Section 1 authored by Wes Vann, with minor revisions and photos by Schurkey

Basics

I don't want to bore (or insult) anybody, but there are a bunch of items that should be said.

This article is written with traditional Chevrolet V-8 engines in mind. This information can be adapted to other engine families but details may differ.

The firing order on a traditional Chevy is: 1-8-4-3-6-5-7-2.

If you view the top of the distributor cap, the spark plug wires should be in a "clock-wise" order.

The spark must occur near the "top dead center" that is at the end of the compression cycle. This is "Top Dead Center-Compression stroke", or TDCC.



Photo 1. Plug wire sequence vs. distributor cap connector location for Chevrolet. Note that the very bottom center hole; and top center hole are un-used.

The other "top dead center" is at the end of the Exhaust stroke, therefore it is TDCE. Keep in mind that we are talking four stroke engines here and there are two rotations of the crank for every one rotation of the cam or distributor!

Centrifugal advance relates purely to distributor (and therefore engine) speed. It is done by the set of weights and springs inside the distributor. When a distributor is "recurved", it's usually the springs, weights, and the center piece the weights act on that are changed, but a more complete job would include optimizing the vacuum advance as well. Vacuum advance is the canister that is mounted on the side of the distributor. It has a hose that is hooked up to a source of vacuum. It controls the advance based on engine load. You can get adjustable canisters. Vacuum advance is strongly recommended for any engine that is run at part throttle. Racers don't spend much time at part throttle, and so they do not use vacuum advance. Somewhere along the line, people decided that if their race hero's car didn't have vacuum advance, that a street-driven car didn't need one either. Wrong. Both fuel economy and throttle response can be improved by proper application of vacuum advance. There are two main sources of vacuum. Manifold vacuum is the vacuum available in the intake manifold. "Ported" or "timed" vacuum is just manifold vacuum that gets "shut off" at idle. It costs nothing to try both sources, your engine will tell you which one it likes more. When talking about re-curving a distributor, the term "total timing" is used. This term is borrowed from race engine builders, and race engines don't have vacuum advance. Therefore "total timing" includes initial timing (sometimes called "static" timing) and the centrifugal advance (sometimes called "mechanical" advance, for no good reason I can think of.) Total timing, therefore does NOT include vacuum advance.



Photo 2. Centrifugal advance parts including center plate and retainers, weights, nylon pads, and springs. Weights and center plate are identified by stamped-in numbers.



You can rotate the distributor body to any position you want, as long as the spark plug wires are positioned so that the rotor is pointing to the terminal with the #1 wire at the correct engine time. With that in mind, it probably takes less effort AND looks more professional to install the distributor "correctly" so that everything is aligned as the factory did, than to play "pin the tail on the distributor". You also run the risk of having your spark plug wires too long or too short if you don't install the distributor as the factory intended. Keep in mind that the terminals on the cap are evenly spaced (except for those weird odd-fire V6s!).

How to find the correct "top dead center" for #1 firing;

This assumes that you trust your timing marker is correct. Depending on the history of the engine, you may not want to make this assumption.

You should remove the spark plugs so that it's easier to rotate the engine. You will also have to remove the valve cover on the driver's side of the engine.

The valve on the driver's (left) side that is the closest to the radiator is the #1 exhaust valve. The second is the #1 intake valve.

Always rotate the engine in a "clockwise" direction as you look at the harmonic balancer from the front of the car. Rotate the engine while watching the #1 intake valve. The first time that the timing mark comes up to "top-dead-center" after the intake valve closes is when the spark should occur!

If you don't trust the timing mark (and not trusting your timing mark is a very good idea if you haven't verified it's accuracy);

You will have to use a piston stop in order to do this. A piston stop is a hard item that limits how high a piston can go. I made one by welding an extension on a sparkplug that would go into the combustion chamber. If you hit the starter, you shatter the piston! Once the piston stop is installed, you have to rotate the engine carefully, by hand, clockwise until the piston hits the stop. Put a mark on the balancer where the timing pointer is pointing. Then rotate the engine counter-clockwise until the piston again hits the stop. Make another mark on the balancer where the timing pointer is pointing.

The point exactly half way between the two marks you made on the harmonic balancer is "top dead center"!

Distributor installation; This is if you didn't note the position of rotor when you pulled it out or just rebuilt the engine. You first have to make sure that you are at TDCC.

One of the biggest headaches in installing a distributor in a Chevy is that not only does it have to engage the gear at the end of the cam, it also has to connect to the oil pump. Due to angled gear teeth, the rotor will rotate a few degrees as you slide it down. If it doesn't go down all the way, it's due to not engaging into the oil pump shaft correctly. Don't try to force it!

If it doesn't engage correctly into the oil pump shaft, you have to use a long screwdriver to rotate the pump a little. Then retry installing the distributor. It's just a matter of playing with it! You could also rotate the crankshaft to line up the distributor with the oil pump shaft, but you'll have to rotate the crank two full turns in order to get back to TDCC to get the initial timing in the ballpark.



Chevy Punch!

Converting a "points" distributor to "nonpoints"

Converting a "points" distributor to electronic ignition requires that you remove the points and replace them with a magnetic or optical sensor and a control module, which may or may not be built-in to the sensor body. The nice thing about this is that there are no points to wear out or go out of adjustment, plus you still have the look of a stock distributor. There are several kits available to do this. A concern is that if you purchase an aftermarket kit, and the ignition dies while you're in the middle of nowhere, will you be able to get replacement parts in a timely and convenient fashion? A kit based on the GM HEI module will allow you to get a replacement module nearly anywhere!

Notes on wiring for a "points" distributor;

There are normally two wires on the "+" terminal on the coil. One is the "resistance" power wire. The other is a wire that supplies power from the starter solenoid "R" terminal, it supplies power only when the starter is cranking.

The "resistance" on a GM isn't anything that can really be seen. It looks like just any other wire. (on some other manufactures cars, the resistance is in a ceramic block)

The wire from the distributor goes to the "-" terminal on the coil.

There may be an additional capacitor on the coil - terminal. This is to eliminate radio interference.

Notes on wiring for an "HEI" distributor with the coil in the cap;

If you are converting from a points type distributor, you have to make sure that the "resistance" power wire is bypassed! It's best to just run a new 12guage wire from the fuse block. This wire goes to the terminal marked "BAT" or "B+" on the distributor cap. I'm told that the average electrical draw of the HEI is fairly low, but the instantaneous draw can be quite high. That's why you need such a large wire feeding power to it.

There is no longer a need for the power wire that comes from the starter "R" terminal.



On most HEI's, there are three wires that come from the base of the distributor and they plug into the cap. It's a connector block and can't be plugged in wrong.





Section 2 "Identification of HEI Ignition Systems" authored by Schurkey.

Identifying your HEI system

There are several variations on the original High Energy Ignition (HEI) system. The original HEI was introduced in 1974 on select vehicles. It had a four terminal module, and both centrifugal and vacuum advance. This and its aftermarket sisters are the most common with performance enthusiasts. Aluminum distributor bodies were cast to fit many different engine families-four, six, and eight cylinders, inline and V-type. The V-6 and V-8 engines got the ignition coil built into the distributor cap, while usually—but not always—the inline 4 and 6 cylinder engines received a separate, external ignition coil. The aftermarket is now building HEI-style distributors for a wide variety of engine families, including Holden, Ford and AMC engines, as well as several GM engines that didn't come with HEI during their production runs. Four pin modules are completely interchangeable, and diagnosis procedures are



Photo 3. Disassembled HEI (Not shown: roll pin for distributor gear, spring clip to retain pickup coil; screws to retain ignition coil and cover, and plastic grease reservoir seal.)

similar. Other internal components have limited interchangeability. More on that later.

Some later HEI distributors used five terminal modules, the fifth terminal was used to retard timing based on sensors and circuitry external to the distributor. Those systems were called HEI-Electronic Module Retard, HEI-Electronic Spark Control, or HEI-Electronic Spark Selection. These distributors also used both vacuum and centrifugal advance. Be careful, there are at least two completely different (not interchangeable) five-pin modules.

Starting in 1981, ignitions with complete computer control of spark timing use a seven terminal module. There is no vacuum or centrifugal advance. In 1987, a "small body" HEI using a separate coil was introduced for Chevy V-8. This is completely computer-controlled and has no centrifugal or vacuum advance. Delco offered a retro-fit electronic ignition system for marine use based on this "small body" HEI called the "Delco Voyager Marine Distributor Ignition System. Timing advance was done electronically, within the module itself. This advance was similar to "centrifugal advance" in that it is purely RPM-related; there is no provision to mimic vacuum advance.

Coming Next Month!

Schurkey explains and shows in detail:

HEI Diagnosing and Troubleshooting





Authored by Schurkey All information believed to be correct at time of writing. Comments/suggestions? Contact schurkey@v-drivemail.zzn.com



Got the HEI No-Spark Blues?

Don't worry, be happy. HEIs are as easy as pie to fix. You don't even need kilobuck 'scopes, module testers, or computer interfaces.

The Usual Legal Disclaimers And Stuff.

This is NOT the official factory diagnostic procedure. This is shorter and simpler. It requires fewer special tools. It is a little less thorough, but a lot faster. This is not designed to locate everything that could possibly go wrong with an HEI. It will locate the common problems.

General Assumptions:

You "know which end of a screwdriver to hold onto". You've even replaced a distributor cap and rotor and timed an engine at some point in your life, and the engine ran good after you completed the job. You have basic hand tools.

You have a non-computer controlled HEI (the module has only four terminals) with the coil built into the cap. If you have a separate ignition coil, the basics are the same, but the details are a little different.

You don't have a pacemaker, 'cause we are dealing with 50,000 volts and I don't want anyone to have their ticker "vapor lock", if you know what I mean. You do not want to "catch a spark" even if you're completely healthy. It hurts, especially if you are leaning over the fender and the spark grounds through your pants zipper.

Whenever I tell you to crank the engine, I'm assuming the ignition is ON and the car has the park brake engaged and the transmission is in "Park" or "Neutral". Your necktie should not be wrapped around the fan blades.

Special Tools:

The most important special tool is a fully functional brain. Be sure yours is completely engaged. If the clutch plates of your mind are slipping, press "BACK" on your browser.

Spark tester: K-D tools 2756 (also available from Snap-On), A-C Delco ST-125, Mac ET 760H, or equivalent. Cost is about twelve dollars. Available at any well stocked auto parts store. This looks like a spark plug with an alligator clip soldered to it. Avoid the temptation to make your own. The real deal has a calibrated spark gap that will properly load the coil.

A straight spark plug boot: You'll cut it so that when you slip it over your spark tester, it extends about $\frac{1}{2}$ inch beyond the tester.

Jumper wire: Plain old 14 gauge primary wire about three feet long, with alligator clips on each end.

12 Volt test light: A cheap one is OK, but test it every time you use it. If the wire is connected to ground, (the usual arrangement) touch the probe to a power source and make sure it lights up. HINT: Use the alternator positive terminal if it is easier to reach than the battery positive terminal. On those occasions that the wire is connected to a power source, touch the probe to ground and make sure it lights up. It's very frustrating to have to re-do an hour's work because the bulb in the test light burned out and has been giving you false readings.

10 MEGOHM (or greater) input impedance multimeter: This is required for module testing. These are getting to be very common. If your meter has a digital readout, you probably have a 10 megohm compatible meter. No harm in verifying that, though.



Optional Tools:

Soldering gun rated at 450 watts: Yup, that's a big 'un.

Remote starter switch: (or a buddy to crank the engine while you're inspecting parts from over the fender) If you use a remote starter switch, be sure the ignition is ON when you're cranking during testing. You'll waste a lot of time if you crank the engine with the ignition off.



Photo 7. The tools you need to diagnose an HEI that has a 4-terminal module. (cranking buddy not shown—see "Victoria's Secret" catalog models for suggestions for a helper.)



Photo 9. Spark testers have calibrated spark gaps. HEI tester has larger gap due to recessed electrode, and requires greater voltage to fire than standard tester.

Photo 10. *HEI Spark tester and cut-off spark plug boot used as a support tool.*





Photo 8. Spark testers: HEI on left, points-style or Chrysler electronic on right. HEI style preferred but not absolutely required.

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Let's begin:

You have an engine that won't run properly, or won't run at all. When you look down the carb throat and work the linkage, you can see fuel squirt out of the accelerator pump nozzle. The engine cranks at its usual speed, indicating both a fullycharged battery and no sudden decrease in cranking compression.

STEP ONE: Verify No-Spark.

Select the easiest to reach plug wire and remove it from the plug. Connect it to the spark tester and ground the tester to any convenient chunk of nearby iron, such as a header bolt or the alternator bracket. Hint: face the sparking end of the tester so vou can see it from the driver's seat.

Crank the engine with the car in "Park" or "Neutral". If you have a good spark, check the other plug wires. The HEI is OK, but perhaps your distributor cap, rotor, or some of your plug wires are defective, or your spark plugs are fouled. Repair or replace the cap, rotor, plug wires and/or spark plugs as needed. If you have no spark, test a couple other plug wires. Still have no spark? Reconnect the plug wires and go to step 2.

STEP TWO: Verify power supply to HEI.

Disconnect the power wire to the ignition coil. If the coil is built into the distributor cap, this wire will If you have a separate ignition coil (inline six or plug into the cap, at the "BAT" or "B+" terminal. Probe the connector on the power wire with the test the spark tester in the coil in place of the coil wire. light, or use the voltmeter set to the lowest scale that accommodates 15 volts. With the ignition ON, but not cranking, you should have within one volt of battery voltage, or a very bright test light. With the engine cranking, you should still have within one volt of battery voltage—but that voltage will be reduced due to the current draw of the starter motor. You should have a minimum of eight volts on the voltmeter or a medium brightness on the test light when cranking. Poor voltage? Repair wiring from ignition switch. If you have good voltage, reconnect power wire. Go to step three.

STEP THREE: Exploratory Surgery

If you have a coil-in-cap distributor, remove the

distributor cap and rotor from the distributor. If it makes it easier to remove the cap, you can first label and remove the spark plug wires from the cap, but leave the three small wires on the side of the cap connected, and leave the power wire connected! Flip the cap upside down. Push the "Special tool" plug boot over the spark tester, and then push the open end of the plug boot over the center post of the distributor cap. This is the post with the carbon button that rubs on the top of the rotor. The tip of the spark tester will be touching the carbon button, held in place by the cut-down rubber plug boot. Use your jumper wire to connect the spark tester to a good ground.



Photo 11. Spark tester connected to carbon button. Tester grounded with jumper cable.

four cylinder) remove the cap and rotor, but install Use the jumper wire to connect the tester to around.

Make sure the advance mechanism of the distributor will clear the upside down cap. Crank the engine with the ignition ON. (Watch the distributor so you know it turns when the engine cranks-if the distributor doesn't turn, you have mechanical problems inside the engine.) This is a repeat of step one, but without the plug wires, rotor and cap in the circuit. If you now have spark, start looking at the wires, rotor and cap. Repair/replace the wires, rotor, and/or cap as needed, put everything back together, and go cruising. If you have no spark, LEAVE THE SPARK TESTER IN PLACE and go to step four or five.



STEP FOUR: (Optional—only if you have the big soldering gun)

YOU ARE NOT TRYING TO SOLDER ANYTHING! IF YOU DO THIS RIGHT, THE TIP OF THE SOLDERING GUN WON'T EVEN GET HOT.

Plug in the soldering gun, and with the ignition ON, hold the body of the soldering gun as close to the pickup coil as you can. Keep your arm away from the spark tester. Pull the trigger on the gun. (One second is enough!) Look for sparks at the spark tester. This is a repeat of Step three, but with the pole piece (reluctor) out of the equation. The alternating magnetic field in the body of the soldering gun will induce voltage in the pickup coil, which should trigger the module, which should trigger the ignition coil. If the soldering gun is not big enough, or is held too far from the pickup coil, you won't induce voltage in the pickup coil and the test is invalid. (I suggest you try this on a known good system, to give you some experience with the procedure-It's a real time-saver! Then, if you have problems later with an HEI, you're familiar with the procedure, and know what to expect.) If you're sure you've done this right, and you get no spark, LEAVE THE SPARK TESTER IN PLACE and go to step five. If you get spark here and you didn't in step three, the pickup coil is defective in a way that is not common. Re-do step three to be sure.

STEP FIVE: Eliminate the pickup coil.

Disconnect the two very fine wires (green and white) from the module. Connect the wire on your test light to a voltage source such as the alternator POSITIVE terminal. Touch the probe of the test light to the module terminal labeled "G". (Its the smaller of the two terminals that you disconnected the pickup coil wires from), and it's the one that had the green wire on it. (The test light will not light up on this test.) If you get no spark when you REMOVE the test light probe from the "G" terminal, go to step six or seven. If you get a spark each time you REMOVE the test light from the module, but got no sparks in the other tests, your pickup coil is defective. Replace it; connect the pickup coil wires to the module and repeat step three. If step three produces spark, the problem is fixed. Put it all back together and go cruising.



Photo 13. Using test light to trigger module.



Photo 12. Using soldering gun to induce voltage into pickup coil.

STEP SIX: Coil primary voltage test

Unplug the connector from the "TACH" terminal on the distributor cap, if there is a connector there. Usually there isn't. Set your voltmeter to lowest voltage scale that will accommodate 15 volts DC. Connect the positive voltmeter lead to the "TACH" terminal on the distributor cap (or to the - terminal of a separate coil) Connect the negative lead to ground. With ignition ON, repeat step five, except watch the voltmeter not the spark tester. The voltage reading should read high, but spike downward when you remove the test light from the module terminal. If it does, replace the ignition coil and repeat step three. If it does not, replace module and repeat step three. If you get sparks in step three, the problem is fixed. Put it all back together and go cruising. This "should" be the end of your no-spark condition—but just in case, there's step 7.



STEP SEVEN: test ignition coil.

Coil-in-cap: Remove the spark tester and all wires from distributor cap. Lift the entire cap out of the engine compartment for testing. You don't need to remove the coil from the cap.

First test: Use ohmmeter set on a "low ohms" scale. Connect between "BAT" ("B+") terminal and "TACH" (C-) terminal. (The OUTSIDE two terminals of the three parallel blades in the distributor cap.) Resistance should be very low—generally less than one ohm. If not, replace coil. If you perform this test on a coil that isn't installed in a distributor cap, you're connecting to the red wire, and to either a yellow or a white wire depending on which color your coil has.



Photo 14. Labeling of terminals. C- and TACH are connected together inside; B+ and BAT are connected together inside.



Photo 16. Testing B+ to C- (coil primary) continuity. Meter shows 0.6 ohms.

Second test—done in two parts: Use ohmmeter set to "high ohms" scale.

Part 1: Connect ohmmeter between BAT or B+ terminal and the carbon button in the middle of the cap. Read ohmmeter and remember the reading. You are looking for "some resistance"—continuity, (The actual amount doesn't matter much—but it's likely to be well over 10,000 ohms.) or "No continuity—infinite resistance". Put another way—you'll either have "some" amount of resistance; or you'll have an open circuit.

If you perform this test on a coil that isn't installed in a distributor cap, use the red wire and the terminal that would connect to the carbon button. You might expect somewhere between 5000 and 10,000 ohms of resistance (but the actual meter reading doesn't matter), or you'll have an open circuit.



Photo 15. Three parallel blades on distributor cap. Because cap is now upside down, the three terminals from left to right are B+, GRD, and C-.



Photo 17. *B+ to Carbon Button. Meter shows* "Open Loop" (open circuit—no continuity) (Some coils may have continuity—that's ok too.)





Photo 18. *Middle blade to carbon button. Meter shows 101.7 Megohms—very high resistance. Some coils will have NO continuity—open circuit. That can be OK.*

Part 2: Connect ohmmeter between ground terminal (the MIDDLE one of the three parallel blades in the distributor cap) and the carbon button. Read ohmmeter (again, you're looking for "some" continuity—likely over 10,000 ohms of resistance, but the actual reading doesn't matter much—versus "no continuity—open circuit") and compare to result in Part 1.

If you perform this test on a coil that isn't installed in a distributor cap, you are connecting to the BLACK wire and the terminal that would connect to the carbon button. You may see somewhere between 5000 and 10,000 ohms but the actual meter reading doesn't matter very much.

VERY EARLY (Mid '75 and OLDER) HEI in-cap coils may not have a black wire, and you CANNOT do this part of the test on those coils—but you MUST have continuity in Part 1 if there is NO black wire. If BOTH of the readings in the second test, Part 1 and Part 2 are infinite (indicating an open circuit on BOTH Part 1 and Part 2) replace coil. It is ENTIRELY acceptable to have ONE reading—either in Part 1 or in Part 2—that shows infinite resistance—open circuit.

Separate coil: Remove spark tester and all wires from the coil.

First test: Ohmmeter set to "low ohms" scale. Connect between "BAT" ("B+" or +) terminal and "TACH" (C- or -) terminal. Resistance should be very low—generally less than one ohm. If not, replace coil.

Second test: Ohmmeter set to "high ohms" scale. Connect between the big terminal where the coil wire would go, and either the "BAT" ("B+" or +) terminal or the "TACH" (C- or -) terminal. If this test results in an "infinite" reading, (open circuit) replace coil)

If you replace the coil, repeat step five. If the coil passes both of these resistance tests, replace module and repeat step five.

Step five should produce spark, and the problem is fixed. Put it all back together and go cruising. If not, go cruising in your buddy's car to clear your head, then start from Step Two and re-check all your work, making sure you have good connections at the spark tester, test light and volt/ohmmeter. Then verify that the wiring harness that connects the module to the coil is sound.

If you're ABSOLUTELY sure that everything tests good, and you still have no spark, replace the module and retest.



Helpful part numbers for HEI distributors:

GM/Delco part numbers

01894379 ZZ4 distributor main shaft assembly w/ rotor.

Includes centrifugal advance. The previous number was the same but did not begin with "0" so try both numbers.

93440806 Complete "ZZ4" style HEI distributor

12167658 Connector used to connect TACH and B+ to distributor .

10456413 Melonized distributor gear for GM roller cams—standard diameter hole. (supplied on distributor 93440806)

1950569 Distributor housing grease reservoir plastic seal

1837617 Distributor shaft washers for adjusting main shaft end play (pack of five) D1906 Delco 4-pin module

NAPA and other aftermarket part numbers

DP109 HEI weight pins for distributors that use plastic bushings on weights DP112 HEI oem-style plastic bushings for weights DP114 HEI weight "stamped 106" DP115 HEI weight "stamped 139" DP126 HEI weight "stamped 105" MP100 (GP Sorensen EL315) HEI yellow color code (Chevy, Caddy except Seville, Olds Toronado) V-8 pickup coil MP101 (GP Sorensen EL310) HEI Blue (or black) color code (Olds except Toro, Buick, Caddy Seville) V-8 pickup coil MP102 (GP Sorensen EL359) HEI clear color code (Pontiac) V-8 pickup coil (My source for the GP Sorensen pickup coils sells them for about \$16 instead of NAPA's \$40. The GP-S ones I bought are even made in the USA!) RR201 Coil frame ground—wire style RR204 Coil frame ground—Stamped steel strap RR202 Plug wire retainer ring—8 cyl. RR230 HEI Capacitor and Harness from module to side of cap 6 1/2" RR231 HEI Capacitor and Harness from module to side of cap 10 3/4 RR233 HEI Harness from module to cap 3 ¹/₂ RR234 HEI Capacitor and Harness from module to side of cap 8 34 TPL45 Heat sink compound for HEI modules—10 small tubes

Provided by Schurkey





Authored by Schurkey All information believed to be correct at time of writing. Comments/suggestions? Contact schurkey@v-drivemail.zzn.com



Common HEI problems:

Insufficient wire gauge to "BAT" or "B+" terminal. You must have 12 gauge wire or thicker. GM knows this, but often cars get converted to HEI and thin wire or the old resistance wire is used. This will produce weak spark, especially at higher RPM.

Module MUST have heatsink compound between bottom of module and distributor housing. WHEEL BEARING GREASE WON'T DO! The module transfers heat through the heatsink compound so it doesn't toast itself. Heatsink compound should be included in the package with a new module, or it can be obtained in single-serving packets or in larger tubes at any "real" parts store, or electronics supply store (Radio Shack, for example)

Very early GM modules were not suitable for high-RPM operation. This problem was soon resolved, but there are still people who believe that "HEI isn't good for more than 4,000—4,500 RPM". The Delco "990" (printed on module) or D1906 (sales number) modules are both very common and will go WAY beyond 4,500 RPM, as will any QUALITY stockreplacement aftermarket module. The stock Delco D1906 module is used in performance applications such as the ZZ4 crate engines.



Photo 19. Internal structure of module.

The carbon button used with coil-in-cap distributors has a very high resistance. These buttons can overheat and melt the cap, especially when used in performance applications. I recommend a lowresistance button available from Crane Cams (730-8412) or MSD (8412) for all coil-in-cap applications. As I write this, the Crane Cams unit is less expensive than the MSD version.

• Incorrect screws are sometimes used to mount coil into cap. Screws that are too long will puncture cap leading to short-circuit of spark from rotor to screw.



Photo 20. Cap punctured in one place by coil hold-down screw—one screw boss not punctured (lower left corner); note "X" of broken plastic on boss at lower right corner.

A ground strap—either stamped metal or a short wire with a metal blade attached—must be attached to coil frame using a coil hold-down screw, with the other end being the middle terminal of the three parallel blades in the cap.



COMMON HEI PROBLEMS



Photo 21. Ignition coil screw length, and wiretype coil ground strap. Three (sometimes only two) short screws mount coil cover to the cap.



Photo 22. HEI coil cover with variation in hold down screws

Windings in pickup coil or the ignition coil open when underhood temperature rises. Car runs great cold but dies suddenly when hot. Wires that connect pickup coil to module break inside the insulation. (They don't look broken.) When the vacuum advance moves the pickup coil, the broken wire opens the circuit so the engine dies. Vacuum is reduced, the vacuum advance relaxes, the wire reconnects and the engine runs. Cycle repeats.

Centrifugal advance doesn't get lubed and wears out the holes in the weights and the pins that the weights pivot on. In addition to screwing up the advance curve, all the metal dust from the worn out weights and pins is now stuck to the inside of the cap and rotor, making a possible path to ground for the spark. Replacement weights, pins, and bushings for some HEIs are available at any "real" parts store. If you have the style of mainshaft that uses plastic bushings in the weights, you're in luck. If not, consider buying the mainshaft assembly from the GMPP HEI distributor—the one used on the ZZ4 engine. GM chose this mainshaft/centrifugal advance assembly for use on some of the medium-performance crate engines specifically because it has a reasonable advance curve.

Photo 23. Mainshaft; with reluctor assembly shown about two inches below where it would normally go. Note grease reservoir machined into mainshaft, and note worn-out pivot pins on mainshaft.





COMMON HEI PROBLEMS

Be careful when re-curving the centrifugal advance; many HEI distributors have "hidden" advance at very high engine speed that could destroy an engine. This happens when using light springs and when the weights act upon the "gently curved" part of the center plate. A positive stop for the advance can be used; or the center plate can be turned upside down so the weights act on the "dogleg curve" part of the center plate—as long as the dogleg provides an acceptable advance curve for the application.

Center plates have as much effect on the advance curve of an HEI as the weights and springs do. There is NO source for an assortment of center plates that I'm aware of—they're salvage-yard-only parts now.

V-6 cars that run really erratic may have the incorrect pickup coil. The Buick even fire, the Buick oddfire, and the Chevy odd-fire V-6 engines each use unique pickup coils. If the wrong coil is used, three cylinders will have incorrect timing.

If you remove the distributor gear, be sure to note the position of the little "dimple" on the gear. It should align with the tip of the rotor.



Photo 24. Weights acting on gently-curved part of center plate. Note pivot hole in lower weight is now a sloppy fit on worn-out pivot pin.



Photo 25. Weights acting on dogleg curve. (center plate upside down) Again, note sloppy fit of weight on wornout pivot pin.



Photo 26. HEI dimple on distributor gear. Also note thrust washers.







COMMON HEI PROBLEMS

Tall-deck big-block engines when used with some non-stock intake manifolds; or any Chevy V-8 that has had considerable milling on the block decks, head decks, or intake manifold may need a distributor with an adjustable slip-collar so that proper engagement with the camshaft (and therefore the oil pump drive) can be maintained. MSD and others supply ready-to-go distributors with slip-collars; but advancing and retarding the timing—unless you it's no big deal to convert your original distributor if you have access to a small metal lathe-or a machine shop. Cut down the distributor housing holddown flange, and slide an aftermarket slip-collar into position. It's up to you to locate the slip collar in the correct place before tightening the collar onto the housing. Slip-collars are available from industrial supply houses; or from MSD (8539) and Moroso (26217)



Photo 28. General instructions for installing a slip-collar.

(Machine to inside diameter of slip-collar so that slip-collar can tightly firmly)

Racers sometimes adjust the end play of the distributor mainshaft using hardened steel washers. The theory is that the helical cam and distributor gears cause any "up and down" movement of the main shaft to also be a rotational movement. (Think about dropping the distributor into the engine—you have to allow for the rotor rotation as the distributor gear meshes with the cam gear.) If the mainshaft is jumping up 'n' down, that will affect the ignition timing of the engine. Although limiting endplay may be a benefit for dry-sump engines (no oil pump drag) it's pretty much wasted effort in wet-sump applications—and can sometimes cause problems. If the distributor is turning an oil pump, the drag from the pump acting on the helical gear

will cause the gear-and therefore the mainshaftto push "up" against the existing thrust washers. The oil pump is always providing drag; so the distributor shaft is always pushed "up" as far as it will go as long as the engine runs. It's unlikely that you're having trouble with erratic timing because the mainshaft is moving up and down and therefore have little or no oil pressure. If you have no oil pressure, you need to fix that problem before you mess with the distributor shaft! If you do choose to limit end play to ~.012 by adding hardened washers, assure that the distributor mainshaft also has "some" end play WHEN IT IS INSTALLED IN THE ENGINE, AND TIGHTENED AGAINST THE MANI-FOLD.

Again, if the block decks, cylinder heads, and/or manifold has been planed, you will reduce the distance between the distributor mount in the manifold; and the oil pump drive—at the same time you are effectively making the distributor housing longer by adding washers. If things get too extreme, the oil pump drive will butt against the mainshaft, forcing the distributor mainshaft "up"; this also puts a thrust load on the drive gear of the oil pump leading to scoring of the oil pump cover and a "bound up" situation that will destroy parts. Adding a second distributor gasket on the manifold, or installing a slip-collar on the distributor housing can restore appropriate distributor-to-oil pump drive clearance.

As with any parts, beware of low-budget "copycat" junk. Sometimes, they're not too careful about how they build their products. I'd much rather have a used-but-usable Delco HEI than a brandnew imported knockoff distributor of the sort polluting eBay and discount catalogs.



Photo 29. Note poor "off center" drilling of gear and mainshaft. This company offers gears with only one hole drilled as service replacements! You'd have to drill the second hole to match the offset hole in the mainshaft.

Photo courtesy of "Rewind"-Thank you, Rewind!



HEI COIL INTERCHANGEABLITY

There are two color-coded (coil-in-cap) **ignition** coils, and three color-coded **pickup** coils. (Note that external ignition coils are not color coded.) One coil-in-cap ignition coil uses red and yellow wires; the other uses red and white wires. They are functionally identical except the magnetic (not electrical) polarity is opposite. The yellow/red ignition coil is neither a higher- or lower-performance version of the white/red ignition coil. They have the SAME electrical specs, differing only in the direction (not strength) of the magnetic field they radiate.

One pickup coil uses either a yellow tyrap or a yellow plastic connector body on the wires that attach to the module. Another pickup coil uses either a blue tyrap or black plastic connector body, and the third pickup coil uses a clear tyrap or a clear plastic connector body. (Some aftermarket manufacturers will use no connector body instead of a clear one.) The yellow pickup coil has opposite magnetic and electrical polarity from the blue/black, and clear pickup coils. The wires leading from the blue/black; and clear pickup coils to the module must be crossed to correct the electrical polarity, leaving the magnetic polarity "backwards". The metal connectors are sized differently; and the molded plastic connectors are positioned in a way that prevents incorrect connection.

Delco discovered that magnetic interference from the starter/battery cable could trigger "false" sparks at low RPM—especially during cranking. Sure, you can use mis-matched components—but if you have misfires, backfires, or other ignition problems especially at cranking speed—you've been warned. Pickup coils are selected based on engine family. Ignition coils are then selected based on which pickup coil was selected.

Engine	Pickup Coil color code	Ignition Coil color code
Buick	Blue/Black	White and Red
Cadillac	Yellow	Yellow and Red
Chevrolet	Yellow	Yellow and Red
Oldsmobile except Toro	Blue/Black	White and Red
Oldsmobile Toronado	Yellow	Yellow and Red
Pontiac	Clear	White and Red

Table 1. Pickup Coil and Coil-in-cap Ignition Coil Selection for Traditional V-8 Engines

So, for the "traditional" V-8 engines, Chevrolet, Cadillac, and Olds Toronado use the yellow-coded pickup coil, and because they use the yellow pickup coil, they use the yellow and red ignition coil. Put another way, the yellow coils are a matched set. Buick, and Oldsmobile except Toronado, use the blue/black pickup coil, and therefore use the white and red ignition coil. Pontiac uses the clear coded pickup coil. It is wound the same way as the blue/black coil, but has longer leads to physically fit in the Pontiac version of the HEI distributor. Therefore it, too, uses the white and red ignition coil. Many parts catalogs indicate the wrong pickup and ignition coils for Olds Toronados.

The Delco service information I've paraphrased in this section can be found at: <u>http://fiedlerh.home.att.net/HEI.pdf</u> (Link verified 31 July 07) A recommended read!



HEI COIL INTERCHANGEABLITY



Photo 31.

Ignition coil variations.

Left to right: Yellow/Red w/o black ground wire; Yellow/Red with black ground wire; White/Red with black ground wire. White/Red w/o black ground wire is not shown. Note broken connector of middle coil. The wires won't take much abuse before breaking.



This concludes our 3 part series on HEI—High Energy Ignition. Our thanks to Team Member "Shurkey" for this excellent series!

