

Engine destruction caused by detonation

by Gene Hailey

Detonation has been around for as long as the internal combustion engine, although it wasn't a major problem when new engines only had compression ratios of 6:1 and lower. Even when we got into the cubic inch and horsepower race during the 50's with stock compression ratios shooting up to 10.75:1, detonation caused failures were not too common.

One factor is that gasoline was available in varieties of up to 100 octane, loaded with lots of tetraethyl lead. It was also quite inexpensive compared to the current fuel prices. Engine management systems were also pretty simple in those days.

Then around 1972 all this simplicity started a gradual change to a jumble of complexities to manage the spark and fuel needs to the engine. This change is in the interest of cleaner air and



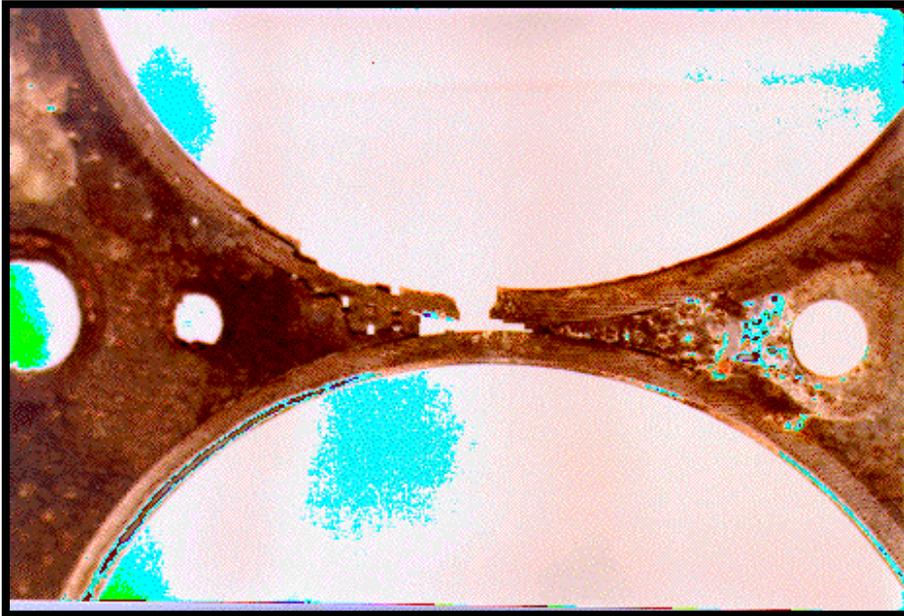
the federal government started mandating certain modifications to new automobiles. In spite of hearing objections to the above and how good the "good old days" were, all of us should be glad that we can find a way to have automobiles and reasonably good air to breathe on the same planet.

The first attempt to control emissions was comparatively simple, lower the compression ratio, remove some of the lead, install a valve to ventilate the crankcase fumes back into the combustion and lean out the mixture. The lean burn created yet another problem, too much

NO_x or oxides of nitrogen. In order to lower the emissions of NO_x, an EGR valve was installed on the intake manifold to recirculate some of the exhaust gas which actually lowers the temperature of the combustion.

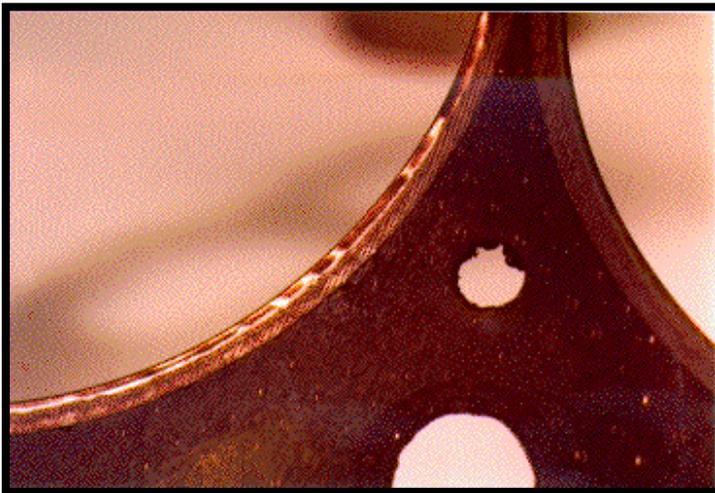
This setup is still the basis of emission control, but now the engine is dependent upon computerized microprocessors and all the sensors which feed data to the computer to control the spark timing and the operation of the EGR valve. The causes of detonation are varied and many, however EGR valve malfunction or non-function is the most common one.

In some of the early setups the cause may be as simple as too much compression and/or spark advance for the octane rating of the fuel. This is relatively easy to correct (like buying some 93 octane go juice) in comparison to some of the newer complex systems.



I won't go into all the causes of detonation at this time but I do want to emphasize the serious effect that abnormal combustion has on the engine. The piston in the photo on the left has failed completely due to detonation, at least the

detonation stops after the heat burns the hole in the top of the piston as the compression drops to zero. The gasket fire ring shown in the photo below is solid proof of the damage from detonation. The usual scenario is complete failure of the fire ring, however this gasket was removed from the engine before a complete burn occurred on this particular cylinder. Note the randomly spaced indentations on the fire ring. The shock loads of extreme pressures have peened the combustion sealing ring of the gasket. Normal combustion pressures reach about 600 P.S.I., in some cases of serious detonation caused combustion the pressures reach ***twelve hundred (1,200) pounds per square inch!!!***



After continuous battering of the gasket (if the piston doesn't cave in first) the combustion flame finds a path across the fire ring and complete destruction of the gasket occurs very quickly afterward as shown in the photo below.

The malfunctioning EGR valve is really a silent killer of the engine because driveability problems are barely noticeable or no symptoms are detected until after the engine has

failed.

The metering of the flow of exhaust gas into the engine is quite critical to the life of the engine. Too little flow or no flow of gas at all will usually go completely unnoticed, the driver of the vehicle thinks everything is just fine until something fails inside the engine. Too much flow of exhaust gas into the engine at slow speeds or idle will affect driveability and also cause an audible ping during acceleration and rough idling.

A new EGR valve installed on the engine is no assurance that it is working correctly, the valve is dependent on the vacuum signals it receives or should receive through a vacuum amplifier. A weak vacuum or none at all will not open the valve at the right time and that's the deadly situation.

Some EGR valves are controlled electronically but even those are at the mercy of the on board computer. Again, there are many other causes of detonation and to be sure that the remanufactured engine is going to run the course, the installation should be finalized with a complete diagnosis of the engine controls.

In several cases, the original engine failed due to a malfunctioning EGR valve or some other component in the engine control system. Replacing the engine fixed the damage but did not correct the root cause.