**The ability to "freeze" a gear while the machine is in operation can help a properly trained technician safely inspect performance**

# Strobe Inspection of Dryer Gears Helps Identify Problems, Plan Maintenance

By **AL LANKFORD**

Mills sometimes encounter the problem of having a dryer section gear drive develop a noise or other problem but are unable to inspect it until a scheduled downtime. There is a relatively simple and revealing method to dynamically and safely inspect drive gearing while the paper machine is in operation. Using a strobe light to "freeze" the image of mating gears can reveal how well the subject gears are meshing and transmitting drive power to the section. It is a task that can also be easily performed by mill maintenance and trouble-shooting personnel.

It takes a little time and practice to become proficient at understanding what is being seen during the strobe inspection, but the investment in time is worthwhile. Performing periodic strobe inspections will help identify problems before they become catastrophes and is a good method for planning gear maintenance ahead of a shutdown.

**FIGURE 1.** *This diagram shows good backlash and tip-to-root settings. Gears are meshing on the correct side for the direction of rotation.*

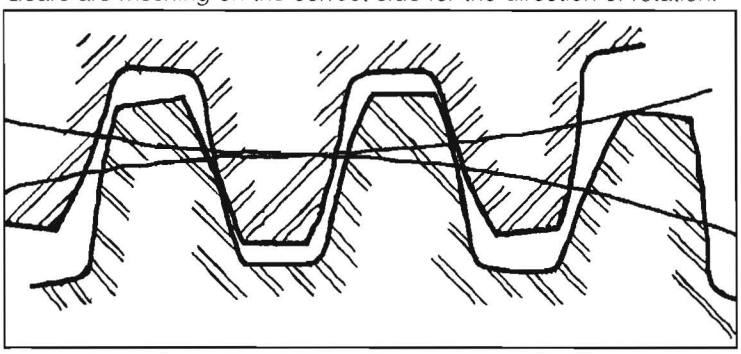
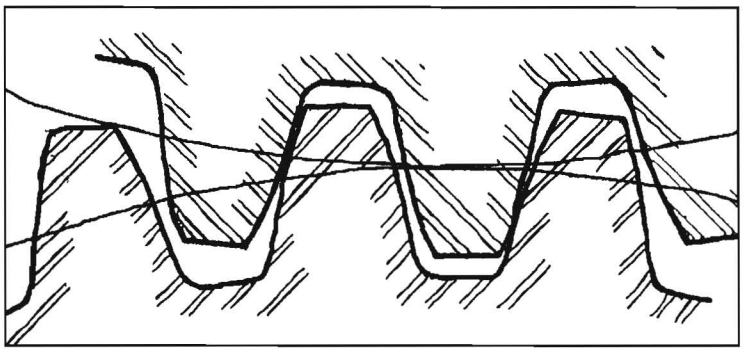


**FIGURE 2.** *In this illustration, the dryer gear is driving the drive pinion, which highlights a case of backdrive.*



**PERFORMING THE TASK.** The procedure involves working from the back side of the paper machine, so personal protective gear is required. Since the task requires that personnel be somewhat close to the gearing of the operating paper machine, eye protection is especially critical. Safety glasses or goggles, ear protection, hard hat, and steel-toed shoes are all mandatory when performing any work in this area.

To perform the procedure, a compact, lightweight, battery-powered strobe light is required. A recommendation is a strobe light from Herman Sticht Co. Inc. (Brooklyn, N.Y.). We like it because it is lightweight, has a bright light, recharges rapidly, and has a hard plastic case that stands up to use in a mill.

If a drive section has recently developed a noise or other problem, start in that area. For general inspection start at the high load areas near the in-drive gear and work outward. Since the procedure requires visual inspection of the gear mesh, it is easily performed on dryer sections with open gearing. Strobe inspection on dryer sections with enclosed gearing can be performed only if some or all of the gear access ports have been replaced with Plexiglas. It is recommend that Plexiglas be used because it can pay big dividends in dryer gear maintenance.

Aim the strobe light at the gear mesh, and tune the strobe so that the flashes/minute "freeze" the image of the gear mesh. You're looking to determine if mating gears are meshing on the correct side of the teeth and that the backlash and the tip-to-root clearance are correct (Figure 1).

**BACKDRIVE.** Backdrive is a condition where a gear (or gears) is driving instead of being driven by the gear train (Figure 4). If a backdrive condition exists, it will be evident in that the gear teeth of the mating gears will be meshing on the wrong side relative to the rotational direction of the dryer.

Backdrive and overdrive will often be accompanied by excessive noise or growling in the affected section. Because the gears are backdriven, power is not being transmitted correctly, resulting in an overdrive condition elsewhere in the gear system. This is

undesirable as it increases the load and stresses in the gear train and can lead to failure. Backdrive can be caused by excessive draw, speed mismatch between sections, improper sheet and/or felt tension, or variations in dryer can diameters.

If there is backdrive at the pinion, check the gears downstream. If the condition exists in most of the gear meshes downstream of the pinion, the cause is likely to be excessive draw between this dryer section and the next downstream section (dryers, calendar, reel, etc.). If the backdrive proceeds from the pinion through the upstream gearing, excessive felt tension or excessive draw between this and the upstream section can be the cause.

Another potential cause of backdrive and overdrive on felted sections is the removal of a gear in the section. When a gear is removed from a felted section and not replaced, this results in the felt transmitting the power to the dryers downstream from the removed gear. The felt will also continue to transmit this power at the beginning of the section on its return run. This additive power works in opposition to the power from the pinion and can result in an overdrive/backdrive condition. If only one gear shows evidence of backdrive, the cause can be a dryer that is different in diameter from its mating dryers.

**FIGURE 4.** *The stress points in mating gears are illustrated.*

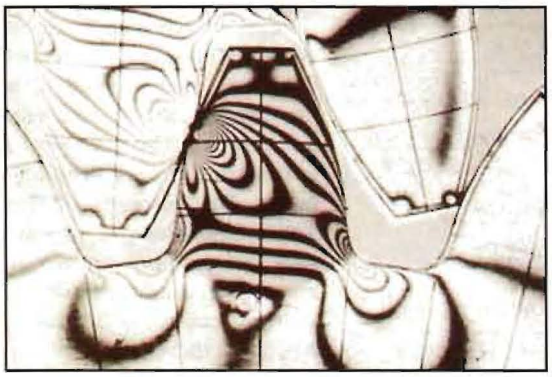


**FIGURE 5.** *Step wear caused by excessive backlash*

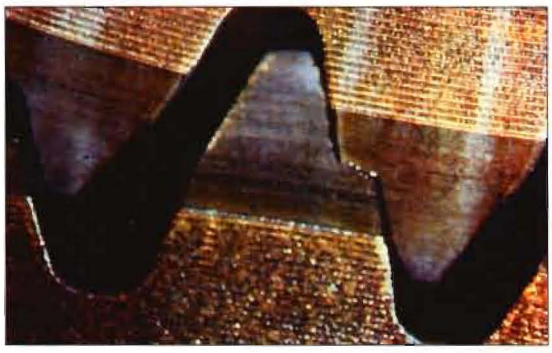


**FIGURE 3.** *This photo shows misalignment caused by axial run-out.*

The gear mesh shifting from side to side is an indication of speed variations of the particular dryer(s). Usually this is caused by dryer imbalances and can be traced to flooding of the dryer(s) or broken balance weights or siphons. If a dryer has a different diameter than the others, the backlash may appear to shift as the can slips against the paper or felt. There will often be noise associated with this condition. If the entire section is affected, the fluctuation is in the drive.

Viewing the gear mesh from the side, if there is a variation in the edge relationship, is an indication of axial run-out in one or both of the gears, a gear not true on the journal, or a bent journal (Figure 3).

**BACKLASH.** Referring to Figure 1, backlash should not be tight or excessive. Tight backlashes interfere with the ability of mating gears to properly roll in and out of mesh. As the mating gears disengage after meshing and transmitting power, the tooth tip of one gear rides against the backside of a tooth on the mating gear, creating scoring, stress, vibration, rapid wear, and noise.

Figure 4 illustrates the stresses of two mating teeth receiving full load.[1] Although there are high compressive stresses at the point of contact, the tensile stress is concentrated at the root radius and is thereby the most common point of failure. Excessive backlash caused by an increase in the center distance between the gears increases the moment arm on the mating teeth and the tensile stress at the root radius, often resulting in vibration, fatigue, and failure.

Tight or loose backlash is caused by a change in center distance between the gears. In dryer sections with open gears, movement of the bearing housing or bearing wear, causing a change in center distance. In dryer sections with enclosed gearing, a change in center distance is usually caused by wear in the bearing. But wear of the gear teeth can also cause a change in the backlash distance, and it is advisable to measure the tooth thickness before making any adjustments to the gearing center distances.

Closely related to the backlash is the tip-to-root clearance between mating gears. Tight or loose tip-to-root clearances are also indicative of a change in the center distance between mating gears, and it results in similar problems.

Of course, the gears should be visually checked for excessive wear or breakage (Figure 5). ■

1. Lester E. Alban, *Systematic Analysis of Gear Failures*, American Society for Metals, Metals Park, Ohio, 1995.

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