SUPERIOR AIR PARTS, INC

Tech Notes

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Subject: Engine Balancing Part IV

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This is the fourth 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

Combustion Forces are the result of the expansion of the burning air-fuel mixture. Imbalances in these forces can be caused by poor spark timing, detonation, pre-ignition, or unequal cylinder air-fuel mixtures, as well as a multitude of cylinder related problems I won't go into.

Variations in spark timing can be caused by plug fouling, magneto problems (arcing, contact wear, etc) or harness problems.

Detonation is a serious problem, but can occur to varying degrees. Detonation is caused by ignition of a high temperature air-fuel mixture. This can be caused by any combination of the following: high CHT or intake air temperatures (temperature), poor valve dynamics or high compression ratios (pressure), or lower than required octane fuels.

Pre-ignition can be caused by plug fouling, combustion residue, "hot-spots" in the combustion chamber, such as sharp corners, metal burrs, or other "glowing" contaminants.

Unequal air-fuel mixtures are the most common contributor of combustion vibrations. There are two ways this can be created: unequal fuel and/or unequal air delivery to the combustion chamber. If unequal fuel is delivered to the combustion chamber, a rich or lean mixture can occur causing variations in the combustion process from cylinder to cylinder. A too-rich mixture has the effect of retarding the spark timing, causing a lower pressure to be created in the combustion chamber. Too-lean mixtures will also have the same effect, but his time the lower pressure is because there's just not enough fuel to burn. These problems are common to carbureted engines, which often have poor fuel distribution.

Fuel injected engines have a somewhat different problem, the cylinders get roughly the same amount of fuel, but different amounts of air. GAMI has addressed this with their injectors, which have flows matched to specific cylinders and the air they receive. While this balances the air-fuel mixture (and EGT's), preventing overly lean or rich operation, each cylinder creates power based on the amount of air it receives, which, with an un-tuned induction systems, can be quite a spread. The variation of air to each cylinder can also be affected by the port flows of the cylinder head. While a tuned induction will get the same amount of air to the cylinders, variations in head castings or port shape can also "choke" the flow, and significantly impact the resulting air-fuel mixture.

Variations in combustion forces are one of the reasons Superior pays such close attention to the Millennium cylinder port and combustion chamber design and consistency. It's also the reason our sump has a tuned, ported induction system design. A better breathing engine is a healthier, stronger engine.

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