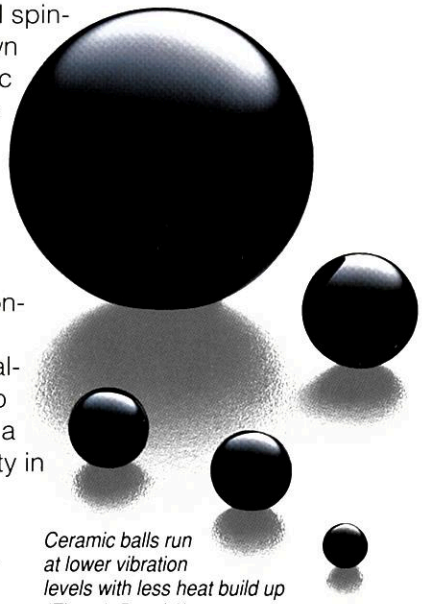
Ceramic Hybrids: Clearly Superior

While some bearing companies still *talk* about the benefits of ceramic hybrid ball bearings, Barden is proving their worth on the factory floor every day.

After years of rigorous testing under a variety of actual operating conditions we decided to replace conventional steel ball spindle bearings in our own machines with ceramic hybrids (silicon nitride balls, steel inner and outer rings). The results have led us to draw one simple conclusion: Ceramic hybrids outperform conventional steel ball bearings so dramatically that their use can no longer be considered a "luxury" but a necessity in many applications.



Ceramic balls run at lower vibration levels with less heat build up (Figs. 4, 5 and 6).

During our evaluation period we discovered that every single spindle tested exhibited vibration levels two to seven times lower when run with ceramic hybrids (Fig. 6). With conventional steel bearings, tolerances were harder to maintain and tool life was shorter.

Barden machines also experienced:

- Better workpiece finish characteristics (Fig. 8)
- A doubling of diamond cutting tool life
- Overall improved accuracy and reduced scrap rates.

While tests showed that individual spindle performance varied by type, the potential benefits that are possible with ceramic hybrids include:

- Extending bearing service life two to five times longer than conventional steel ball bearings (Fig. 7)

Ceramic hybrid bearings run 50% faster and last two to five times longer than steel ball bearings (Figs. 3, 7).

- Achieving running speeds up to 55% higher resulting in reduced cycle times (Fig. 3)
- Increasing productivity through faster acceleration and deceleration boosting metal cutting time, reducing down time.

Because of the unique properties of silicon nitride (Fig. 9), ceramic balls drastically reduce the predominant cause of surface wear in conventional bearings

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Deviation from True Circularity (DFTC)

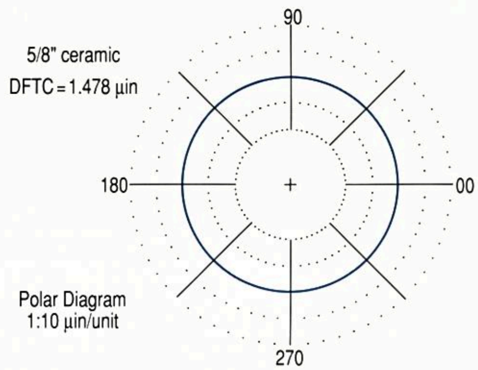

FIG. 1: Polar trace of a 5/8" silicon nitride ball indicates near perfect roundness, a characteristic which results in dramatically lower vibration levels.

Operating Temperatures

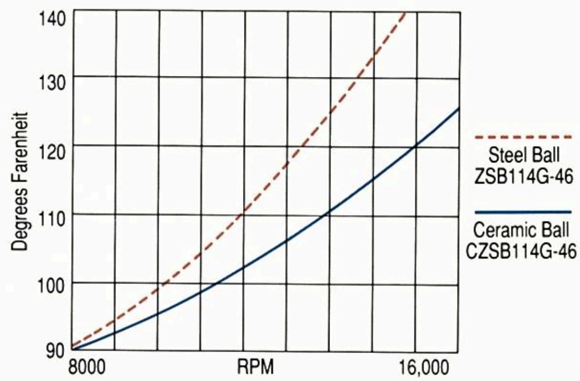

FIG. 4: As running speeds increase, ceramic balls will always run cooler than conventional steel balls. With reduced heat build up, lubricant life is prolonged.

Service Life (Fatigue Life)

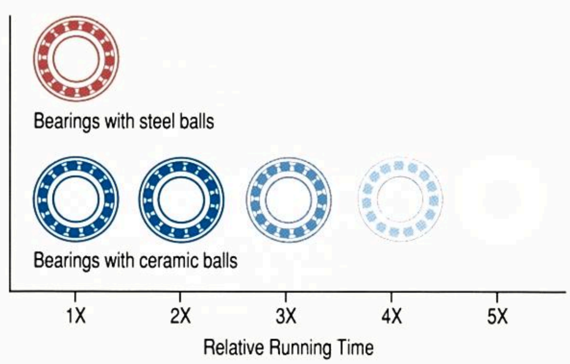

FIG. 7: Service life for ceramic hybrid bearings is at least double that of conventional steel ball bearings and could last up to five times longer, depending upon operating conditions.

Surface Finish of Silicon Nitride Balls

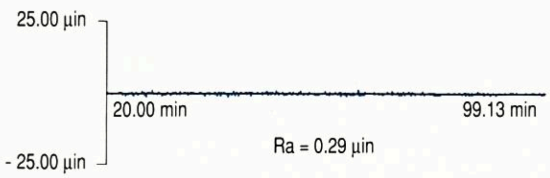

FIG. 2: Finish of a ceramic ball, as expressed in this Form Talysurf trace, reveals a surface that is almost perfectly smooth.

Running Speeds

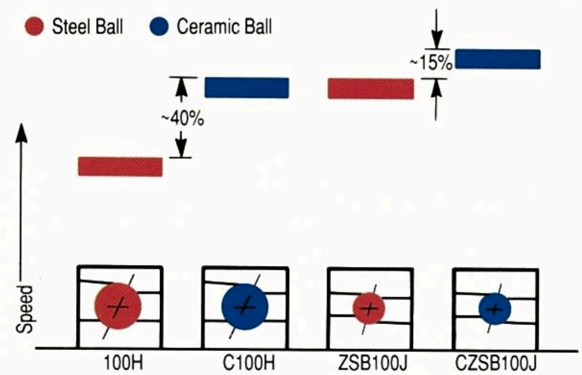

FIG. 3: Running speed of large diameter ceramic ball exceeds same-size steel ball by 40%. Converting to a small diameter ceramic ball will boost running speeds an additional 15%.

Higher Rigidity and Natural Frequency

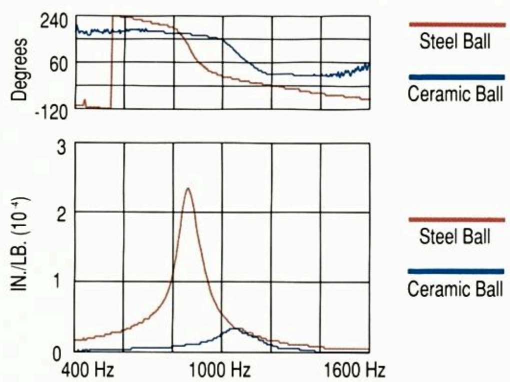

FIG. 5: Dynamic stiffness analysis performed before/after grinding spindle rebuilding shows higher rigidity and higher natural frequency for hybrid bearings, making them less sensitive to vibration.

Vibration

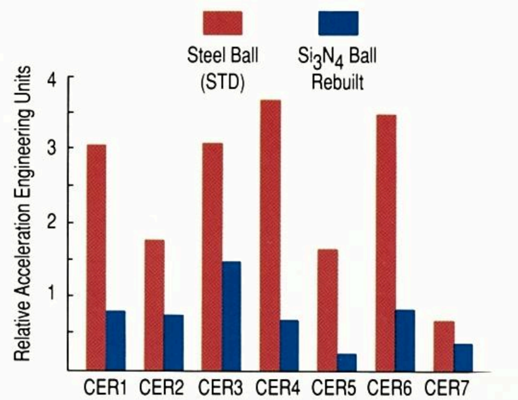

FIG. 6: Vibration tests comparing spindles with steel ball bearings and the same spindle retrofit with ceramic hybrids. Vibration levels averaged two to seven times lower with silicon nitride balls.

Workpiece Surface Finish/Geometry

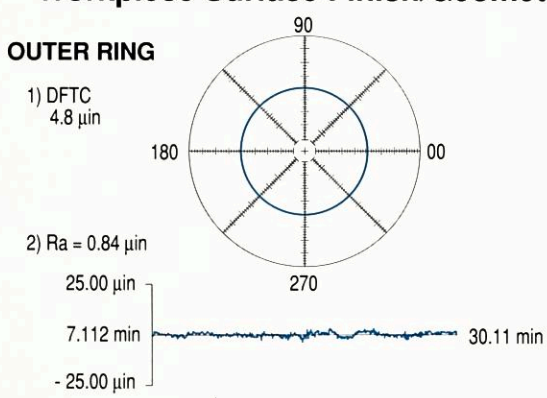

FIG. 8: Ceramic hybrids improve spindle rigidity resulting in greater accuracy and enhanced workpiece finish characteristics. Form Talysurf traces show high degree of precision in finished part.

Comparison of Bearing Steel and Silicon Nitride Properties

FIG. 9:

Property		Steel	Ceramic
Density	(g/cm³)	7.8	3.2
Elastic Modulus	(10^6 psi)	30	45
Hardness		R_c60	R_c78
Coefficient of thermal expansion	($X10^{-6}$/°F)	6.7	1.7
Coefficient of friction		0.42 dry	0.17 dry
Poisson's ratio		0.3	0.26
Maximum Use Temperature	(°F)	620	2,000
Chemically Inert		No	Yes
Electrically Non-Conductive		No	Yes
Non-Magnetic		No	Yes