

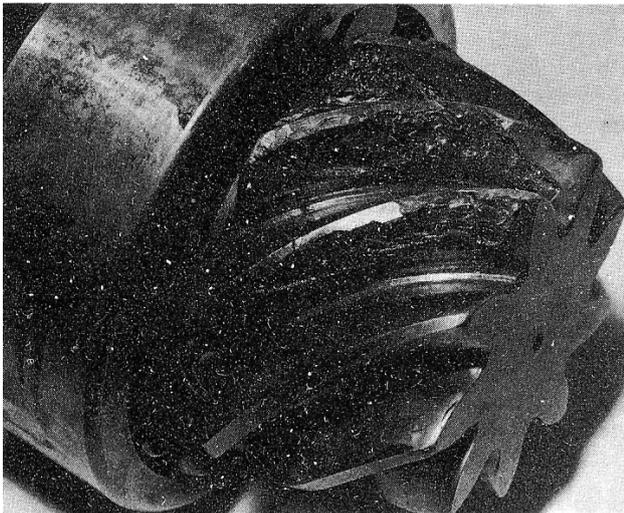
Gear failures rarely occur. A gear pair has not failed until it can no longer be run. This condition is reached when (a) one or more teeth have broken away, preventing transmission of motion between the pair or (b) teeth are so badly damaged that vibration and noise are unacceptable when the gears are run.

By no means all tooth damage leads to failure and immediately it is observed, damaged teeth should be examined to determine whether the gears can safely continue in service.

SURFACE FATIGUE

This includes case exfoliation in skin-hardened gears and pitting which is the commonest form of damage, especially with unhardened gears. Pitting, of which four types are distinguished is indicated by the development of relatively smooth-bottomed cavities generally on or below the pitch line. In isolation they are generally conchoidal in appearance but an accumulation may disguise this.

Case exfoliation



Case exfoliation on a spiral bevel pinion

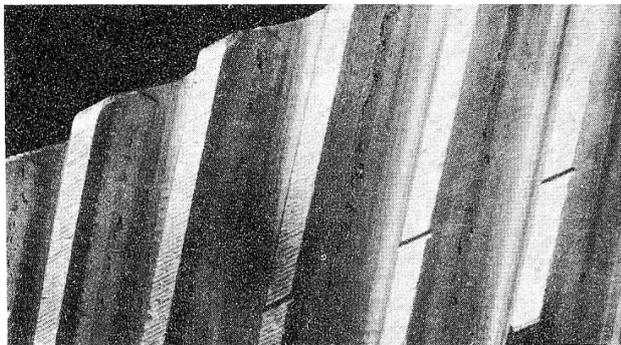
Characteristics

Appreciable areas of the skin on surface hardened teeth flake away from the parent metal in heavily loaded gears. Carburised and hardened, nitrided and induction hardened materials are affected.

Cause

Case exfoliation often indicates a hardened skin that is too thin to support the tooth load. Cracks sometimes originate on the plane of maximum Hertzian shear stress and subsequently break out to the surface, but more often a surface crack initiates the damage. Another possible reason for case exfoliation is the high residual stress resulting from too severe a hardness gradient between case and core. Exfoliation may be prevented by providing adequate case depth and tempering the gear material after hardening.

Initial or arrested pitting



Initial or arrested pitting on a single helical gear

Characteristics

Initial pitting usually occurs on gears that are not skin hardened. It may be randomly distributed over the whole tooth flank, but more often is found around the pitch line or in the dedendum. Single pits rarely exceed 2mm across and pitting appears in the early running life of a gear.

Cause

Discrete irregularities in profile or surface asperities are subjected to repeated overstress as the line of contact sweeps across a tooth to produce small cracks and clefts. In the dedendum area the oil under the high pressure of the contact can enter these defects and extend them little by little, eventually reaching the surface again so that a pit is formed and a small piece of metal is dislodged. Removal of areas of overstress in this way spreads the load on the teeth to a level where further crack or cleft formation no longer occurs and pitting ceases.