Detonation and Pre-Ignition

When an internal combustion engine is torn down for rebuilding and badly burned and distorted pistons and valves are found, it is very likely caused by extremely high combustion chamber temperatures and pressures from detonation or pre-ignition. Generally speaking, most machine shop personnel know that such damage is caused from abnormal engine operation. Too often, the customer does not know what causes the costly damage, yet the machine shop may be unjustly blamed for an engine "that didn't stand up".

Detonation and pre-ignition are forms of abnormal combustion in the combustion chamber. During normal operation of the engine, the burning of the fuel-air charge produces a steady, smooth push on the pistons of each cylinder. At the instant of ignition by the spark plug, the flames of combustion moves rapidly outward from the plug very much like the waves when a stone is dropped into a pool of water.

Abnormal operation may allow combustion pressures to develop so fast that the heat and pressure will "explode" the remaining unburned fuel. This produces the knock, often called "ping", carbon knock, etc. Actually this is detonation. The knock results from the violent explosion when the normal flame front runs into the secondary flame front. Detonation will cause piston and ring damage, top ring groove wear, scoring, sticking rings, loose head gaskets and possible complete engine failure.

Detonation can be caused by:

- 1. Lean fuel mixture
- 2. Fuel octane too low
- 3. Improper ignition timing
- 4. Lugging
- 5. Carbon deposits
- 6. Excessive milling of heads or block, which will increase compression ratio

Pre-ignition, as the term suggests, is the ignition of the fuel-air mixture before the regular ignition spark from the spark plug. If the regular spark occurs shortly after the pre¬ ignition, the colliding of the two flame fronts will cause a pinging noise. Pre-ignition causes loss of engine power and can cause severe damage to pistons, rings and valves.

Detonation and pre-ignition are so closely related that it is difficult to distinguish one from the other by sound. Each can lead to the other and either condition can cause extensive engine damage. Inspection of damaged pistons and rings quite often indicate which caused the damage.

Damaged pistons and rings usually mean replacement. The same damage can occur again unless the cause of the detonation or pre-ignition is corrected.

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Pre-ignition can be caused by:

- 1. Carbon deposits that remain incandescent
- 2. Spark plugs too hot a heat range
- 3. Spark plugs not firmly seated against gasket
- 4. Detonation or the condition leading to it
- 5. Sharp edges in combustion chamber
- 6. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats
- 7. Overheating
- 8. Ignition cross-firing. Induced voltage in spark plug wires that run parallel to each other for long distances

Thank you for looking,

Gregg Spears

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