Table 3 Calculated contact stress

	Mean Hertz stress (N/m^2) $\times 10^{-9}$		
	Ball-inner	Ball-outer	Ball-ball (max)
Mineral oil	1.002	0.832	>1.323
Traction fluid	1.002	0.832	1.125
n-hexadecane	1.002	0.832	1.125

Summary

Substantial load carrying capacity has been demonstrated for the ball-ball contacts in a small high-speed ball bearing. Lubricants of widely varying structure and type showed differing ball-race coupling and scuff resistance, but in every case sufficient capacity existed for full complement operation. It is suggested that this mode is thus an attractive and viable solution to the retainer instability problem.

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DISCUSSION

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Dr. Kingsbury mentioned that he did not get scuffing failures for the tests with mineral oil lubrication. However, tracks were formed on the balls. We have observed the same phenomenon in a retainerless bearing, but by means of etching we observed that the track formation on the balls was due to rehardening of the ball surface, indicating that very high "flash" temperatures had taken place, although no scuffing failure. I suggest that Dr. Kingsbury etches his balls also in order to check whether high surface temperatures had occurred in his experiments with mineral oil.

Author's Closure

A further discussion of ball tracks will be found in the reference.[2] In both that paper and the present paper the tracks are attributed to organic deposits derived from the lubricant. The reason is that the tracks can be removed without trace (if they have not grown too dense) with concentrated H_2SO_4. This is not exactly etching within Mr. Hemskerk's meaning, but does indicate something of the nature of the present tracks. It would be unwise for me to speculate on Mr. Hemskerk's tracks without more detailed information on his work, unpublished so far as I know.

In any case, the main point of the present paper is that plenty of load carrying capacity exists between the balls in a retainerless bearing, and that retainer instability is an unnecessary burden for the bearing engineer.

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[2] Kingsbury, E., "Ball Contact Locus in an Angular Contact Bearing," Submitted to ASME.