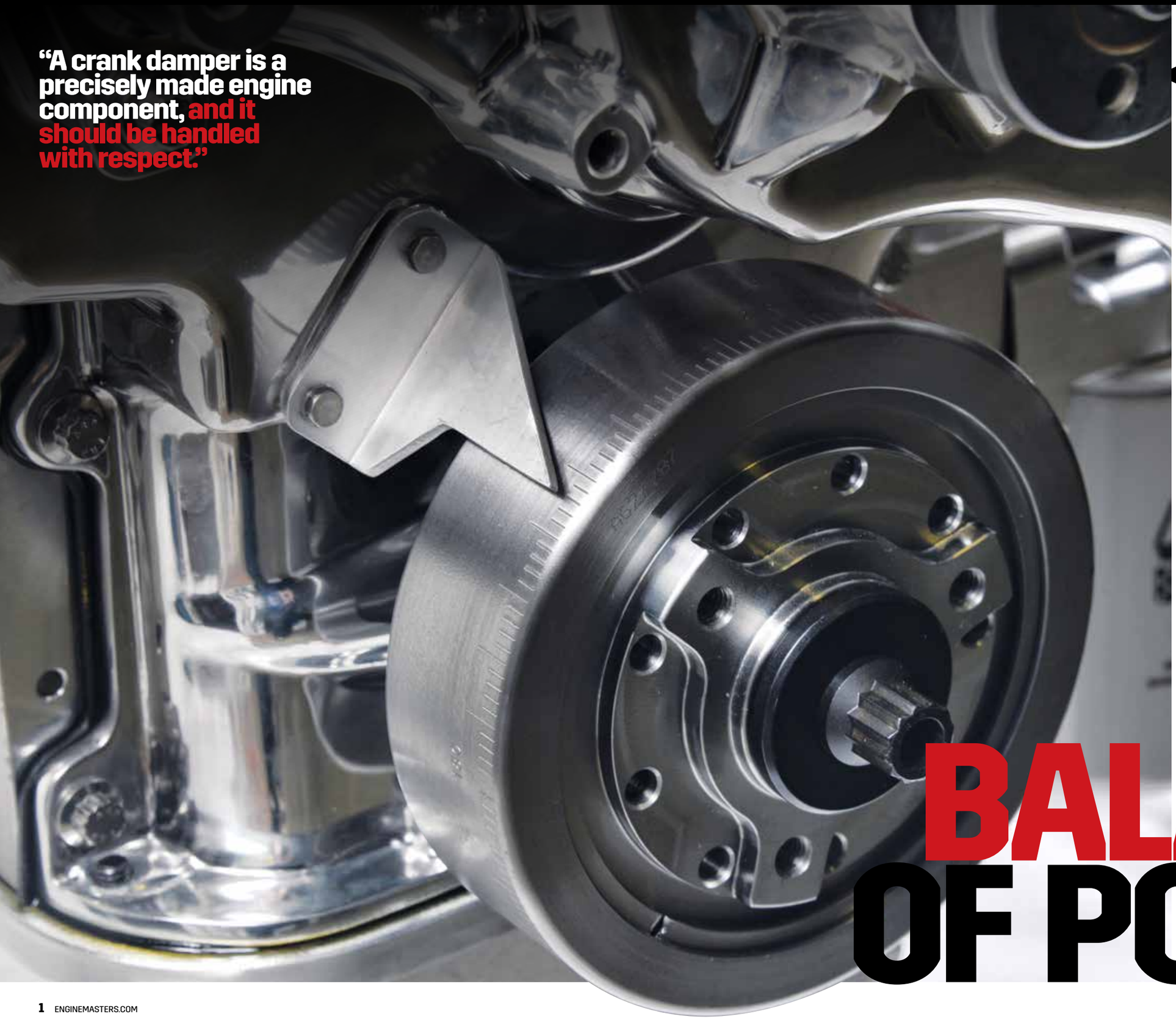

"A crank damper is a precisely made engine component, and it should be handled with respect."

BALANCE OF POWER

Harmonic Balancer Types and Tech

By Archie Bosman

It's easy to underestimate the importance of an engine's harmonic balancer. They can have a profound effect on the reliability and longevity of any engine, particularly a performance or race engine. Harmonic vibrations are a natural enemy of the engine's backbone—the crank and bearings.

With the engine running, camshafts and crankshafts vibrate torsionally (in twist) and, as the saying goes, for every action there's a reaction. Camshafts are affected by the forces related to the opening and closing of the valves while crankshafts by the combustion events. Each time the cylinders fire, torque is imparted to the crank, causing deflections—twisting it as much as 2 degrees. All of this affects and complicates the timing of the valve events and valvetrain stability, as well as ignition timing. This is in addition to the oppressive conditions in which the crank must operate.

As a result of the vibrations and deflections in both shafts, a harmonic balancer or damper is connected to the crank to help absorb them. Vibrations are at their highest when farthest from the flywheel. Therefore, dampers are mounted on the front of the crank, yet, on historic and vintage race engines there is often no provision at the front of the crank to mount a damper. Consequently, they might use a custom elastomer or tunable pendulum damper at the rear of the crank near the clutch.

RESONANCE

At certain engine speeds, the torques imparted by the cylinders are in sync with the vibrations in the crankshaft, which results in a potentially destructive phenomenon known as resonance. This resonance can cause stress beyond what the crank can endure, resulting in crankshaft failure due to fatigue. Robert Bartlett of the noted historic race engine firm Virkler & Bartlett from Virginia uses specialty software to identify how damaging the vibrations are, where they exist in the rev range, and how to move them to maintain them at a safe level.

Says Bartlett, "Two of the many terms used to define torsional vibration are frequency and order. Frequency refers to how many things occur in a period of time; order by the number of events per

[1] The three most common types of harmonic dampers are identified as elastomer, clutch, or fluid. This competition clutch-style damper uses an aluminum case, cover, and hub for low rotational weight.

[2] Inside the casing, spring-loaded 1040 steel inertia rings reside, a part of a free-floating wet-friction clutch pack. The objective is to dampen crankshaft harmonics over a wide rpm range.

[3] Perimeter surfaces vary on this clutch-style damper. Some are smooth and graduated in degrees while others accommodate differing belt-drive forms, commonly serpentine or the cogged HTD (high torque drive). Heat is dispersed by means of a small amount of fluid inside that also acts a lubricant.

[4] The rubber between the crank hub and inertia ring in an elastomer-style damper is what absorbs engine vibrations and keeps them at a safe level.

[5] This custom pendulum damper, employed by V&B Engineering, is useful for eliminating torsional vibrations in historic and vintage race engines that rev higher than originally intended. The arrangement is often incorporated with the flywheel-clutch assembly because the crank doesn't protrude from the front of early race engines.

[6] This pendulum damper features 12 tubular chambers, each containing a loose roller. As the rollers climb the walls of their chambers, they create a strong force that damps crankshaft resonance.

[7] On very powerful drag race engines, this hollow crankshaft pulley drives an HTD belt that spins the blower. This drive employs a sprag mechanism. The sprag device counters stress reversals and prevents belt breakage when driving aggressively on and off the throttle.

crankshaft revolution. If, for example, a rotating shaft is disturbed by two of these vibrations or resonances each revolution, they are defined as second order and they always happen 180 degrees apart. Fourth order torsional vibrations indicate four resonances occurring 90 degrees apart."

CRANK DAMPERS

What are the common options in dampers to help counteract these forces? The three most common types of harmonic dampers are elastomer, clutch, and fluid. The elastomer damper features a ring of rubber placed between the inner hub and the outer inertia ring. This is a very simple and cost-effective solution, and is the type primarily found in OEM engine applications. Probably the chief complaint with the common elastomer damper is deterioration at the elastomer interface. Over time, this energy-dissipating component becomes ineffective due to deterioration from age, temperature extremes, as well as oil and chemical exposure. If visual inspection reveals separation, cracking, or bulging of the elastomer, or wobbling while running, it's time to replace it.

In contrast to the common damper described earlier, the two-part flat-clutch harmonic damper operates with a Bellville spring—there is no elastomer. Race engine builder and racer Chuck Lawrence says, "It's a wet friction clutch-style damper and, similar to an automatic transmission clutch, it operates in oil or fluid, though not much." This type of damper uses the fluid to lubricate the clutch pack and to dissipate heat, however, it is not a fluid damper.

The most desirable harmonic damper for a race car, according to Lawrence, is the all-aluminum clutch-style with 360-degree calibrations. With lighter rotational mass and constructed to an SFI-certified standard, these have been produced for more than 25 years by Innovators West of Kansas. "The clutch pack in these dampers is long lasting, but they rely on a proper 0.002- to 0.003-inch interference fit," he insists. "Aluminum expands twice as fast as steel and therefore the installation requires diligence—a clean, smooth lubricated fit (assembly lube) with no burrs, no blemishes, on the contact surfaces." Innovators West produces the same style damper with a steel hub for street performance muscle car engines. The steel hub makes it more suitable for road use.

The primary function of any harmonic damper is to resist accelerating vibrations and to absorb them over a wide rpm range. Its secondary function is to accommodate belt drives for a variety of engine accessories. This will commonly include V-belts, serpentine, or High Torque Drive (HTD or "cogged"). Drive belt tracks can operate around the balancer's perimeter or on bolt-on pulleys, situated both fore and aft. Serpentine belts are almost always favored for high-performance street vehicles and are required in some classes of drag racing. They comprise six or eight ribs and even ten ribs are available for higher torque engines. On high-horsepower supercharged applications, HTD belt systems are the preferred method of driving the supercharger.

CRITICAL ADVICE

A crank damper is a precisely made engine component, and it should be handled with respect. Keep the hammers in the toolbox and use the correct installation and removal tools. Measure the interference fit of the damper and make sure the press meets the manufacturer's specifications. Wailing on a damper that is too tight will usually result in damaged parts, and honing a competition damper to enable it to slip on and off easily is just as wrong, and will compromise the function of this important component. **[EM]**

SOURCES:

INNOVATORS WEST
(785) 825-6166
innovatorswest.com

VIRKLER & BARTLETT
Chatham, VA
(434) 432-4409