SUPERIOR AIR PARTS, INC

Tech Notes

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Subject: Engine Balancing Part III
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This is the third in a five-part series of short, somewhat-technical articles on methods of minimizing Engine Vibrations. Vibrations in a reciprocating engine are primarily caused by imbalance of 5 types:

Rotating, Reciprocating, **Inertial,** Combustion, and Torque

Inertia is defined as the resistance of a body to change in velocity, or acceleration. In the case of an accelerating car, this is mass. In the case of a rotating body, such as a flywheel, this is called the moment of inertia. The rotating motion of a reciprocating engine is analogous to the moment of inertia of a flywheel. This is actually a much simpler problem, and much easier to correct, that the dynamic balancing of a crankshaft from part 1.

The moment of inertia of the crankshaft is changed by the addition of the masses of the connecting rods to the crankshaft's crankpins. If the center of gravity of one of the connecting rods is different than the others, it's as if the flywheel in our example were egg shaped. You can imagine the extra vibrations that would occur if the flywheel was out of round. In fact, great care is taken to balance the moment of inertia of rotating masses – it's just not apparent to think of four or six rods on a crankshaft the same way as you think of a disk. This is why it's important to have the ends of rod sets weigh the same – so the center of gravity is the same, so the moments of inertia are the same and balanced.

Inertial forces are also the culprit in torsional vibrations. Torsional vibrations are induced through the interaction of the propeller moment of inertia and the engine. The propeller tries to stay rotating at the same speed, but the pulses transmitted through crankshaft from combustion instantaneously try to accelerate the large flywheel on the nose. The result is feedback through the not-so-stiff crankshaft. When this hits, or even comes close to a resonant natural frequency of the system, the torsional vibrations go though the roof. Resonant systems are simple to demonstrate: put a weight (prop) on the end of a rubber band (crank), hold the other end and move it up and down (combustion), trying various speeds. Eventually you'll find the resonant frequency and the weight's motion will quickly exceed your input.

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