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Differential Crowning: A New Weapon Against Gear Noise and Dynamic Load

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

As the power density of gear sets increases, mesh deflections increase, and the variations in those deflections, which result primarily from mesh stiffness variation, become increasingly significant. This is because these variations translate directly into transmission error and provide the excitation that generates the periodic inertial load supplement called "the dynamic increment of load". In addition to subtracting from the useful torque capacity, the dynamic increment is the main generator of gear noise.

To minimize these undesirable effects, designers of power train gear pairs have traditionally specified various forms of profile modification, the most common of which is tip and/or root relief. The problem with these conventional modifications is that they give only a limited reduction in transmission error at a particular roll angle and load (the "design load") but produce increases in transmission error at other roll angles and loads.

A new system of modifications, however, has recently been devised that substantially eliminates mesh stiffness variations throughout the entire engagement angle regardless of what torque load is being transmitted. This new system of modifications is described and confirmatory test results are reported.

By substantially eliminating gear noise and dynamic increment, the new modifications make it possible to replace costly helical gear sets with better performing spur sets in many applications. In addition, gear sets embodying these new modifications are significantly less sensitive to profile manufacturing errors than gear sets having tip and/or root relief. Together, these features can lead to substantial reductions in cost without compromising performance.

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