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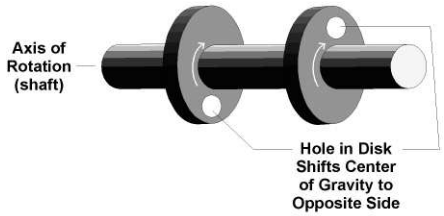
This is the first in a five-part series of short, somewhat-technical articles on methods of minimizing Engine Vibrations. Vibrations in a reciprocating engine are primarily caused by imbalance of 5 types:

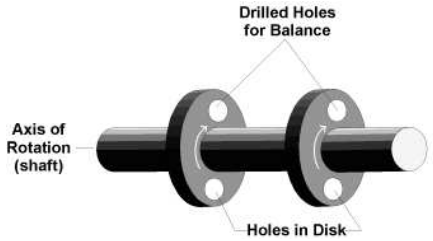
Rotating, Reciprocating, Inertial, Combustion, and Torque

Rotating parts can be balanced either statically or dynamically. The flywheel is a good example of a static balance. In order to balance the flywheel, holes are drilled on the heavy side to remove weight and make a balanced disk, where the center-of-gravity is on the axis of rotation of the part.

Crankshafts require 2-plane dynamic balancing to minimize vibrations. A 2-plane dynamic balance is analogous to 2 flywheels on a shaft, (see figure below). As a system, the shaft and 2 flywheels may be balanced in a single plane (looking from the end of the shaft), but not in 2-planes (the second plane being perpendicular to the shaft). The shaft of the rotating system seen below would rock up and down or vibrate (imagine a pivot at the middle of the shaft, like a see-saw or scales).



The goal in a 2-plane dynamic balance is for both discs to have the same static balance. Again, looking from the end of the shaft at the system below, we can see that the system is statically balanced; and looking at the location of the balancing stock removal of both disks we can see that it is also dynamically balanced in 2-planes.



Of course, most dynamic balancing is more complex than this simplified example, since it isn't very likely that the two discs will have the same amount of imbalance. The magic is in getting both the location and amount of stock removal right so that the center-of gravity of both discs is the same.

A small amount of imbalance can have a large effect on vibrations. For example, a 2500 RPM crankshaft with a 1 ounce imbalance at 1 inch from the axis of rotation will result in 11 pounds of force applied at every revolution. If this is applied at 2

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disks (throws), 1 foot apart, the resulting rocking torque would be over 130 in-lbs. This is why Superior takes great care in the manufacture of our parts and engines to insure the highest level of static and dynamic balance.

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