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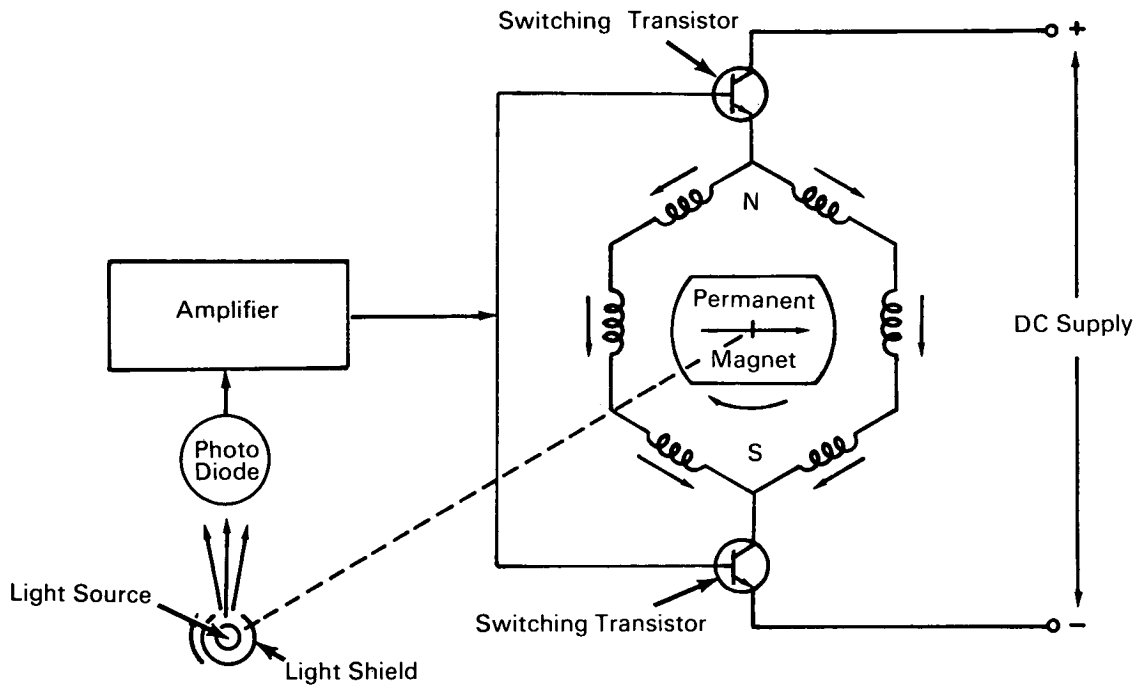
NASA TECH BRIEF

Brushless DC Motor Has High Efficiency, Long Life



The problem:

Brush life of conventional carbon brush commutators is measured in minutes when operated in a vacuum environment.

The solution:

Development of a brushless dc motor with true dc motor characteristics.

How it's done:

The principle of operation of this brushless motor is identical to that of the conventional dc motor. A torque is produced when two magnetic fields are established with a relative angle between them. This torque reaches a maximum when the relative angle is 90 degrees. It is the function of the commutator to apply the external power to the motor windings in such a manner as to maintain this angle for all positions of the rotating member. Physically, this motor is an inversion of a conventional dc motor in that the rotor is a permanent magnet and the stator is wound (in effect a stationary armature). Attached to the end of the rotor, opposite the drive end, is a small light source within a shield, in which a small aperture has been cut. In the plane of sweep of this aperture are six photodiodes spaced at equidistant points, 60 degrees apart. When the dc supply current is applied, a portion of the light strikes one of the six

(continued overleaf)

photodiodes. The illuminated photodiode produces a current which is amplified and fed to the bases of a pair of switching transistors. These transistors apply the power supply current to the appropriate points in time on the ring-type stator (stationary armature) winding. This produces a magnetic field at the proper angle in relation to rotor position and a turning force is imparted to the rotor. As the rotor turns, the light source, shining through the shield aperture, illuminates the other five photodiodes in turn, and the above process is repeated at each 60 degrees around the solid state commutator. The detecting devices are silicon photodiodes with rise time of 1.5 microseconds and fall time of 15 microseconds, affording a system capable of speeds well in excess of the design speed of 3,000 rpm.

Notes:

1. This motor, because of its excellent response time, has considerable potential for use in the servomechanism field.
2. The motor has an efficiency of 50 percent. This could well be increased to 70 to 80 percent using the latest magnetic alloys and winding techniques.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B66-10355

Patent status:

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

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