MAPPING YOUR ADVANCE CURVE

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Last month we discussed timing and vacuum advance, why it's necessary, how those systems operate, and how they work independently to keep your classic Corvette operating at maximum efficiency. Now that we have a basic understanding of these systems, we need to know how to keep them operating as they were designed, how to check them out during routine maintenance, and what's involved in modifying their behavior for improved performance.

The objective of this article is to show how to verify the operation of these systems and make necessary corrections at home, using ordinary tools; there's no need for a classic Corvette owner with average mechanical skills and a few basic tune-up tools to pay shop rates to have this work done – you can do it yourself and get to know your car better at the same time.

Tools: We're not talking about "engine analyzers" here – all we need is basic hand tools, a dwell meter, vacuum gauge, and a timing light, all of which most Corvette owners have who do their own tune-ups. A "dial-back" timing light simplifies the job, but an ordinary fixed timing light will work fine. The Chevrolet Chassis Service Manual for your year Corvette is also handy, as all of the centrifugal and vacuum advance specifications for your distributor are shown in the back, in the distributor chart in the "Engine Electrical" section. For illustrative purposes, we'll use the "numbers" for a 1967 327/300hp; for your Corvette, just plug in the specs for your particular engine combination as we go along.

Preparation: Although we're not going to go through a description of a complete tune-up, this is probably a good time to change your plugs, points, condenser and rotor, and inspect the inside of your distributor cap and your plug wires to make sure they're in good shape before we get started so we're working with "fresh" components in peak condition. Fire it up, let it warm up to operating temperature, and we'll get started.

Precautions: We're going to be working from here on out under the hood with a running engine and various wires and cables strung around it from a timing light and dwell meter; make sure those wires and cables are routed away from the fan and belts, and be careful using the timing light – don't get so focused on the timing readings that you stick the light (or your hands) into the path of the fan or the various drive belts. Think safety first – you need two hands and ten fingers to read more good stuff in future issues of "Corvette Enthusiast".

Setting Dwell: It's important to set the dwell of your points before we do anything else, as point dwell affects ignition timing; there's no point in mapping your advance curve first and then finding out that dwell is not set correctly and having to do it all over again. Hook up your dwell meter to the coil and ground (instructions are usually on the meter) and use a 1/8" hex Allen wrench to adjust the screw behind the "window" in the distributor cap until you see 30° on the meter with the engine running. You can also get an idea of the condition of your distributor by watching the dial as you gradually increase engine speed up to 4000-5000 rpm; if you note more than 2° variation in dwell at high rpm, that's a clue that the distributor needs attention (which they rarely get, as they sit neglected back there in the dark under the shielding and don't get the maintenance they need). Excessive dwell variation can be caused by worn shaft bushings (usually the upper bushing), too much shaft end play between the top of the drive gear and the bottom of the housing (should be .002"-.007"), or a wobbly breaker plate (the circular plate the points are attached to).

Most dwell meters also have a tachometer feature (just flip the switch from "dwell" to "tach") which we'll use shortly, so leave it connected.

Checking Timing: We're going to check all three systems we discussed last month – initial (base) timing, centrifugal advance, and vacuum advance. Part of this involves checking "total timing" (initial plus centrifugal, with the vacuum advance disconnected), which will be in the range of 34-38 degrees BTDC (Before Top Dead Center); the tab on the timing cover is only calibrated up to about 15° (depending on the engine), so we need to be able to measure well beyond that. If you have a "dial-back" timing light, it's duck soup – at any given point, you just turn the dial on the light until the index mark on the balancer aligns with the "0" mark on the timing tab, and read the degrees of advance on the timing light's dial.

If you have a standard fixed (non-dial-back) timing light, we can accomplish the same thing with a piece of masking tape. Measure the circumference of the balancer and divide by 10; this will give you the length of a 36° segment. Cut a piece of masking tape exactly that length, and subdivide and mark it into smaller divisions (center is 18°, center of each resulting half is 9°, center of each of those segments is 4.5°, etc.). Then mark the piece of tape with 0° at the left end, 18° in the center, 9° between 0° and 18°, 36° at the right end and 27° between 18° and 36° (see photo), and apply it to the balancer with the 0° end aligned exactly on the balancer's timing index line and the 36° end down, clockwise on the balancer as viewed from the front. You now have calibrated markings on the balancer from 0° advance to 36° when aligned with the "0" on the timing tab. Or, you can buy a "timing tape" for your particular diameter balancer from any speed shop and apply it permanently for future "quick checks".

Initial (base) Timing: This is the foundation we start from, and we need to measure and set it accurately, at the lowest possible idle rpm, with the vacuum advance hose to the distributor disconnected and plugged (golf tees work great). Old, weak springs on the advance weights can allow the centrifugal advance system to “start” too early and influence the initial timing reading/setting, so we can eliminate that possibility by putting a rubber band around the advance weights to hold them in their fully-retracted position, only for this check. Remove the distributor cap and rotor, apply a rubber band, re-install the rotor and cap, and we’re ready to go. Fire it up, adjust the idle speed screw on the carb to get the lowest possible idle rpm, and check the reading at the timing tab with your light; if it’s different than the spec on the distributor chart for your engine, loosen the distributor hold-down clamp bolt and rotate the distributor (the advance can makes a good handle) until your timing light shows the correct advance number on the timing tab. write this number down (6° for our 327/300hp example). Remove the rubber band around the weights and we’ll move on.

With the rubber band removed, fire it up again (vacuum still disconnected and plugged), set the idle speed screw on the carb to get your normal idle speed (500 rpm for our example), and check the timing again with your light; if it shows more advance than the reading we took with the rubber band in place, the centrifugal advance system is starting too early. For our example, the centrifugal advance isn’t supposed to start until 900 rpm. If your reading hasn’t changed, you’re OK for this phase of the check.

Centrifugal Advance and “Total Timing”: In this phase, we’re going to check “total timing”, then we’ll “map” the centrifugal advance curve and compare it to the original specs. Have a note pad and pencil handy to jot down various rpm levels and advance readings, and you might pre-write three columns, using the specs from the distributor chart in the Shop Manual – one with rpm levels (900, 1200, 1500, and 5100 for our example), and one with advance readings at those rpm levels (0, 9, 15, and 30 degrees for our example). Leave space next to this second column to jot down your observed readings so you can compare them with the design specs. **Note for C-1’s:** The distributor chart in the back of the “ST-12” 1953-1962 Corvette Servicing Guide for centrifugal advance specs shows rpm and advance numbers in **distributor** rpm and degrees, not **engine** rpm and degrees – double the printed numbers to get them in **engine** terms.

Total Timing: Connect your timing light, fire up the engine, and pull the trigger on the light while observing the timing marks. Continuing to observe the timing with the light, gradually rev the engine up until the marks stop moving (advancing), and write down both the rpm at which the marks stop moving and the observed maximum advance reading; this reading is “total timing”, the sum of initial and maximum centrifugal advance. For our 327/300hp example, it should be 36 degrees (6° initial plus 30° from the distributor). Subtracting your initial timing reading from the observed maximum reading will tell you how many degrees of advance are being provided by the centrifugal mechanism in the distributor, which should correspond with the maximum spec number in the “Centrifugal Advance” column of the distributor chart.

This check also provides another opportunity to judge distributor condition; if the observed timing “jumps around” or moves rapidly back and forth at steady high rpm, that’s another indication that the distributor needs attention. This is called “spark scatter”, and has the same causes outlined earlier in the “Setting Dwell” section – worn shaft bushings, excessive shaft end play, and wobbly breaker plate.

If the “total timing” number is more than 38 degrees, that’s excessive, and may indicate that the advance limiting bushing has fallen off the pin that protrudes downward through the slot in the autocam under the advance weights. This is not unusual in an old distributor; if that’s the case, it’s advisable to loosen and re-adjust the distributor to reduce initial timing so it won’t have more than 36-38 degrees total advance until the bushing is replaced. Most speed shops have an assortment of advance limiting bushings; the larger the O.D. of the bushing, the more it will limit maximum advance.Total tIming over 38 degrees can cause detonation at full throttle, which is highly destructive.

Mapping Centrifugal Advance: Gradually rev up the engine to each of the rpm levels in the left column, and write down the observed advance readings at each level next to the “spec” advance numbers from the distributor chart in the right column. Then subtract from each your initial advance reading (6° in our example) to get only the degrees of advance added by the distributor’s centrifugal advance mechanism. This now constitutes a “map” of your centrifugal advance system you can compare to the original design specs in the first and second column.

This is not a NASA-level mechanical system (the weights and springs), and a few degrees of deviation at each point is normal; more than a few degrees at each point, however, indicates possible weak springs, sticky or worn weights, or a missing advance limiting bushing.

Vacuum Advance: Now that we’ve dealt with initial timing and centrifugal advance and have a feel for the mechanical condition of the distributor, we can examine the vacuum advance system and see how it’s working. Go back to the distributor specs chart in the Shop Manual, and it will show how the vacuum can was originally calibrated, in “X” degrees of advance at “X” level (in inches of mercury – Hg.) of vacuum; this is expressed with two specs – starting point, and maximum advance. For our 327/300hp example, it says the can provides 0° at 6” Hg. (which means it starts pulling on the breaker plate at 7” Hg.), and provides its maximum of 15° of advance at 12” Hg. This is where your vacuum gauge comes into play.

Remembering last month’s discussion, you want the vacuum advance can connected to **full manifold vacuum**, normally found at the base of the carburetor; you can check the ports with the engine running by connecting the vacuum gauge to each until you find the one that shows 12”-18” of vacuum at idle (depends on each engine). **“Ported” or “timed”** vacuum ports will show no vacuum at idle at all, then will show vacuum when the throttle plates are opened off-idle.

Your vacuum gauge can be connected to full manifold vacuum at several locations – teed into the existing vacuum advance hose (if it's connected to full manifold vacuum), connected to the vacuum fitting on top of the intake manifold behind the carburetor (normally used for power brakes and/or the Powerglide vacuum modulator connection), to the large PCV hose nipple on the carburetor base, or teed into the rubber hose from the carburetor base to the choke pull-off diaphragm.

Verifying Vacuum Advance Operation: With your vacuum gauge connected (and the vacuum to the distributor still disconnected and plugged), start the engine and let the idle stabilize. Your timing light should show the same initial timing reading you observed during the **"Initial Timing"** step earlier (check your notes); note the vacuum reading on the gauge and write it down. Now remove the plug from the distributor vacuum hose and connect it to the nipple on the advance can (quickly, so the engine doesn't die); idle rpm will increase. Now check the timing again with your light and write down the advance number, and the reading on the vacuum gauge. The timing should show an advance equal to the maximum advance spec for the can; for our example, it should increase 15° from 6° (vacuum disconnected) to 21° with the vacuum hose connected. If no increase in advance is noted, the diaphragm has failed and the advance unit must be replaced, or the breaker plate is stuck. If less than the specified advance is noted, the diaphragm may be leaking, or the breaker plate may be binding.

Assuming the check shows positive results, the vacuum advance is working properly; leave it connected, and re-set idle speed and the idle mixture screws (work back and forth between the two screws to achieve highest steady vacuum reading) to re-establish your desired idle rpm.

This is a "gross" test, which simply says the vacuum advance is working or it isn't; in order to check vacuum advance more closely, you can use a MityVac vacuum pump, which has its own gauge, on the vacuum advance can's nipple with the engine running to see at precisely what vacuum level the advance diaphragm starts to move and how much advance it provides at that vacuum level. The "gross" test is usually sufficient.

Modified Engines And Vacuum Advance: Looking at vacuum advance specs again, you'll note that maximum advance is achieved at "X" level of manifold vacuum (generally 12"-15" Hg. for production engines); these engines normally have 15"-18" Hg. of vacuum at idle, so the advance can is fully deployed at idle. This is important for stable idle speed and good idle cooling. Modified engines with aftermarket cams or production engines with factory high-performance solid-lifter cams frequently only produce 9"-12" Hg. of vacuum at idle, so they need advance cans calibrated to be fully deployed at much lower manifold vacuum levels in order to provide the advantages of full advance at idle. Advance cans for these engines need to be calibrated to provide full advance at vacuum levels at least 2” Hg. less than the engine produces at idle. Corvette advance cans specified for those engines were so calibrated from mid-1964 on; they started pulling at 4” Hg. vacuum and provided the full 15° of advance (fully deployed) at only 8” Hg. of manifold vacuum. However, those uniquely-calibrated GM advance cans were discontinued from the GM parts system many years ago – what do we do now if we need one? No problem – go to NAPA and get an Echlin #VC-1810 advance unit, stamped “B28” on the bottom (about $10.00); it has the exact same calibration (4” Hg. start, fully-deployed with 15° of advance at 8” Hg.), and it’s a bolt-in replacement. Echlin makes a full line of replacement vacuum advance units for Delco distributors with specs to match the originals; take the spec your engine requires from the Shop Manual with you and the counterman can get you an Echlin unit that will match it.

C1 Dual-Point Distributors: Many C1 applications (mostly 2x4 carbs and fuel injection) used dual-point distributors with no vacuum advance; in those days, the feeling was that most of the buyers of those engines were concerned only with maximum performance or would be racing the cars, and didn’t need the street advantages of vacuum advance. Those distributors had unique centrifugal advance curves, which can be checked out in the same manner I’ve described in the **“Centrifugal Advance”** and **“Total Timing”** sections earlier. They’re more of a challenge to work on, however, as the distributor has to be disassembled to get at the centrifugal advance mechanism, which is buried underneath the breaker plate.

Altering The Advance Curve: A glance at the distributor specs chart will show that nearly all production applications have centrifugal advance curves that don’t reach maximum advance until 4000-5100 rpm. This is a form of warranty protection for the manufacturer, as it ensures that the production calibration will prevent destructive detonation under almost any circumstances, and will only expose the engine to maximum advance for short periods at high rpm. Almost any production engine will show tangible seat-of-the-pants performance improvement with a “faster” advance curve that reaches maximum advance by 2800-3000 rpm, which explains the number of aftermarket “advance curve kits” hanging on the walls of speed shops everywhere. These kits generally have lighter weights, several different limit bushings, and three strengths of pairs of springs, so many combinations are possible with experimentation. The challenge is to come up with a combination that doesn’t “start” too early and is “all in” by 2800 rpm or so for peak performance, **AND** doesn’t result in detonation with your particular engine combination. Trying different combinations, mapping the resulting curves (as we did earlier), and then driving the car with each change to check for detonation takes time, but usually a good compromise can be found eventually, with noticeable improvements. Stick with the GM advance weights – they’re much better than the kit pieces.

There’s an old-school theory that says “Just set total timing at high rpm and let the initial fall as it may”, but that’s bad advice; it may work on a race car that’s run all the time at high rpm and full load, but it ignores the needs of street operation. A street-driven car needs advance systems that handle the full spectrum of operating conditions, loads, and speeds and are both rpm-sensitive and load-sensitive, and that requires carefully mapped systems that work together to optimize performance without risking detonation. Start with the factory specs and optimize from there.

Summary: Last month's issue described and de-mystified the theory and operation of the three ignition advance systems – initial, centrifugal, and vacuum, and dispelled some myths about them. This month we've taken them out of the "rocket science" category and shown you how to check them out, verify their operation, and optimize them, at home, with simple tools. In effect, simply an extension of normal tune-up practices you can do yourself instead of paying someone else seventy-five bucks an hour to do it for you, and at this point you probably know more about advance systems than the guy in the shop does anyway. That's what we're all about here at "Corvette Enthusiast" – helping you understand your classic Corvette better and passing along knowledge so you can keep it in peak condition yourself, drive it, and enjoy it! Stay tuned……