



Most of the tools needed to baseline and recurve a distributor can be found in your toolbox. From upper left: hand vacuum pump, remote starter button, timing light, tack, selection of advance springs, timing tape and vacuum gauge. A new distributor collar/pin/thrust washer kit is handy when rebuilding the distributor.

## “Timing is everything:”

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Anyone who's into wrench turning on their MoPar is familiar with timing. Open the hood, loosen the clamp, and give the distributor a twist - OK, all done. Well, that isn't necessarily so. Given a stock engine with a stock distributor, used in the manner the engineers envisioned, and you probably won't be too far off. Throw in a hotter cam, bolt up that pretty Holley carb, toss in the Electronic Ignition distributor scored at the local salvage yard and the picture changes.

The hard fact is, once the original combination has been modified, there's no reason to assume the distributor's calibrations are anywhere near correct. So, what's to do? To zero in on the answer, let's take a brief look at what's going on under the cap. The distributor has two basic functions: one (primary side) is to signal the coil to spark at equal intervals, four times per crank revolution for a V8 engine, and the other (secondary side) is to send those sparks in the correct sequence to the engine's cylinders.

Plug the spark plug wires into the correct hole of the distributor cap and the secondary side of the distributor takes care of itself. The primary side, however, has to trigger the spark to happen at the most advantageous moment as a piston is coming up on the compression stroke. This is timing, which is really nothing but the phasing of the spark in relation to the crankshaft and piston position. With an old industrial Hemi set up to turn a water pump at a constant 2,100-rpm, the ignition timing can be fixed at a certain ideal point, since it works at a constant load and RPM. On the flip side, that 'Cuda in the driveway needs to idle cleanly at 900-rpm, scream through the traps at 6,500 and take you to the 'Nats, while (hopefully) delivering reasonably trouble-free and economical cruising.

Combustion chamber shape, cylinder pressure, fuel octane, temperature, RPM, load, exhaust scavenging, air density and a laundry list of other factors affect the timing requirement of an engine. The stock distributor has two weapons in its arsenal to cope with the various timing requirements: centrifugal and vacuum advance.

Centrifugal or mechanical advance is, as the name implies, a mechanical device in which flyweights spinning with the distributor shaft swing out at one end against spring tension as RPM increases - the result of centrifugal force. The flyweights engage slots in a plate at the base of the upper distributor shaft, causing the reluctor (distributor cam) to advance the spark. The length of the plate's slots control the maximum amount of centrifugal advance allowed what racers and engine builders refer to as the amount of timing "in the plate." Spring tension controls how fast, or at what RPM, the advance comes in. Combine the two, and you have the advance curve.

While centrifugal advance varies timing strictly by RPM, 3,000-rpm at wide-open throttle on your local dragstrip's launch pad doesn't call for the same timing as 3,000-rpm on US Hwy 99. For increased efficiency, vacuum advance is a way to vary the timing in accordance to load. Linked to the distributor's pickup (or breaker) plate, the vacuum advance uses a spring-loaded vacuum diaphragm to pull the plate in against the reluctor's (distributor cam's) rotation to advance the timing. On the dragstrip, with your right foot mashed to the firewall, the engine sees full load for the whole 1,320-feet. So, purpose-built racecars and racing distributors don't need vacuum advance. However, on a streetcar it is a must for maximum efficiency, plug life and economy.

The engineers did a pretty good job balancing the varied requirements over a broad range of applications with the stock advance curve. In a high performance/modified application, changes to the ignition timing will optimize performance while improving drivability. Problem is, few of us have a distributor machine sitting in the back of the garage. So, how do you check the advance curve and baseline and modify the distributor? Open the hood and use that 400-hp distributor machine sitting between the fenders.

Actually, although it's kind of a pain, setting up the distributor live on the engine does have some advantages over using the trusty Sun bench. Primarily, with the distributor live you can see first-hand how the engine responds to various tweaks.

Here's the lowdown - Four steps to setting up the centrifugal curve: Baseline the distributor. Figure out the idle initial timing requirement and idle RPM. Calculate and set the amount of mechanical advance (how much "in the plate"). Set up the advance rate for your combination. Only after the centrifugal advance curve, which is the "go fast" part of the job, is done should attention be turned to the vacuum advance.

## ***BASELINING***

Setting out to modify the advance curve without knowing what you've got is like picking up a date in a smoky Vegas lounge at closing time. The modifications may work out, but you might be disappointed with what you end up with. You need to check the RPM at which the centrifugal advance begins to kick in, how much it advances for an incremental RPM increase and at what RPM it has finished advancing or is "all in." To do this, you need only a timing light, tach and degreed damper. Mark the damper yourself as described in the MoPar Engine Book or stick on the MoPar Performance timing tape. Use graph paper to plot the point to generate a nifty looking curve. It will give you something to hang on your fridge besides your three-year olds' artwork.

With the marked damper, the timing can be read up to 60° using the -0- mark on the timing tab as a reference. Disconnect and block the vacuum advance and read the timing at idle. Bump up the RPM while reading the timing until the advance just begins to kick in. Record the RPM. If it's right off idle speed, try backing down the idle and start again. Continue to increase the **RPM** in even steps of 500-rpm, recording the timing until it no longer advances. Zero-in on the exact RPM at which the timing is "all in." Subtract the initial timing and you've got the centrifugal advance curve. The total timing reading at maximum advance minus the initial advance is the total amount of centrifugal advance, or how much is "in the plate." If you're mathematically challenged like us, you can set the initial timing at TDC and read the centrifugal curve directly without having to subtract the initial setting.

## ***INITIAL TIMING REQUIREMENTS***

So, you put in that hairy cam and single plane manifold. The combination runs like a scalded cat, but it doesn't idle worth a darn. Advancing the distributor smoothes out the idle some. However, if the timing is bumped up, the death bell of detonation begins to toll, so you back off the distributor, curse the guy who sold you the cam and live with the rough idle. What's happened, among other things, is that the long duration has killed off low speed cylinder pressure, and the overlap dilutes the intake charge at idle. More advance helps on both counts.

The therapy here is to find the best initial advance for the engine combination and worry about detonation later. Disconnect the vacuum advance. Pull back the initial timing to a relatively low setting. Set the idle speed to where the cam needs to idle (as close to the desired final idle speed as possible) and hook up a vacuum gauge and tach. Adjust the mixture to the leaner side of the sweet spot, giving the highest RPM and vacuum and note the readings. On auto trans cars, you can also check and record the vacuum and RPM drop when the trans is popped into gear. Now, bump up the timing 2 1/2-degrees. Vacuum and RPM should both jump up substantially. Back off the idle speed to where it was before and fine-tune the mixture again. You're after the same RPM as the previous test, but at a higher initial timing setting. Once set, record the vacuum reading and the in gear checks with an automatic. Both should improve. Continue advancing the distributor in 2-1/2-degree steps, resetting the idle speed/mixture and checking for improvements.

Generally, the biggest gains will come from the earlier tests, reaching a point of diminishing returns. Analyze the results and choose the final initial timing setting. Pick the lowest timing setting consistent with improvements in vacuum (and in-gear idle qualities with automatics), without getting too greedy for that last 1/2 inch-of-mercury (hg.) of vacuum. Every degree added to the initial timing is later going to be stolen from the centrifugal advance. In other words, don't trade 10° more advance (plus the hard starting and potential detonation) for a 1/2-inch increase in vacuum if the prior 10° netted a 3-hg. improvement. Typical street settings should range from 8-16-degrees, depending mostly on cammyness.

## ***HOW MUCH TO PUT "IN THE PLATE"***

With the distributor baselined, we know how much centrifugal advance it will give us. Also, we now have set the initial advance for the best idle quality, which in many cases will be a significant jump from stock. Add the two and we're usually looking at too much total timing. As a rule of thumb, hot street MoPar small-blocks will like to run about 35° total, with B-RB engines wanting 38-degrees, fuel quality permitting. These numbers can be fine tuned only on the dyno or dragstrip.

Lets say, on a small-block, we end up with 12-1/2° initial timing and our baseline test showed 34° in the plate. By my new calculations, we're looking at 46-1/2° total, or about 11-1/2° worth of piston melting over advance. In this example, we're going to have to pull the 11-1/2° of centrifugal advance out of the plate. This is done by removing the plate and shortening the length of its slots, usually by welding or brazing at the outside stop and filing to shape.

## ***SETTING THE CURVE***

The advance rate is controlled by the tension of the advance springs. With lighter springs, the faster the advance. Simple, huh? Actually, setting the curve portion is the trickiest part of the game. The reason is simple - no two engines are likely to want precisely the same advance rate. While up to now it's been a little addition and subtraction, which even we could handle, the advance rate will depend on everything: Load, traction, tire size, [converter] stall, octane, temperature, gear ratio, cylinder pressure, exhaust scavenging efficiency - just for starters. Also, the best way to figure out the ideal advance rate requires a dyno. The good news is we can use the good old rule of thumb and trial-and-error system to get it.

Typically, for high performance street/drag type applications, the established rule of thumb is to have the advance "all in" by about 2,000-rpm. The most common stock spring sets used a light and heavy spring with a little bit of a trick. The heavy spring had an extended attachment eye, keeping it from kicking in until about the last one third of advancement. With the stock arrangement, the light spring does all the work for the majority of the advance, and is actually a relatively fast advancing spring. The heavy spring gives up the last few degrees gradually, up to as much as 4,500-rpm. The old trick of tossing the heavy spring and running just the single light one, really just adds an extra quantity of advance to the already-quick early start.

MoPar Performance markets a set of very light springs, which, when installed in a production distributor, provides a lightning quick advance curve. Unfortunately, it violates rule of thumb number two: Keep the centrifugal advance away from the idle RPM. By having the advance kicking-in at or below idle, the engine idle speed will tend to hunt or hang up to a higher speed as the timing kicks up and down. With an automatic, this problem is even worse, with idle speed and smoothness artificially boosted by the centrifugal advance. Toss it in gear and the normal pull-down of RPM also will take down the advance, retarding the timing and pulling the rug out from under the engine. All of these erratic idle woes are the reason to provide a buffer of a couple hundred RPM from idle speed for the centrifugal advance curve kick-in.

The bottom line is, work with the above two rules of thumb: Delay the advance curve if full throttle detonation is a problem, and speed it up if the combination can take it and trap speed shows it's the correct direction to go. Good things never come easy. Use the baselining technique above to map the advance curve for any spring change.

## ***VACUUM ADVANCE***

Only once the centrifugal advance curve is sorted out should the vacuum advance be dialed in. There are two considerations with vacuum advance: How much total and how soon? How much total is built into the unit. The arm off the diaphragm has a stop built into it, which limits how much travel is available to advance the timing. There are a bunch of different units, and fortunately most are stamped with the amount of advance in distributor degrees, which is half of crank degrees. Eight and-a-half degrees will give you 17° at the damper at full advance. Theoretically, grinding back the two stops could increase the advance "in the can", but in practice they're very difficult to get to. Advance can be taken "out of the can" by epoxying tabs which bend over the stops, but not, as I've seen suggested, by welding/brazing the stops. That'll cook the diaphragm.

When the vacuum advance kicks in, it can have a significant effect. If it starts at a too low vacuum level, light part throttle acceleration can cause detonation problems. Try to adjust the spring tension on the diaphragm by inserting a 3/32-inch Allen wrench through the vacuum nipple. Counter-clockwise delays the action, while clockwise kicks it in at a lower vacuum level. Most, but not all, diaphragms have this provision, with one full turn typically changing the kick-in point by 1-hg. Vacuum.

As with centrifugal advance, to tune vacuum advance requires its curve be mapped. Again, this can be done with the engine used as the distributor machine, only this time using a hand vacuum pump to check the rate of advance for various vacuum levels. The procedure is simple enough: Pull up vacuum with the hand pump while checking the timing. Note the vacuum pump's gauge point where the advance just begins to kick in and record this. Move the vacuum level up in 1-inch increments, recording the vacuum level and how much the timing has



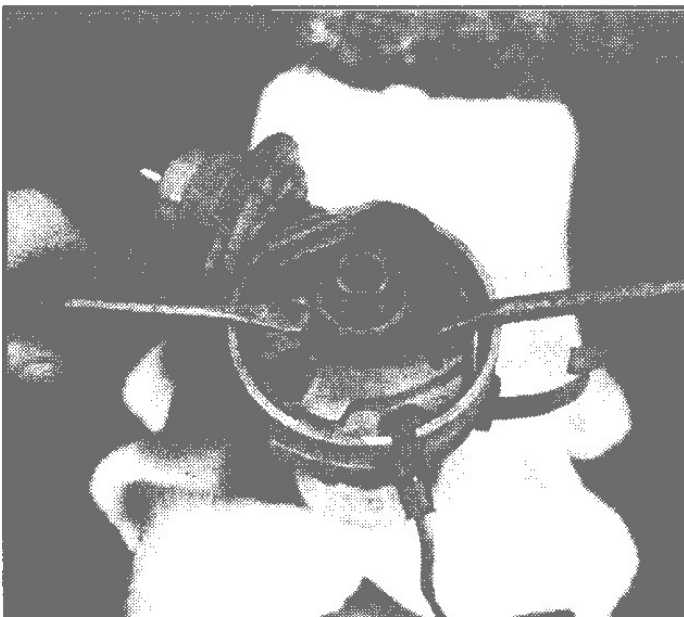
correspondingly been increased. There's a trick here: Lower the idle speed to well below the RPM at which the centrifugal advance kicks in each time the vacuum pump level is pulled up. Otherwise, as the vacuum advance brings up the timing, the RPM will increase causing the centrifugal advance to come into play and invalidating your readings.

## ***AT WORK***

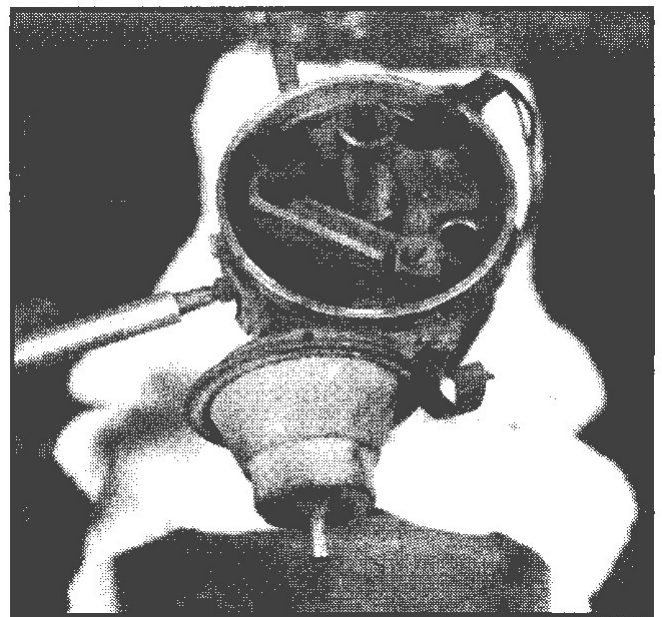
We practiced what we preached with a '69 Dart with modified 273. The engine had been fitted with a stock boneyard Chrysler electronic distributor with a four-pin ECU setup. The engine was still Chrysler assembled, the car being a low mileage survivor. With a small runner Edelbrock intake/TQ combo, 270/280duration hydraulic cam and 340 exhaust manifolds feeding a 1-1/4-inch exhaust; it was your basic induction/cam/exhaust type street engine.

Running freeway 2.73:1 gears and a factory high stall, trap speed ran 86-mph, shifting at 5,200-rpm using only the TorqueFlite's first two gears. After sorting out our obviously sick distributor, trap speed increased to 90-mph (admittedly in much better air) with the shift now occurring at 6,000-rpm.

The real story however was in the idle quality. Our starting point was 4° initial advance, with 11-hg. of vacuum at an 800-rpm idle dropping to 8-hg. in gear. After the recurve, idle vacuum increased to 14.2-hg. at the same 800-rpm, dropping to only 10.5-hg. in gear and running 12-1/2° initial advance. That's nearly 30% more vacuum at idle and better than 30% in gear - a huge improvement.

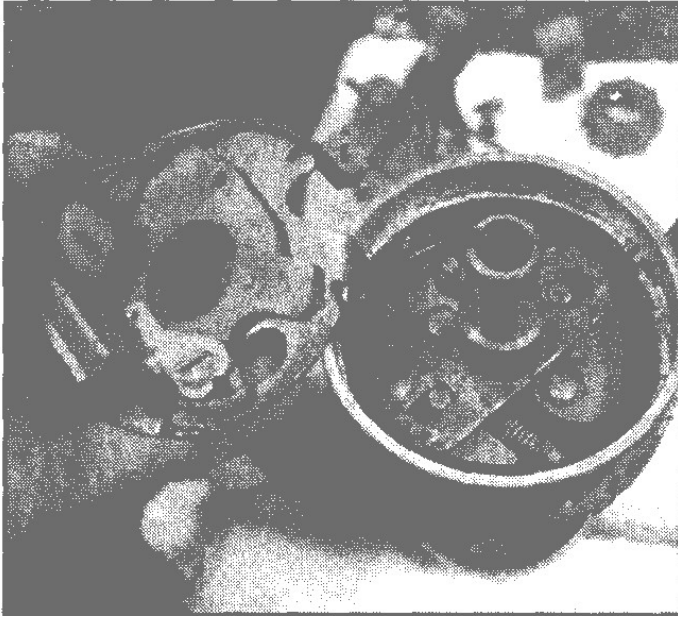


**2.** Baselineing our stock distributor showed a sticking advance mechanism. We decided on a full rebuild, along with a recurve, Begin disassembly by prying off the reluctor with two screwdrivers. Avoid prying on the teeth of the reluctor. Save the small roll pin, which indexes the reluctor, and note which hole it indexes into.

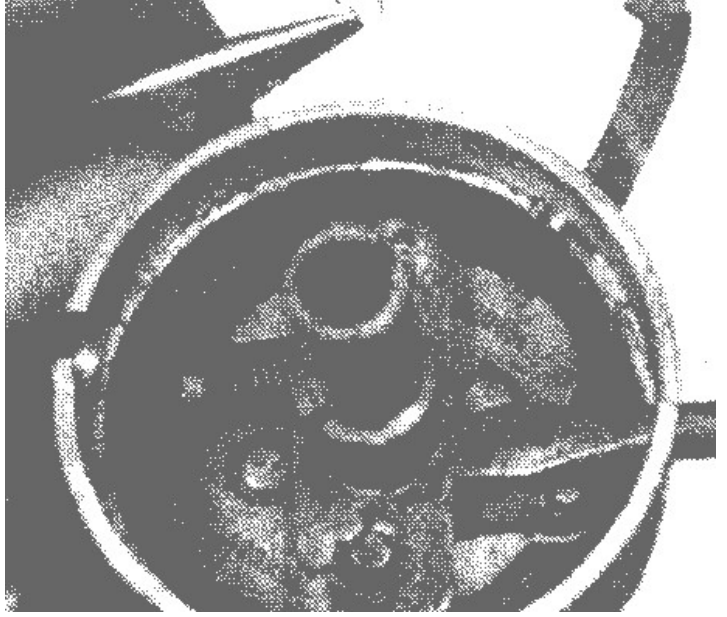


**3.** The advance can and pick-up (breaker) plate comes free by removing the four small screws on the outside of the housing. The vacuum advance arm unhooks by slightly spreading the upper and lower halves of the plate assembly. Note the indexing of the pickup plate to the housing.

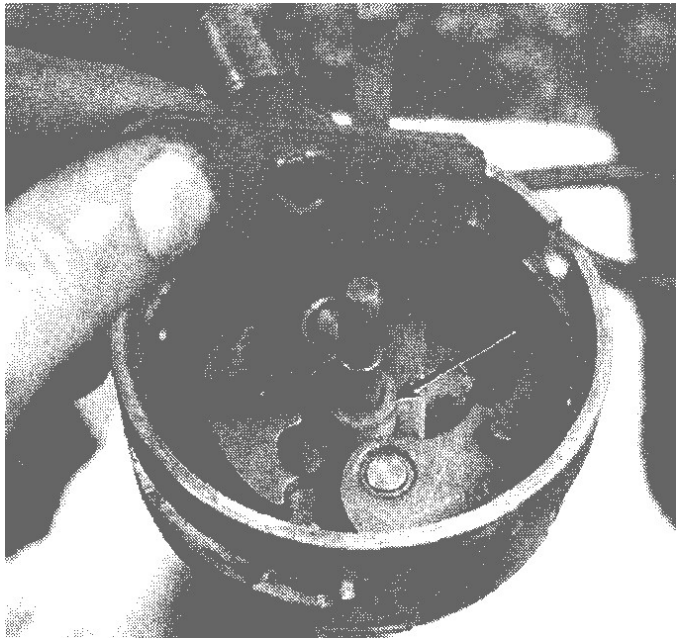
**DO NOT** forget to check the side play in the bushing(s). This should not exceed .006" If you have to replace them, soak the new ones in engine oil first. (We keep a few sets in a jar of 10W40 oil). Refer to the FSM for replacement information.



**4.** With the pick-up plate clear we find the centrifugal advance mechanism. The culprit that caused it to stick is dried-up, hard grease and dirt on the advance mechanism.



**5.** Here's the part the service manual doesn't show. Removing the small horseshoe clip from inside the shaft allows the upper distributor shaft/advance plate to be separated from the lower shaft. Removing the clip is a three-handed job. We used a couple of mini screwdrivers. Separate the plate with a screwdriver as shown.



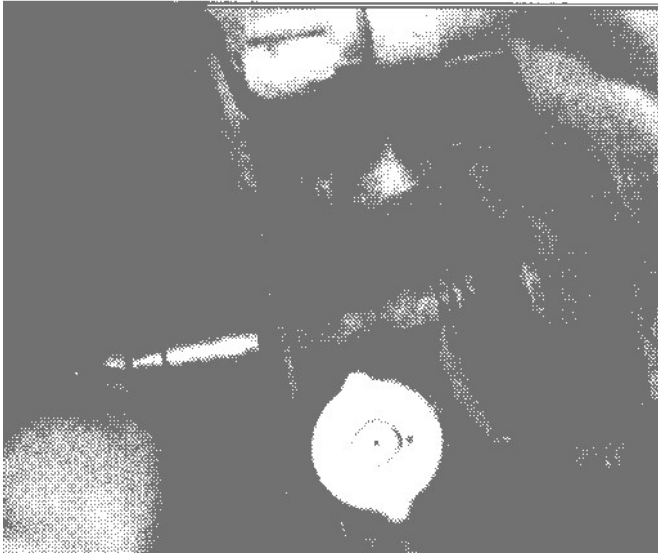
**6.** Rust between the two shafts prevented smooth motion, but Kroil helped free it up. This is as far as you need to go for a recurve, but we finished disassembly to clean everything up. To continue, pull off the weights and nylon spacer (arrow).



**7.** To remove the distributor shall, punch out the roll pin at the lower collar. Note the padding on the vise.







**12.** Installing the timing tape is tough with the engine installed. We pulled the P/S pump clear to gain access. Clean all traces of oil film from the outer surface of the damper for the best shot at having the tape stick. Pre-71 units are easiest-no removal required.



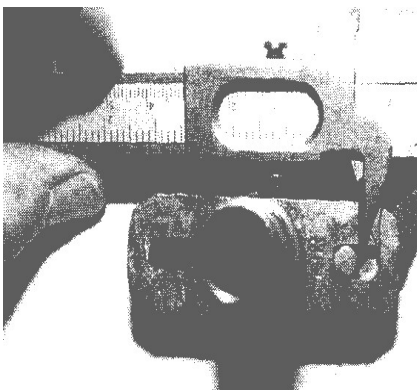
**13.** On small-block engines, this is the correct positioning of the tape. Notice that the numbers read upside down. Big-blocks, reading from the right side of the engine, read right way up. Turn the crank counterclockwise with a socket to wind on the tape.



**14.** The MoPar Performance tape came through with an adhesive about as sticky as a post-it-note and blew off at 2,000 rpm. We salvaged the business end of the tape and re-glued it with contact cement.



**15.** We ran through the initial timing procedure and found 12° to be the best compromise, up from our old setting of 4°. With the stock number 13 plate, as expected, we found 26° advance "in the plate." Wanting to come in at 35° total, this was about 4° too much advance.

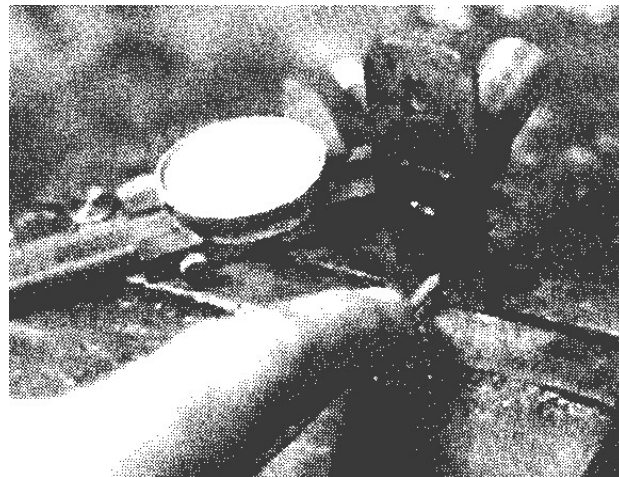


The distance the pins travel in the slot controls the amount of the advance. The 13R plate provides 26° (13°x 2) of advance in 1/2" of travel. If you needed 4° more advance, you could file the far end by 1/32 inch, to equal X inch. (4/26) x **0.1875-0.0288** or about Y inch.

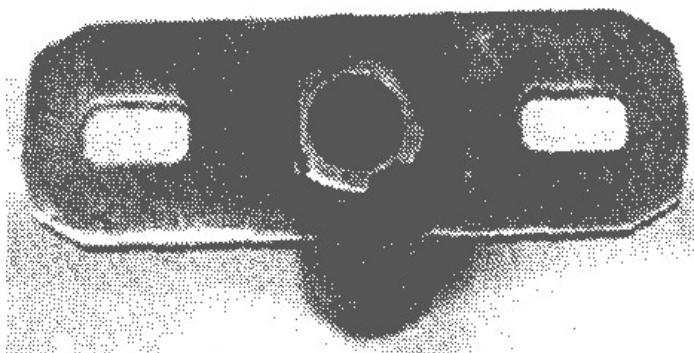




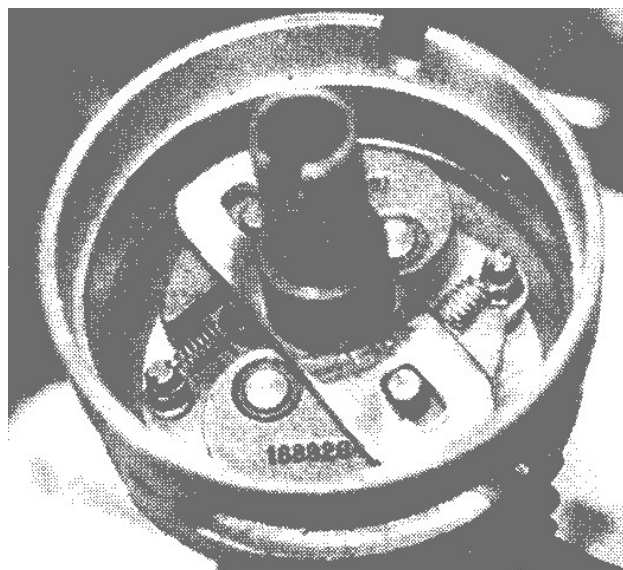
**16.** Using the time-honored technique, we built-up the stop end of the plate with a bead of weld to limit the amount of centrifugal advance.



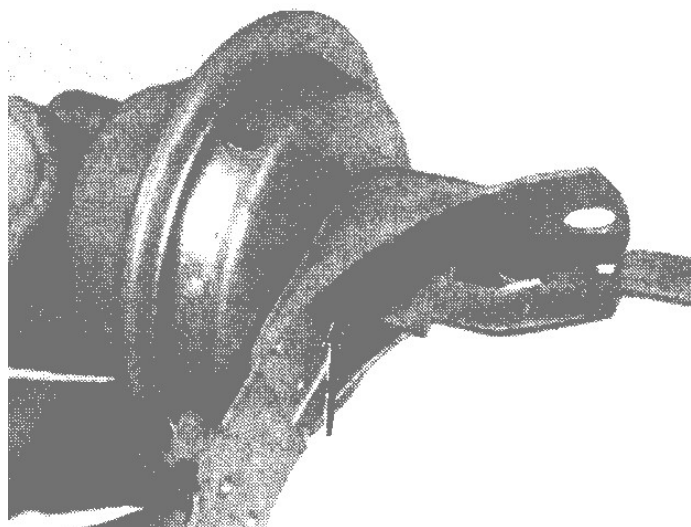
**17.** We figured about .040 less stop would give us the desired spec. Measure carefully when filing until the desired spec is reached.



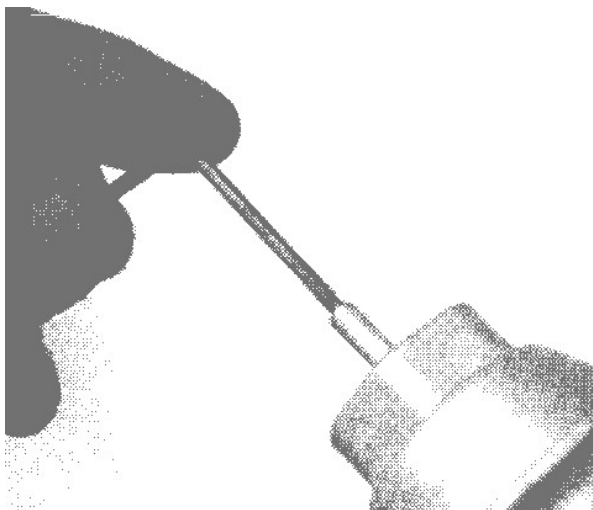
**18.** This is our finished plate. Dress the plate nicely with a file and polish off any burrs with a sander. Check for a smooth fit with the pins on the advance weights.



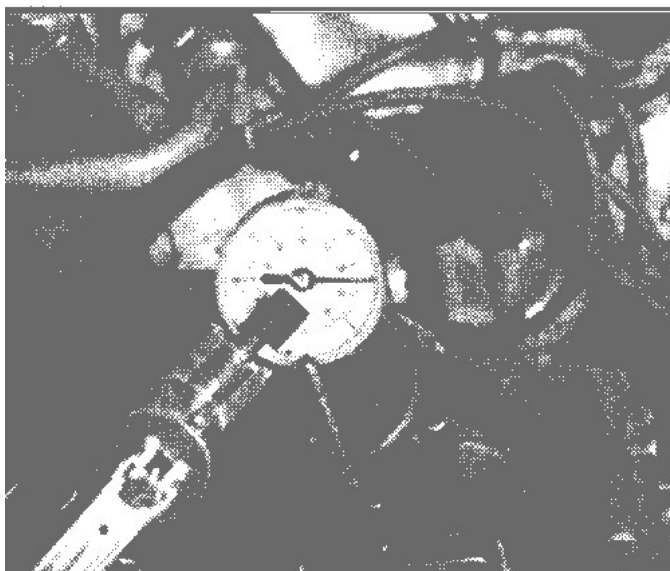
**19.** After experimenting with several combinations, we settled on running the two lightest Mr. Gasket springs. These springs were packaged for a small-block Chevy application. **Do not forget to re-install the felt wick, and lubricate it sparingly with 10W oil-around three drops.**



**20.** Most vacuum advance cans have the advance specs in distributor degrees (double this to get crank degrees) stamped in the arm. The stops (arrow) set the total advance. But, bear in mind that different cans have a variety of values.



**21.** Spring tension is adjusted with a 3/32-inch Allen wrench. We discovered that about one full turn changes the vacuum level by 1-hg. Counter-clockwise delays the vacuum advance.



**22.** We ended up going with a number 11 can to aim for best economy at cruise. Mapping the curve we found the advance kicked in at a low 5-hg. and was all in at 10hg. The can gave 24°. Advance, which was slightly more than the rated 22°. There are production tolerances. At this low kick-in level, vacuum advance would operate on part throttle acceleration, so the adjuster was unscrewed to obtain a 7-hg. kick-in with vacuum advance "all in" by 13-hg.

### CENTRIFUGAL ADVANCE CURVE

ADVANCE	KICK-IN	ALL-IN	MAX ADV.
Single Stock Light 13° Plate	<b>900 RPM</b>	<b>1,700 RPM</b>	<b>26°</b>
(2) MoPar Performance 13° Plate	<b>650</b>	<b>1,200</b>	<b>26°</b>
Mr. Gasket (2) Lightest 13° Plate	<b>1,100</b>	<b>2,200</b>	<b>26°</b>
Mr. Gasket (2) Lightest Modified -.040" Plate 13° Plate	<b>1,100</b>	<b>2,100</b>	<b>23°</b>

<b>VACUUM ADVANCE #11 CAN</b> <u>Stock</u> 1 ½ Turns C/CLK 2 Turns C/CLK Vac Advance Rated: <b>22°</b> Vac Advance Actual: <b>24°</b>	<b>KICK-IN</b>  <b>5" hg.</b> <b>6.5" hg.</b> <b>7" hg.</b>	<b>ALL-IN</b>  <b>10" hg.</b> <b>12" hg.</b> <b>13" hg.</b>	
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