Ball Bearings Equipped for *In Situ* Lubrication on Demand

Operational lifetimes can be prolonged.

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In situ systems that provide fresh lubricants to ball/race contacts on demand have been developed to prolong the operational lives of ball bearings. These systems were originally intended to be incorporated into ball bearings in mechanisms that are required to operate in outer space for years, in conditions in which lubricants tend to deteriorate and/or evaporate. These systems may also be useful for similarly prolonging bearing lifetimes on Earth.

Reservoirs have been among the means used previously to resupply lubricants. Lubricant-resupply reservoirs are bulky and add complexity to bearing assemblies. In addition, such a reservoir cannot be turned on or off as needed: it supplies lubricant continuously, often leading to an excess of lubricant in the bearing.

A lubricator of the present type includes a porous ring cartridge attached to the inner or the outer ring of a ball bearing (see Figure 1). Oil is stored in the porous cartridge and is released by heating the cartridge: Because the thermal expansion of the oil exceeds that of the cartridge, heating causes the ejection of some oil. A metal film can be deposited on a face of the cartridge to serve as an electrical-resistance heater. The heater can be activated in response to a measured increase in torque that signals depletion of oil from the bearing/race contacts.

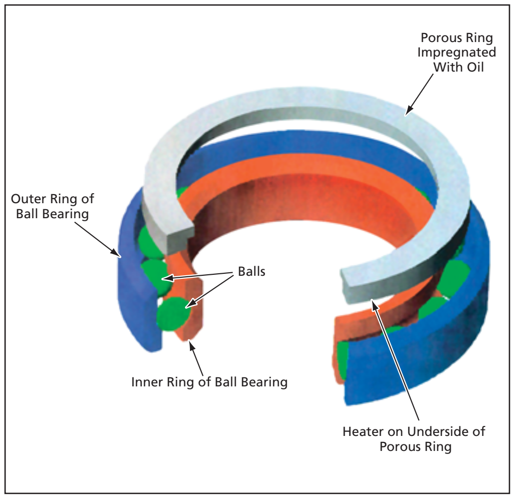

Figure 1. A **Porous Ring** impregnated with oil is attached to one of the ball-bearing rings. When the porous ring is heated, some oil is squeezed out. The oil then spreads over the bearing surface and eventually reaches the bearing/race contacts.

Because the oil has low surface tension and readily wets the bearing-ring material, it spreads over the bearing ring and eventually reaches the ball/race contacts. The Marangoni effect (a surface-tension gradient associated with a temperature gradient) is utilized to enhance the desired transfer of lubricant to the ball/race contacts during heating.

For a test, a ball bearing designed for use at low speed was assembled without lubricant and equipped with a porous-ring lubricator, the resistance heater of which consumed a power of less than 1 W when triggered on by a torque-measuring device. In the test, a load of 20 lb (≈89 N) was applied and the bearing was turned at a rate of 200 RPM. The lubricator control was turned on at the beginning of the test, turned off for about 800 seconds, then turned on again. As shown in Figure 2, the controlled lubricator stabilized the torque in a low range, starting immediately after initial turn-on and immediately after resumption of the lubricator control.

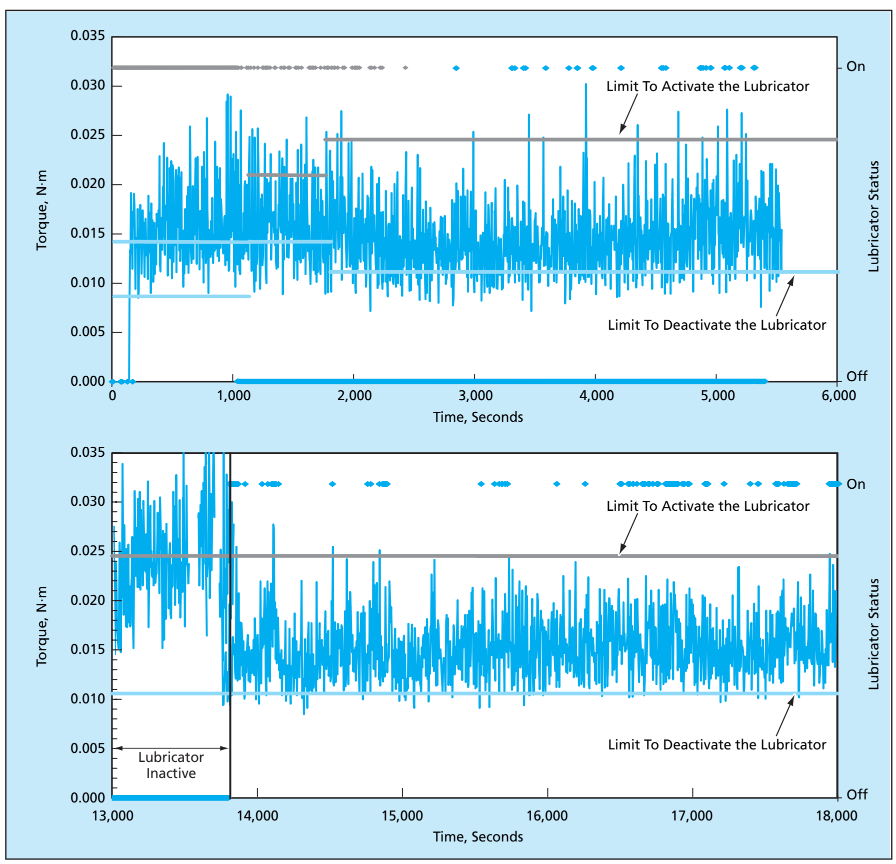

Figure 2. **Ball-Bearing Torque** was maintained within a low range by using a lubricator as described in the text to dispense lubricant as needed.

This work was done by Mario Marchetti of National Research Council; William R. Jones, Jr., and Stephen V. Pepper of **Glenn Research Center***; Mark Jansen of Sest, Inc.; and Roamer Predmore of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).*

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