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Brief 70-10435

NASA TECH BRIEF

Optimal Electric-Drive System for Vehicles

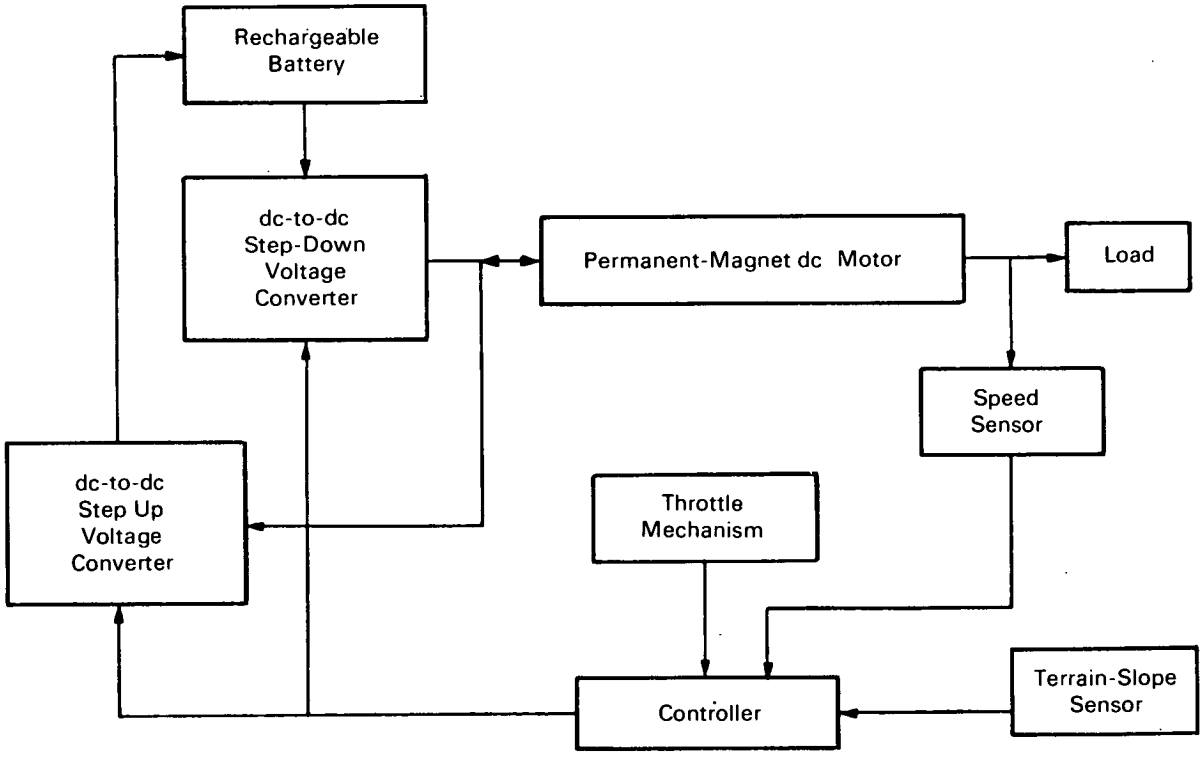

Figure. 1. Essential Elements of the Electric-Drive System

The problem:

Design of a controller for a vehicle electrically driven by direct current from a storage battery and requiring the highest possible efficiency in use of its battery.

The solution:

A novel design (Fig. 1) is based on theoretical concepts from modern control theory and on several justifiable assumptions; thus the uncertainties associated with earlier empirical approaches are eliminated. A mathematical expression for the automatic control of the motor's armature voltage requires measurement of the vehicle's speed and the slope of the terrain, and responds to an acceleration/deceleration controller. The controller uses a pulse-width-modulation technique, according to an optimal control law, for variation of the electric power through silicon controlled rectifiers (SCR's) for the permanent-magnet dc motors.

(continued overleaf)

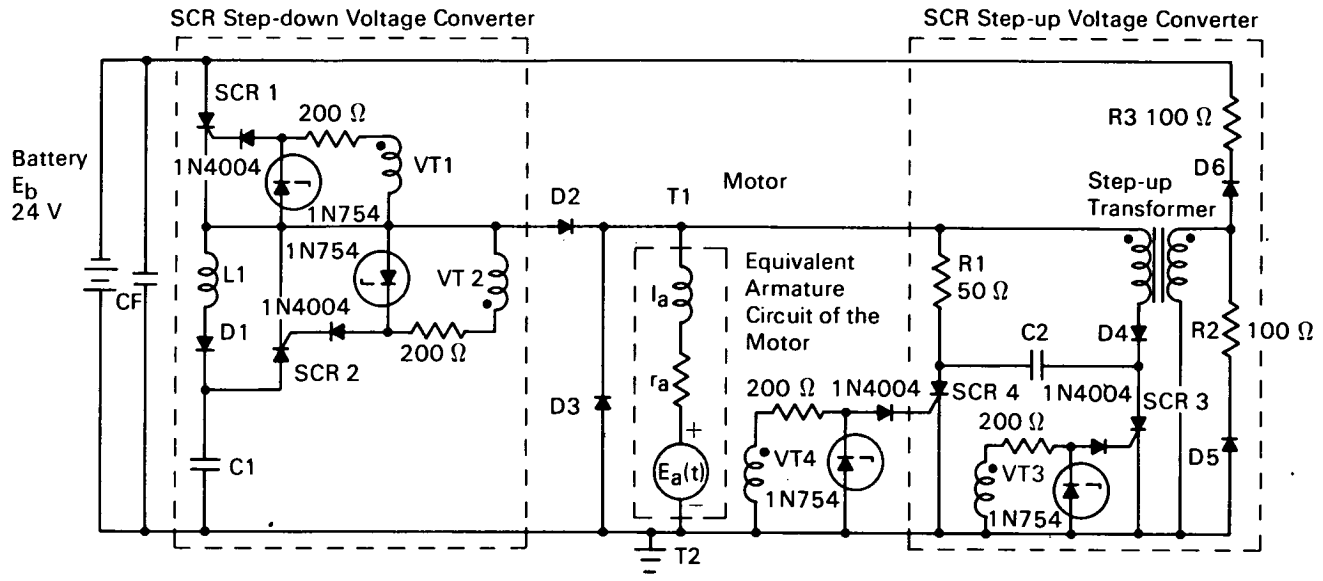

Figure 2. The SCR dc-to-dc Voltage Converters of the Minimum-Energy Controller

Thus the motor's speed is so controlled, in accordance with the sensed conditions, that minimum energy is expended during the motoring mode and maximum energy is recovered by regeneration during the coasting or (regenerative) braking mode.

Two SCR converter subsystems (Fig. 2) are controlled by the pulse-width modulator in conjunction with an armature-current direction sensor that determines which of the two converter systems is exclusively operative at any instant in accordance with the actual work load. One converter powers the motor for propulsion of the vehicle, and control is effected in the form of variable-duration pulses of battery voltage applied to the motor's armature.

Pulses are produced by conduction of an SCR as triggered by the pulse-width modulator. Since these pulses are directly related to the instantaneous needs of the drive system, only sufficient power is supplied by the battery to meet such needs; battery energy is therefore conserved, and a minimum of energy is converted to heat.

Potentially the system is widely applicable and is not necessarily restricted to dc motors.

Notes:

1. A prototype model of the optimal-drive system has been built and tested at the Jet Propulsion Laboratory.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP70-10435

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Y. E. Sahinkaya of
Caltech/JPL
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