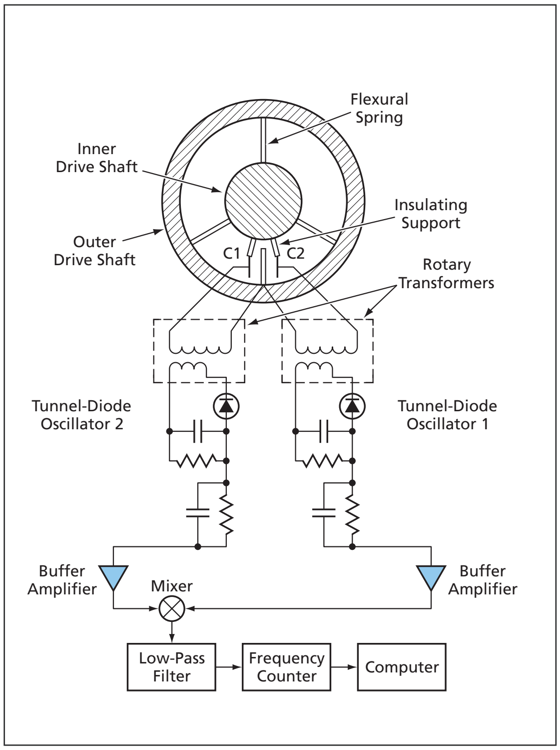
Torque Sensor Based on Tunnel-Diode Oscillator

This sensor would function over a wide temperature range.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed torque sensor would be capable of operating over the temperature range from 1 to 400 K, whereas a typical commercially available torque sensor is limited to the narrower temperature range of 244 to 338 K. The design of this sensor would exploit the wide temperature range and other desirable attributes of differential transducers based on tunnel-diode oscillators as described in "Multiplexing Transducers Based on Tunnel-Diode Oscillators" (NPO-43079), *NASA Tech Briefs*, Vol. 30, No. 9 (September 2006), page 42.

The proposed torque sensor (see figure) would include three flexural springs that would couple torque between a hollow outer drive shaft and a solid inner drive shaft. The torque would be deduced from the torsional relative deflection of the two shafts, which would be sensed via changes in capacitances of two capacitors (C1 and C2) defined by two electrodes attached to the inner shaft and a common middle electrode attached to the outer shaft. Each capacitor would be part of a tunnel-diode oscillator circuit. Each capacitor would be coupled to the rest of its oscillator circuit via a rotary transformer, so that there would be no need for wire connections between the shaft and the stationary part of the affected machine.



Torque Would Bend the Flexural Springs, causing a slight relative rotation of the inner and outer shafts, thereby increasing one of the capacitances and decreasing the other one, thereby further causing a decrease in the frequency of one tunnel-diode oscillator and an increase in the frequency of the other one.

The sensory principle would be mostly the same as that described in the cited prior article. At zero torque, the flexural springs would cause the common middle electrode to lie midway between the C1 and C2 electrodes. The two capacitances, and thus the frequencies of the two oscillators, would vary in opposite directions as torque caused the middle electrode to move away from the midpoint. The outputs of the tunnel-diode oscillators would be mixed and low-pass filtered to obtain a signal at the difference between the frequencies of the two oscillators. The difference frequency would be measured by a frequency counter and converted to torque by a computer.

This work was done by Talso Chui and Joseph Young of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-43325

Shaft-Angle Sensor Based on Tunnel-Diode Oscillator

Advantages would include relative simplicity and low-temperature capability.

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A proposed brushless shaft-angle sensor for use in extreme cold would offer significant advantages over prior such sensors:

- It would be capable of operating in extreme cold; and
- Its electronic circuitry would be simpler than that of a permanent-magnet/multiple-Hall-probe shaft-angle sensor that would otherwise ordinarily be used to obtain comparable angular resolution.

As in the case described in the immediately preceding article, the design of this sensor would exploit the wide temperature range and other desirable attributes of differential transducers based on tunnel-diode oscillators as described in "Multiplexing Transducers Based on Tunnel-Diode Oscillators" (NPO-43079), *NASA Tech Briefs*, Vol. 30, No. 9 (September 2006), page 42.

The principle of operation of the proposed shaft-angle sensor requires that the shaft (or at least the portion of the shaft at the sensor location) be electrically insulating. The affected portion of the shaft would be coated with metal around half of its circumference. Two half-circular-cylinder electrodes having a radius slightly larger than that of the shaft would be mounted on the stator, concentric with