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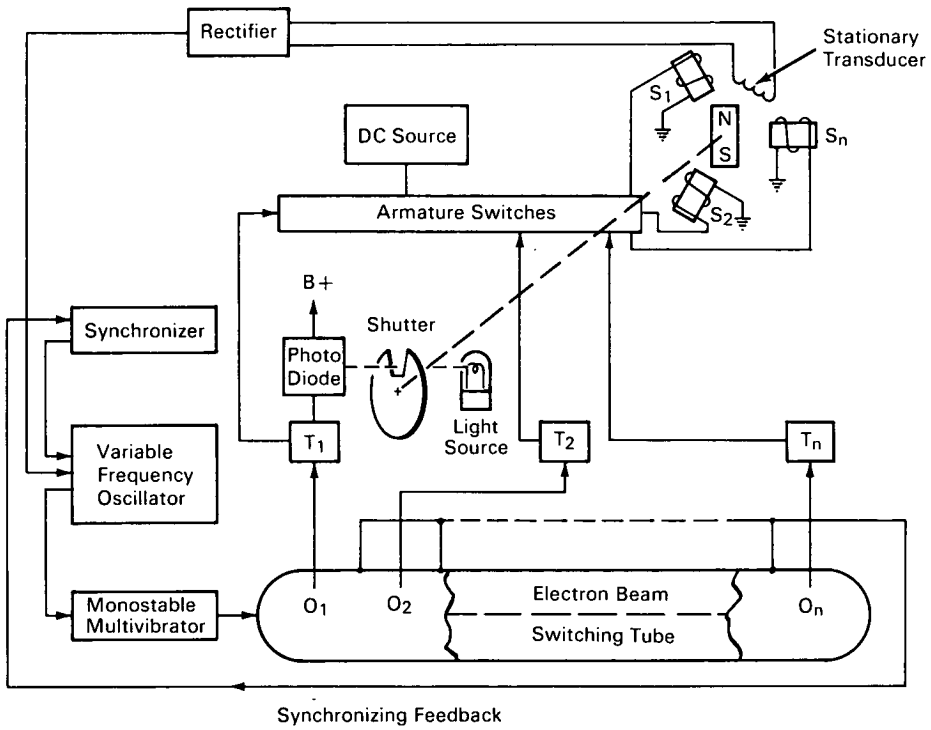
NASA TECH BRIEF

Brushless DC Motor Uses Electron Beam Switching Tube as Commutator



The problem: To design a self-starting brushless dc motor in which there is no physical contact between rotor and stator. Experience has shown that efficient motor operation may be obtained by using a number of stator windings that are sequentially energized and a permanently magnetized rotor that rotates to reduce the torque angle between the stator rotating field and and the rotor field. Relative positions of rotor and stator must be sensed so that the stator windings can be energized at a rate proportional to rotor angular velocity.

The solution: An electron beam switching tube and associated circuitry that control the output of a dc source to sequentially energize the motor stator windings. The tube is driven by a pulsed input that is responsive both to rotor position for proper sequencing and to rotor angular velocity for smooth acceleration during self-start.

How it's done: The beam in the electron beam switching tube is sequentially switched through succeeding outputs (O_1 through O_n) in response to pulses

(continued overleaf)

from the monostable multivibrator. The output pulses are coupled through the pulse transformers (T_1 through T_n) to gate the armature switches that enable the dc source to sequentially energize the stator windings (S_1 through S_n). A voltage, proportional to rotor angular velocity is induced in the stationary transducer, rectified, and used to control the frequency of the variable frequency oscillator. Output of the variable frequency oscillator controls the switching rate of the monostable multivibrator, thus relating the switching rate in the electron beam tube to rotor angular velocity. Frequency range in the variable frequency oscillator is sufficient to provide for self-start and a preset rotational speed limit.

Precise sequencing is achieved by means of a light source acting on a photodiode through a shutter that revolves with the rotor. Whenever the light beam is interrupted by the shutter, output of the electron beam tube is routed to the synchronizing feedback loop. The synchronizer then inhibits the variable frequency oscillator, and stops triggering of the pulse input of the monostable multivibrator until the photodiode is again illuminated. When the photodiode is energized, the monostable is again triggered as output to the synchronizing feedback is removed.

Notes:

1. This invention uses a standard electron tube and standard related components to accurately commutate a brushless dc motor and can be applied to any size rotating equipment including motor-generator sets.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10237

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use are available. Inquiries concerning license rights should be made to NASA, Code AGP, Washington, D.C., 20546.

Source: Phillip Studer
(GSFC-345)