NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
CONTRACT NO. NAS 7−918

TECHNICAL SUPPORT PACKAGE

On

CROWNED RACES FOR CROSSED ROLLER BEARINGS

for 06/01/2002

NASA TECH BRIEF Vol. 26, No. 6

from

JPL NEW TECHNOLOGY REPORT NPO− 30203

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pp. i, 1−2

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06/01/2002

Crowned Races for Crossed Roller Bearings

Scuffing would be reduced.

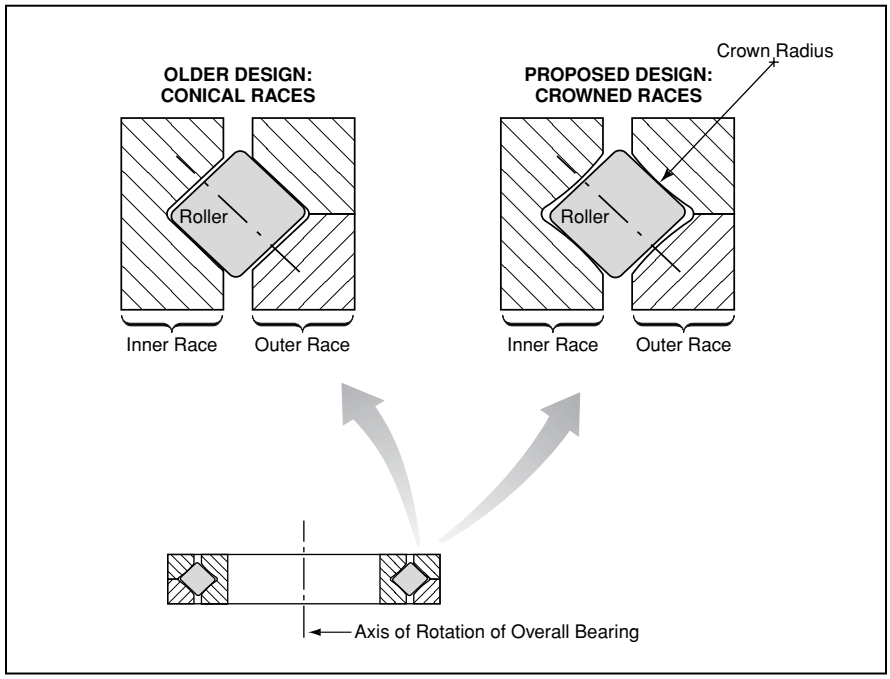
NASA's Jet Propulsion Laboratory, Pasadena, California

Crowned races have been proposed for crossed roller bearings. Crowning of the races is expected to reduce scuffing of the cylindrical rollers. Crowning of the races is expected to be especially beneficial in bearings made of polymers (instead of metals) to reduce weight.

The crossed-roller bearing design is the roller equivalent of the x-type ball bearing design. In a crossed-roller bearing, the races are conical surfaces at angles of 45° to the axis of rotation. The advantages and disadvantages of the ball and crossed-roller designs are complementary: In comparison with ball bearings, roller bearings can withstand greater loads. On the other hand, roller bearings are more susceptible to scuffing, which is caused by a kinematic mismatch between tangential roller speeds at the inner and outer diameters of the races.

In a crossed-roller bearing with crowned races (see figure), the contact area, and thus the amount of scuffing, would be reduced (relative to that of conical races) to a value near that of ball bearings. The crown radius is a free design parameter that can be chosen, along with other parameters, in consideration of the bearing material(s) and the loads that must be borne in a given application.

One might ask why it would be preferable to crown the races instead of crowning the rollers. The reason is a practical one: Unlike in the case of steel bearing balls, it is difficult to fabricate polymeric bearing balls or polymeric crowned rollers with sufficient precision to ensure sharing of loads as needed for long bearing life. On the other hand, cylindrical crowned rollers of sufficient precision can be fabricated easily by centerless grinding in conventional machines.



Crowned Races, in contradistinction to conical races, would function with less scuffing in roller/race contact areas.

This work was done by Donald Bickler of Caltech for **NASA's Jet Propulsion Laboratory**.

NPO-30203

NTR INVENTOR'S REPORT
NTR: 30203

PLEASE BE AS CLEAR AND SPECIFIC AS POSSIBLE, AS THIS REPORT MAY BE MADE AVAILABLE THROUGH TECH BRIEFS

Section 1 (Novelty), 2A (Problem), and 2B (Solution) must be completely fully. Your published paper may be attached to satisfy Section 2C (Description and Explanation).

1. Novelty- Describe what is new and different about your work and its improvements over the prior art. Attach supporting material if necessary.

   State of the Art crossed roller bearings use conical surfaces at 45 degrees. This innovation is to crown the conical surface to reduce scuffing.

2. Technical Disclosure

   A. Problem-Motivation that led to development or problem that was solved.

   Extraterrestrial vehicle polymer ball bearings have superior performance (weight, wear, debris tolerance, lubrication needs, shock tolerance) to metal ball bearings but have reduced load capability. Single row (x type) ball bearings reduce mass for extraterrestrial use. The crossed roller design is the roller equivalent to x type ball bearings. Cylindrical rollers (not tapered) scuff.

   B. Solution

   Crown the races to reduce scuffing to the relative values using balls.

   C. Detailed Description and Explanation

   An improvement on the design of crossed roller bearings has been devised. Plastic rolling elements have some advantages for spacecraft applications. They can be made to operate without lubricant, which freezes up at extremely low temperatures. "X" type ball bearings with plastic balls were used on the Sojourner Rover on the surface of Mars because only one bearing is necessary for a given wheel. Plastic rollers are easier to manufacture than plastic balls in custom sizes to precise dimensions. Conventional crossed roller bearings use a set of conical surfaces on their inner and outer races. These races mate with the cylindrical rollers over their entire length. The differences between the inner diameter of the conical races and the outer diameter cause the cylindrical rollers to "scuff" as they attempt to satisfy the two different tangential velocities.

   In the improved configuration, the conical raceways are crowned to reduce the contact area, and the scuffing, to an equivalent area in the realm of balls bearings. Since the radius of this crown is a free design parameter, the bearing can be designed specifically for load and material properties.

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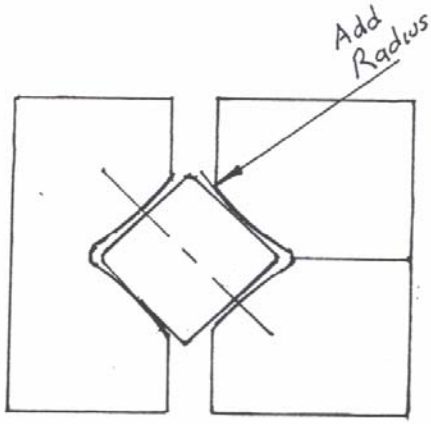

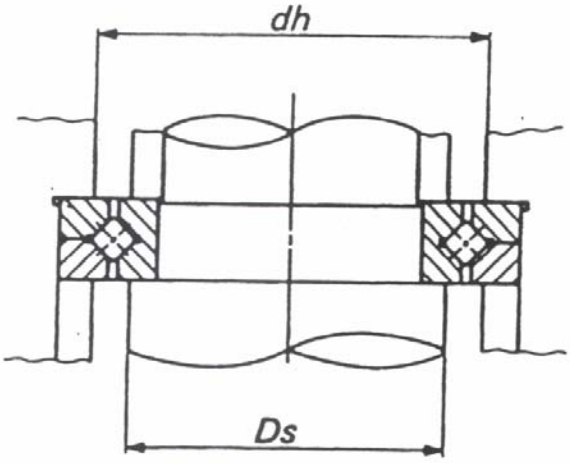

“The work described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautics and Space Administration.”