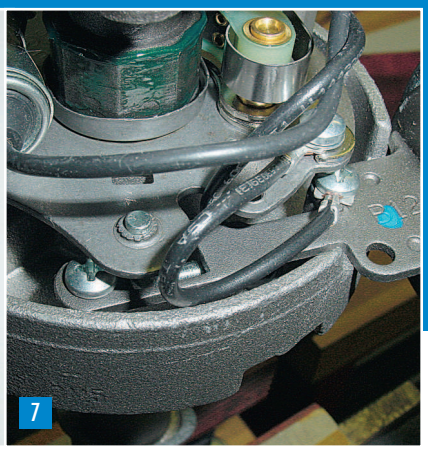




6 A typical vacuum advance unit. The rod at the bottom is connected to the vacuum diaphragm, and connects to the movable points breaker plate at the other end. When vacuum is applied, it advances the breaker plate.

7 The vacuum advance unit, attached with two screws to the distributor body. The tip of its actuating rod is visible at the left, protruding through the movable breaker plate.

pressure is still reached at the same point just after TDC.

Now we have the basic physics handled, but we still need another system to manage spark advance based on all the variations of driving conditions and engine load variations experienced in normal operation. This is handled by the vacuum advance system.

VACUUM ADVANCE: The vacuum advance system consists of a vacuum diaphragm mounted on the distributor body. The diaphragm is spring-loaded in the zero-advance position, and has a rod that connects to a hole in the breaker plate, which is the movable plate the points are mounted on. When vacuum is applied to the diaphragm, it pulls on the rod, which in turn pulls on the breaker plate, rotating it with respect to the eight-sided cam on the distributor shaft which opens and closes the points. When viewed from the top, the distributor shaft (and the eight-sided cam for the points) turns clockwise. When the vacuum advance rod pulls on the breaker plate, it rotates the breaker plate (and the points) counter-clockwise, which "advances" the opening of the points (triggering the coil to fire the spark plugs). A typical vacuum advance unit, when fully deployed, will add about 15 (crankshaft) degrees of spark advance over and above what the distributor's centrifugal advance system is providing at the moment, which depends on engine rpm. They are two independent systems, but they work together to provide the correct amount of spark advance.

CONTROLLING VACUUM ADVANCE: Let's look at how the vacuum advance system is controlled. Referring back again to burn rates, remember that lean mixtures burn slower and rich mixtures burn faster. Engine load conditions (idle, steady cruise, acceleration) result in how lean or rich the air/fuel mixture is (the carburetor handles this), and the best indicator of engine load is intake manifold vacuum. At idle and steady cruise, engine load is low, and intake manifold vacuum is high due to the nearly closed carburetor throttle plates. Under acceleration, the throttle plates open wider, and intake manifold vacuum drops. It is essentially zero at wide-open throttle. As a result, intake manifold vacuum is a "free" indicator of engine load, which correlates nicely with fuel mixture being supplied – lean mixture at high vacuum, and rich mixture at low vacuum.

At idle, the engine needs additional spark advance in order to fire the lean (and exhaust-diluted) idle fuel/air mixture earlier in the cycle in order to develop maximum cylinder pressure at the proper point after TDC for efficiency, so the vacuum advance unit is activated by the high manifold vacuum, and adds another 15 degrees of spark advance on top of the fixed initial timing setting. For example, if your initial timing is set at 10 degrees, at idle it's actually 25 degrees with the vacuum advance connected (a properly calibrated centrifugal advance mechanism will not have started to move yet at idle rpm).

The same thing occurs under steady highway cruise conditions. The mixture is lean, takes longer to burn, the load on the engine is low (it takes only about 40 horsepower to cruise at 50mph) and the manifold vacuum is high, so the vacuum advance unit is again deployed and adds 15 degrees of spark advance over and above whatever the distributor centrifugal advance mechanism is providing at that engine rpm. If you had a timing light connected so you could see it as you cruise down the highway, you'd see about 45-50 degrees of spark advance – your fixed initial advance of 10 degrees, 20-25 degrees provided by the centrifugal advance mechanism, and the 15 degrees added by the vacuum advance unit.

When you accelerate, the fuel/air mixture is immediately enriched (by the accelerator pump, power valve, metering rod piston, etc.), and that rich mixture now burns faster and doesn't need the additional spark advance anymore. When the throttle plates open, the manifold vacuum drops, and the vacuum advance unit diaphragm retracts to its zero position, "retarding" the spark timing back to what is being provided at that moment by the fixed initial timing and the centrifugal advance mechanism. The vacuum advance doesn't come back into play until you back off the gas and manifold vacuum increases again as you return to steady-state cruise, when the mixture again becomes lean and needs more spark advance for fuel efficiency.

VACUUM ADVANCE CALIBRATION: There are also many different calibrations of vacuum advance units. Some begin to deploy at different vacuum levels than others, and some provide more degrees of advance when fully deployed than others. The original calibration was selected based on the intake manifold vacuum characteristics of that particular engine/transmission combination and how it was expected to perform in daily use. Vacuum advance units were connected to full manifold vacuum for decades. In the late '60s and early '70s, when emissions began to become an issue, many were instead connected to "ported" or "timed" vacuum sources. We'll discuss this aberration a little later.

THE ADVANCE COMBINATION: Now we have two different advance systems working independently, but complementing each other, to manage spark timing – centrifugal, based on