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NASA TECH BRIEF

Lewis Research Center

Lightweight, High Speed Bearing Balls: A Concept

The Problem:

In ball bearings operated at high rotational speeds, centrifugal forces of the balls on the outer race are detrimental to bearing life. Low mass balls can reduce the centrifugal force and increase bearing life and reliability. Low mass balls can be either fabricated of a material with significantly less density than conventional bearing steels, or fabricated of conventional materials but with hollow cores. However, the fatigue strength of the low mass balls must not be less than that of solid balls of high quality bearing steel. To date, hollow balls of conventional bearing steels have shown inadequate fatigue strength resulting from weakness in the weld material or flexure fatigue of the wall.

The Solution:

Low mass bearing balls with hardened iron-plated surfaces can eliminate both the problem of low fatigue strength and the problem of flexure fatigue, and lead to increased life and reliability of high speed ball bearings.

How It's Done:

Low-mass, hollow steel balls can be made by welding together hollow hemispheres fabricated from inexpensive low or medium carbon steels. The hollow spheres can then be plated with pure iron by an electrolytic deposition, ion plating, or sputtering process, heat treated by a case hardening process such as carburizing, and ground and finished to bearing ball tolerances. The resulting balls will have low mass with a hard (Rockwell C 60-65) homogeneous surface over a relatively soft and ductile inner hollow core (Figure 1). The thickness of the finished iron surface coating should be at least twice the depth of the maximum shear stress expected in the application, or on the order of 0.2 to 0.375 mm (0.008 to 0.015 in). The homogeneous, inclusion-free surface can provide rolling-element fatigue strength equal to or better than conventional high quality bearing steels. The relatively soft, ductile inner hollow sphere can eliminate the problem of flexure fatigue of the wall.

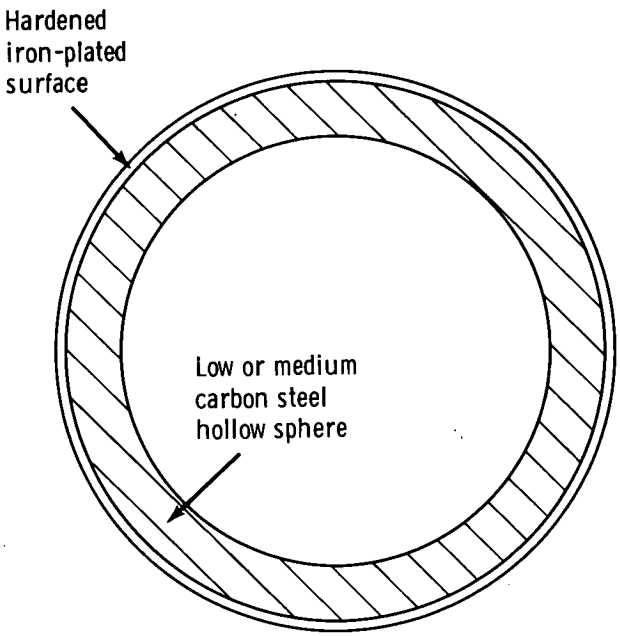

Figure 1. - Iron-plated hollow steel ball.

Low-mass solid balls can also be made of relatively low-density materials such as aluminum oxide. Aluminum oxide balls can be formed by cold pressing and sintering, hot-pressing, or other powder metallurgy techniques. The balls can then be plated with pure iron by an electrolytic deposition, ion plating, or sputtering process, heat treated by a case hardening process such as carburizing, and ground and finished to bearing ball tolerances. These low mass balls will have a hard (Rockwell C 60-65) homogeneous surface with a solid, lightweight core (Figure 2). The homogeneous, inclusion free surface can provide rolling-element fatigue strength equal to or better than conventional high quality bearing steels. Since the ball is solid, no flexure problem exists.

(continued overleaf)

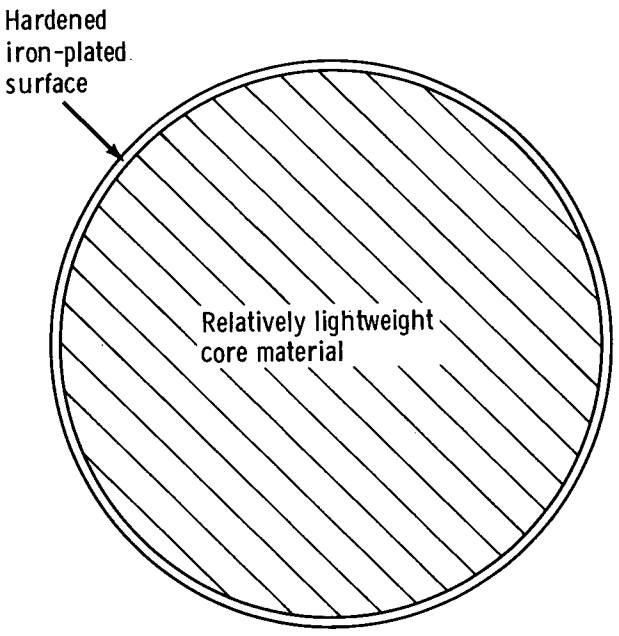

Figure 2. - Low mass, iron-plated ball.

Notes:

1. For high speed applications where high centrifugal forces on the outer races of conventional ball bearings are detrimental to the fatigue life and reliability of the bearing, low mass iron-plated balls can replace conventional solid bearing steel balls. Such low mass balls exert lower centrifugal forces on the outer race of the bearing than do conventional solid steel balls. The detrimental effect of the high speed operation can thus be eliminated.
2. Related information on hollow ball bearings is given in NASA Tech Brief 70-10331, "Fabrication of Hollow Ball Bearings by Diffusion Welding."
3. No additional documentation is available. Specific technical questions, however, may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10013

Patent Status:

This invention has been patented by NASA (U.S. Patents No. 3,751,123 and No. 3,781,958). Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
Mail Stop 500-113
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Source: Richard J. Parker
Lewis Research Center
(LEW-11087)