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PREVENTING RING FAILURES DUE TO ROTATIONAL MOVEMENT IN WIND TURBINE GEAR BOXES

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According to Sandy Butterfield at the National Renewable Energy Laboratory (NREL) today's gearboxes last 7–11 years versus the 20 years expected from the average wind turbine. Extending gearbox life is critical to current and future wind energy projects.

Enormous axial loads impact the gear box assembly, including bearings and planet gears in both directions. The bearing race wears; the resulting metal debris leads to bearing failure. These bearings are typically secured via retaining rings designed to eliminate such movement; though analysis shows this is not always successful. The rotational movement spins the ring in the groove, leading to failure of the ring and gearbox.

The reasons for this unwanted movement are:

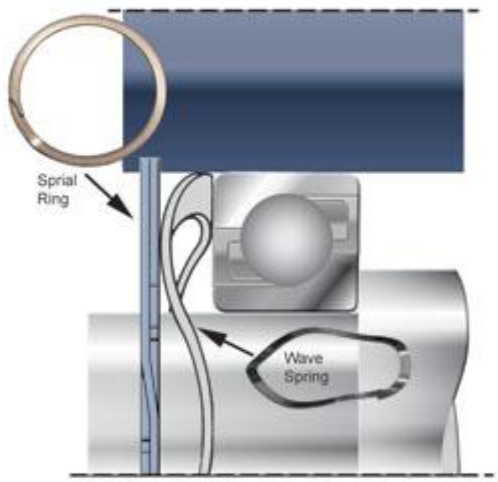
1. Bearings fit relatively loose in the bore. This guarantees easy assembly of large components typically used for wind turbines and balances possible thermal radial expansion during operation of the gear box. Such will not prevent rotational movements of the bearing because there isn't sufficient friction between the outer race of the bearing and surface of the housing. A retaining ring's axial contact with the bearing causes the rotational movement of the ring, resulting in the failure.

2. A rotating gear is fixed by a retaining ring. As the axial friction between the gear wheel and the retaining ring is greater than the radial load of the ring and the friction between it and the groove, the ring will rotate.

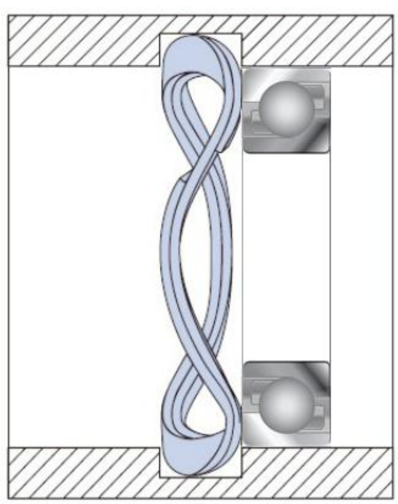
3. Rotational movements can be caused by high dynamic torsional loads in an axial direction. As components in a turbine gear box are fixed by a retaining ring, and dynamic punctual axial loads are introduced, the ring rotates in the groove. This is not caused by the rotation of a retained component but by the dynamic punctual axial loads exerted on the ring.

Fortunately, there are various retaining ring types designed to eliminate the movements described above; thereby increasing bearing life and improving performance.

<u>Preventing Rotating of Outer Races of Bearings</u>
If the application does not generate enough radial friction between the outer race and the surface of the housing, it should receive an axial load to prevent the race from rotating. A single-turn wave spring with a specific axial load will hinder the tendencies of the outer race and the retaining ring to rotate. A very precise load should be generated to guarantee non-destructive levels of force. A spiral-wound flat-wire single-turn wave spring can generate such a load.

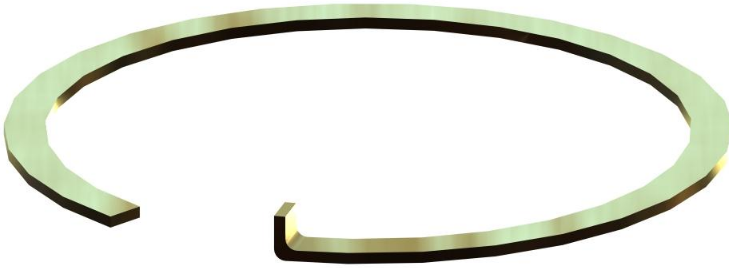


Alternatively, single-turn or two-turn wave rings can replace the retaining ring. These retain and pre-load the outer race of the bearing, streamlining the assembly process.



Rotating Gear & Retaining Ring

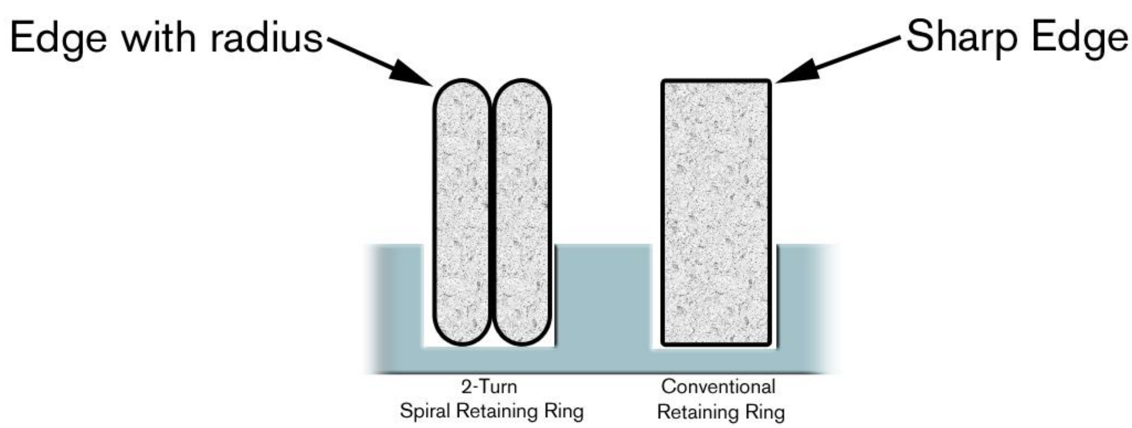
Instead of a conventional retaining ring, a modified retaining ring can be used to solve the problem. A keystone assembled in the gap of the snap ring with an L-profile similar to the following prevents the ring from rotating:



The bent end offers a "nose" which hinders the rotation. No additional keystone needs to be handled in the assembly process. Time and costs for machining the additional groove is comparatively less.

High Dynamical Punctual Loads in Axial Direction

A spiral-wound constant section or multiple-turn retaining ring offers an elastic effect in an axial direction. As this is a coiled part, it eliminates damaging sharp corners. Thus, the ring can withstand higher dynamic axial loads and not rotate in the groove.



Improving the performance of wind turbines is an important industry objective as the market grows. Eliminating damaging movement through the prudent selection of a retaining ring is an important step in achieving that objective.