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engine rpm, and vacuum, based on engine load and operating conditions. The centrifugal advance system is purely mechanical and is only rpm-sensitive; nothing changes it except engine rpm. Vacuum advance, on the other hand, responds instantly to engine load and rapidly changing operating conditions, providing the correct amount of spark advance at any point in time, to deal with both lean and rich mixture conditions.

By today's engine management terms, this was a relatively crude mechanical system, but it did a good job of optimizing engine efficiency, throttle response, fuel economy, and idle cooling, with absolutely zero negative effect on wide-open throttle performance, as the vacuum advance is inoperative under that condition. In modern cars with computerized engine controllers, all those sensor inputs to the computer change both spark timing and fuel/air mixture 50 to 100 times per second, and we don't even have a distributor anymore – it's all electronic.

"PORTED" VACUUM: Now to the widely misunderstood manifold vs. "ported" vacuum aberration. After 30-plus years of controlling vacuum advance systems with full manifold vacuum, that "free" indicator of engine load and fuel mixture, along came early emission control requirements (seven years before catalytic converter technology was introduced), and all manner of crude band-aid systems were introduced to try to reduce hydrocarbons and oxides of nitrogen in the exhaust stream. One of these crude, but effective systems was GM's Air Injection Reactor (A.I.R.) system, which pumped fresh air into the exhaust ports to "afterburn" pollutants in the exhaust manifolds. The key to making this system work at maximum efficiency was retarded spark at idle; with retarded idle spark timing, the "burn" begins late, and is not complete when the exhaust valve opens, which does two things that were important for emissions. The incomplete burn reduced combustion chamber temperatures, which reduced the formation of oxides of nitrogen (NOX), and the significant increase in exhaust gas temperature ensured rapid "light-off" and combustion of the hydrocarbons in the exhaust gas stream when the fresh, oxygen-carrying air was introduced from the air pump.

As a result, these engines ran poorly, and an enormous amount of wasted heat energy was transferred through the exhaust port walls into the coolant, causing them to "run hot" at idle; cylinder pressure fell off, engine temperatures went up, combustion efficiency went down the drain, and fuel economy went down with it. "Ported Vacuum" was easy to implement – they just moved the distributor vacuum port orifice in the carburetor from below the throttle plate (where it was exposed to full manifold vacuum) to above the throttle plate, where it was exposed to manifold vacuum only after the throttle plate opened. This meant that the vacuum advance was inoperative at idle (retarding idle spark timing from its optimum value), and these applications also had very low initial timing settings; they were usually set at four degrees before TDC or less, and some even had initial timing settings as much as two degrees after TDC. The vacuum advance still worked at highway cruise, but not at idle, which caused all manner of problems. "Ported Vacuum" was strictly an early pre-converter crude emissions strategy and nothing more. Don't believe anyone who tells you that ported vacuum is a good thing for performance and drivability – it's not. Anyone with a street-driven car without manifold-connected vacuum advance is sacrificing idle cooling, throttle response, engine efficiency, and fuel economy, probably because they don't understand what vacuum advance is, how it works, and what it's for. There are lots of long-time experienced mechanics who don't understand the principles and operation of vacuum advance either, so they're not alone.

THE BOTTOM LINE: Now that we've covered the why's and how's of spark timing and its control systems, you can appreciate what's going on underneath your ignition shielding and how it affects performance and drivability. Checking the operation of the centrifugal and vacuum advance systems during periodic maintenance and tune-ups can pay real dividends that you can feel in the seat of your pants. Well, you say, "How do I do that?" Tune in next month, when we'll show you how to check out those systems, how to "map" your advance curves against their design specifications and verify proper operation, and pass along some simple tips and techniques for improving your Corvette's performance by "tweaking" its advance systems for peak efficiency. ■