity pattern is unacceptable. The pulsed control signal circumvents this feature. When pulses of high current but short duration are fed to the motor, it will have sufficient current to start but will still "leap" forward. The "leaps", however, will be of curtailed duration (time length of the pulse). If a train of pulses is fed to the motor, it responds with incremental bursts of rotation of reasonable fidelity. Because of the short time duration of the pulses, the motor rotation appears to be one smooth continuous motion rather than discrete steps. Motor braking is applied between pulses, to prevent undesirable overshooting or coasting.

The final circuit design (see figure) responds to an analog input signal by delivering frequency modulated output pulses. Increasing the magnitude of the input voltage increases the frequency of the output pulses. When large currents are required, power transistors are added to the circuit.

Note:

Requests for further information may be directed to:

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Patent status:

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