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MEASUREMENT OF PREFERRED ORIENTATION
IN BALL BEARINGS BY ULTRASONIC METHODS

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BY ULTRASONIC METHODS

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Preferential corrosion and wear of steel ball bearings led to an investigation into the possibility of measuring preferred orientation in these bearings by nondestructive means. Ultrasonic methods were chosen as a possible way of accomplishing this task. It was found that of the many ball bearings measured, most exhibited preferred orientation which was symmetrical with the original axis of the rod from which the bearings were formed. The measurements reported here were conducted on 1-in.-diameter bearings of 52100 steel. However, the results should be equally valid for other steels.

Procedure

The measurements were carried out in the following manner. A 5-Mc lead zirconate transducer (flaw detection type) was fitted with a 2-in.-long Teflon collimator which had been drilled with a 1/16-in. hole down the center. The upper section of the collimator was dished out to hold the ball bearing. A connection for pumping water through the collimator was installed so that the water made acoustical contact between the bearing and the transducer. The flow of water was adjusted until the bearing was suspended upon a blanket of water which allowed it to be rotated freely. The transducer was

excited with 300-V, 1- μ sec pulses* at approximately 100 pulses/sec repetition rate. This induced ultrasonic pulses with a carrier frequency of 5 Mc into the water column. These pulses propagated up the water column and into the steel bearing. Due to the curvature of the bearing the pulses suffered drastic mode conversion at the water-steel interface. This multiple mode conversion caused the pulses to reverberate within the bearing in a random manner. Each reflection within the bearing at the water-steel interface caused some of the energy to be propagated across the interface back to the transducer where it was converted to electrical energy. The output of the transducer was then connected to a 545 Tektronix oscilloscope which was synchronized by a variable delay trigger from the pulser, making it possible to view the reverberation signals at various times after the input pulse struck the bearing - ranging from immediately after to 11,000 μ sec after.

Results

The reverberation signals immediately following the input pulse to the bearing showed negligible variation as the bearing rotated. But the reverberations 11,000 μ sec after the input pulse gave an entirely different effect. As the bearing rotated the reverberation signals fluctuated in amplitude by as much as a factor of 2 (Fig. 1). This fluctuation of the later reverberations suggests that some type of mode coupling and addition occurs along a particular axis within the bearing after many reflections. The maximum signal was found to correspond to the original axis of the rod from which the bearing was made. The correlation of the signal and rod axis was achieved

*PG-650-C Pulser; Arenberg Ultrasonic Lab., Inc.

by first marking the point of maximum amplitude on a bearing then etching the bearing in acid. Figure 2 shows an etched and an unetched bearing. The preferred orientation is very evident.

It was found that a few of the bearings inspected showed no preferred orientation, although they were supposedly made from the same material and were the same size. Apparently something in the fabrication and/or heat treating process was different in these specimens. Microstructures of the bearings with measured preferred orientation showed no observable difference when taken parallel and perpendicular to the rod axis.

Conclusion

The results shown suggest that not only is ultrasonics a fast, simple, and nondestructive method for detecting preferred orientation in ball bearings, but it might also be the only method available without resorting to the acid bath which would render the bearing useless for service. This technique could easily be automated for production inspection of ball bearings, which might be of some interest to ball bearing manufacturers.

I wish to thank Herman Bechtholdt for his assistance in setting up this experiment, Fred Fulton for making the metallographic studies, and Rolland Watson for supplying the specimens. The work was done under the auspices of the U. S. Atomic Energy Commission.

(a)

(b)

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Fig. 1. Typical oscilloscope presentation showing the difference in multiply reflected ultrasonic energy received when propagated (a) along original rod axis, and (b) perpendicular to original rod axis.

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Fig. 2. Photograph of an etched and an unetched ball bearing.

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