

## Coil on Plug Ignition

**C**oil on plug ignition is the latest development in precisely controlling spark intensity and timing for optimum power, fuel economy, and low emissions.



Most “coil on plug” (one coil for each spark plug) systems are actually “coil near plug” because a short mechanical connector, or a spark plug wire connects the coil to the plug. True coil on plug systems, with the coil mounted directly to the plug, are now being introduced on both domestic and foreign engines, including the new Vortec series from General Motors.

As an intermediate step between one coil for multiple spark plugs and coil on plug systems, many vehicle manufacturers used “coil packs” with one coil firing two spark plugs. Coil packs are often called “waste spark” systems because each coil fires both of its spark plugs at the same time. However, the spark fires on the compression stroke in only one cylinder. In the other cylinder, the spark occurs during the exhaust stroke. The second spark is “wasted” because it doesn’t ignite a fuel-air mixture. The move toward individual coils for each spark plug was inevitable. Obtaining optimum engine performance requires getting the most power and least emissions from the leanest possible fuel mixture. Lean mixtures require a strong,

precisely controlled spark to burn properly. A strong spark requires high voltage.

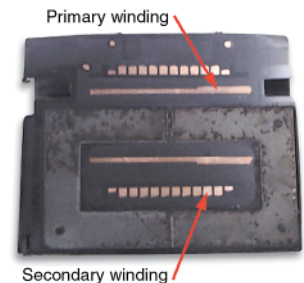
### CIRCUIT COMPRESSION

High-voltage circuits always risk degradation at any connection point between two parts. High voltage also will escape from its intended circuit whenever it finds an easier path to ground because of component failure or insulation breakdown. With coil on plug, there is no high-tension lead between the coil and the distributor, no mechanical switches to wear out, and any spark plug wires are extremely short. The system “compresses” the secondary ignition to the minimum number of components and reduces the distance the high-voltage circuit must travel.

### COIL WORKS

Coils work on the principle of induced voltage. When electricity flows through a wire, it generates a magnetic field outside the wire. On the other hand, when a magnetic field moves across a wire, it induces an electrical current in the wire.

Inside of any coil, there are two sets of windings. These are the primary and the secondary windings.



Both windings are made of insulated copper wire, although the windings are next to each other, there is no direct connection between the windings. Both windings are wrapped around a silica steel core at the center of the coil. This helps create an improved magnetic field that dramatically enhances ignition coil performance.

The primary coil winding has about 150 turns of a heavier gauge wire. The secondary winding can have more than 10,000 turns of wire. The secondary wire is so fine, it is smaller than the diameter of a human hair.

Coil operation starts with low-voltage current flowing through the primary windings. The ignition control module (ICM) limits the amperage flow to prevent overheating the coil. As the electrical current flows through the primary windings, it generates a magnetic field that surrounds both the primary and secondary windings. A signal from the ICM stops current flow in the primary winding. The instant this happens, the magnetic field collapses. As the field collapses, it induces an electric current flow in the secondary windings. Because of the higher number of windings on the secondary side, and the lower number of windings on the primary side, the current induced in the ignition coil has very low amperage, but extremely high voltage.

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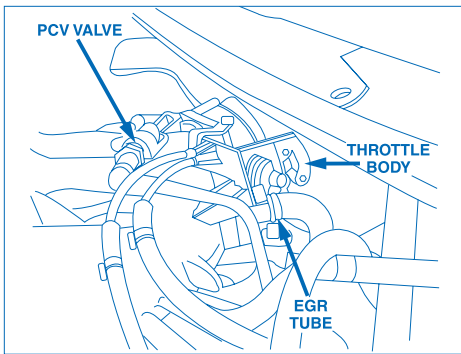
# Fine Tuning



Fine Tuning questions are answered by Jim Bates, Technical Services Manager. Please send your questions to: Jim Bates c/o Wells Manufacturing Corp., P.O. Box 70, Fond du Lac, WI 54936-0070 or e-mail him at [technical@wellsmfcorp.com](mailto:technical@wellsmfcorp.com). We'll send you a Wells' shirt if your question is published. So please include your shirt size with your question.

**Q. "I have a 1998 Dodge Intrepid with a 2.7L DOHC in the shop that makes a loud hissing noise that you can even hear when you are inside of the car. It is worse when the engine is cold. It sounds a lot like a vacuum leak, but we have checked for leaks in the gaskets and hoses and have found none. This is quite a loud noise for something we can't find. Any suggestions?"**

*McCabe Auto Service, Dallas, TX*



There have been several reports of the EGR tube seals leaking on these vehicles. Be sure the clamps and flanges are tight and that the silicone seals are in good shape.

**Q: "We have a 1996 Dodge Caravan, 3.0L, with 70,000 miles, that starts and runs, but will lose power and quit after driving a short distance. After it dies, it won't start unless it sits for several minutes. Then the cycle repeats - drive a short distance, lose power, quit, wait to restart. But if you**

**start it and just let it idle, there is no problem. Only code set is for a misfire. We've replaced the cap, rotor, wires, plugs, and coil with no success. Any ideas?"**

*Lancaster Service Garage, Lancaster, PA*

You've already eliminated most ignition components as problems. Have you checked the fuel system for pressure and volume? A marginal fuel system could meet engine demand at idle, but not under load. The misfire code may be the result of a too lean condition because of inadequate fuel before the engine starves completely and stops.

**Q: "We have a 1997 Chevrolet Tahoe 5.7L engine, with 57,000 miles, that misfires at idle and sets a code for intermittent misfire on #3. Off idle, the engine runs smoothly. Ignition checks out, compression test and running compression test OK. Replaced the distributor cap and #3 injector, but no change. What have we overlooked?"**

*Service Plus, New York, NY*

A misfire at idle that goes away off idle is usually a lean miss. Because only one cylinder is affected, check for a gasket or other sealing problem at #3.

## Diagnose The Problem Win A Shirt

There is a constant no-start problem on a 1995 Mercury with a 4.6L engine. No codes are set, ECM and ignition control module were swapped with known good units. Ignition and valve timing is normal. Fuel pressure and

quality are normal. Compression is good on all cylinders. The spark plugs, however, carbon up badly upon attempt to start the engine. Keep cranking and the engine backfires through the throttle body.

Where would you go from here?

*The first reader to respond with the most accurate answer via e-mail or fax, and the first reader to respond with the most accurate answer via snail-mail, each will receive a Wells golf shirt. The answer will appear in the next issue.*

## Here is the answer to last issue's question regarding the problem with the 1998 Ford E-350 4.2L SEFI V6.

Disable the EGR to see if the miss goes away. This vehicle has EGR ported to each individual cylinder. The EGR orifice for number six cylinder was unobstructed and coated with a bit of dry sooty carbon. The other five EGR orifices were plugged with carbon. Restricted EGR to five cylinders caused the ping and too much EGR to cylinder number six caused the miss. A good cleaning of the orifices, EGR valve and adapter was necessary to get the vehicle running properly again.

The first most-correct answer received by e-mail or fax on March 29th was from Alvin Shelton of Shelton Automotive Services in Beaumont, TX. The first most-correct answer received by snail-mail was from Schumanns Automotive in Brewster, NY. Congratulations!

# Quality Points

## Wells Manufactures Better Circuit Boards

For the independent technician, the decision to install one part over another is often based solely on the perceived quality with fit and finish serving as the only criteria.

However, in many cases, it's what can't be seen that matters the most.



Wells Manufacturing Corp. prides itself on manufacturing electrical components to the highest standards using the latest technologies. It is this pride that drives it to seek better solutions during the engineering process; its circuit boards are one such example.

Wells is the first full-line ignition supplier to have received QS-9000 certification for the design and manufacture of electronic engine-management systems, charging systems and

sensors. Today, all of Wells' facilities, from design to engineering and from manufacturing, to distribution are QS-9000 certified.

Many companies in the automotive world still use old-fashioned plastic-based printed circuit boards with copper paths. Wells uses an aluminum oxide based substrate with palladium silver silk screened onto the board in a four-step 1730° F firing process.

Palladium silver provides a stronger pull and mechanical strength for a longer lasting part; pure silver degrades over time through thermal cycling.

Instead of populating a board with individual resistors, Wells screen prints resistors onto the boards using state-of-the-art robotics, and then laser trims them to  $\pm 1\%$ . This makes for a longer lasting, more compact board with fewer parts to malfunction.

## Coil on Plug Ignition

In addition to better control of a high voltage secondary, coil on plug systems allow the coils to work more efficiently.

Coils require time to build the magnetic field (called “dwell or coil saturation”), but also become hotter the longer current is flowing in the primary windings. Multiple coils allow more time for coil saturation, for a stronger spark, while also allowing more cooling time between firings.

## TROUBLESHOOTING

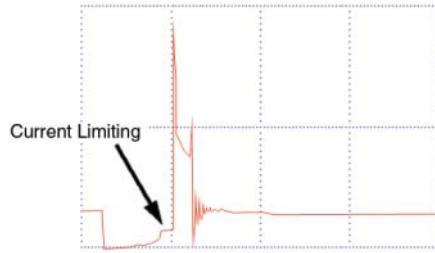
Detailed specifications for the engine you are servicing are essential, because there are many different ignition systems using coil packs, coil near plug or coil on plug. General Motors, for example, uses multiple coils with at least four different ignition control systems. Here are some general troubleshooting tips that can be helpful.

- Always verify the complaint. However, remember that no start, misfire, and engine-stalling complaints can be fuel related, spark related, or both. These types of problems also cause high-hydrocarbon (HC) emissions.

- Check the basics. Make sure all wiring connections are good. Look for obvious problems like damaged wires, corrosion, etc. Make sure the charging system is normal. A weak charging system reduces the voltage to the primary side of the coil, which then prevents the induction of a powerful secondary current. Although the electronic ignition system will operate with as little as 7 volts input to the primary side, the voltage should be normal system voltage (12 to 14 v) to create a strong spark.

- Correct all codes present before doing additional diagnosis. Pay special attention to codes for the ICM, crankshaft position sensor (CKP), and camshaft position sensor (CMP). Coil operation and spark timing are controlled by the ICM based on signals from the CKP and CMP.

- Coils can die, but they are more likely to be murdered. If you identify a defective coil, try to determine what caused the coil failure and correct the problem. Otherwise, the replacement unit will be doomed to failure just like the original coil. For example, a bad current limiting circuit in the ignition control module can cause rapid overheating and early ignition coil failure.

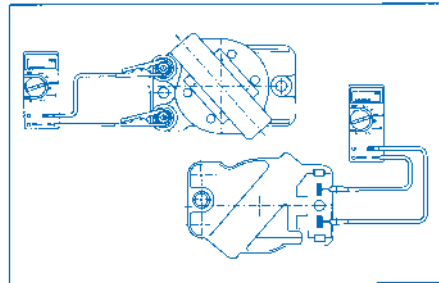


Scope illustration showing current limiting circuit.

- If a coil is suspect, you may be able to swap it with another coil on the same engine to see if the misfire follows the suspected bad coil. If the misfire moves with the suspected coil, the unit is bad. If the misfire stays at the same cylinder, there may be a problem with the voltage supply or trigger signal to that cylinder. However, on some engines, swapping coils may be too time consuming.

- A commercial coil tester, available from many tool suppliers, is an excellent way to test suspect coils. If the coil can generate a spark on the tester, the coil should be in good condition.

- An ohm meter can also be used to test coil winding resistance. Primary-side resistance, from coil minus to coil plus, is typically between 0.3 and 1.0 ohm on electronic ignition type coils.



Ohm meters are used to test winding resistance.

Secondary resistance values vary widely, so consult a specifications chart for the engine you are servicing. If a spec chart isn't available, compare secondary readings among all the coils to see if any one is higher than the others. A high resistance indicates deterioration in the wiring. Surprisingly, a coil with high resistance may still fire the spark plug, but the voltage produced will be higher because the current must jump the open wiring in addition to jumping the spark plug gap.

- Although coils can generate up to 45 kV (45,000 volts), normal firing voltage is typically 20 kV to 25 kV. Voltage levels much over 25 kV indicate an opening in the coil windings, worn plugs or a bad connection between the coil and the plug. Prolonged exposure to more than 25 kV can cause a coil

to fail by breaking down the internal insulation or overheating the unit.

- Shorted windings inside the coil can be difficult to diagnose. Just a few turns shorted together can cut maximum coil output from 45 kV to only 10 kV. Typically, a shorted coil will produce an adequate spark under light loads, but will misfire under load or hard acceleration.

- A coil may operate normally when the engine is started, but then fail after becoming heated. The engine will start and run well, but then develop an intermittent or steady misfire in one cylinder. The engine will operate normally during low-speed operation, but misfires under load or hard acceleration, especially after the engine has been running for a period of time. If possible, swap coils and see if the misfire follows the suspected coil.

- If an engine starts normally, but then develops random misfires, stalls, or has other performance problems traced to the ignition system, and no problems are found in the secondary ignition system, check CKP and camshaft sensors operation. Make sure all connections between the sensors and the ICM are clean and tight.

***Are you a full-time professional automotive technician interested in networking with other professionals from around the world? Do you have at least 4 years of full-time work experience as an automotive technician? Are you currently ASE certified?***

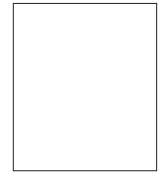
If you answered yes to these questions, please consider becoming part of the largest network of professional automotive technicians in the world. The International Automotive Technicians' Network. The iATN is a group of 26,133 professional automotive technicians from all over the world that offers an incredible resource for automotive professionals. Members of the iATN exchange technical knowledge and information with their fellow members through e-mail, forums and information databases. The combined knowledge of top industry professionals networking together, 476,270 years to be exact, helps the professional members of this group provide the highest quality automotive diagnosis, service and repair.

Wells Manufacturing Corp. supports iATN, International Automotive Technicians' Network, and its mission of excellence. "To promote the continued growth, success and image of the Professional Automotive Technician by providing a forum for the exchange of knowledge and the promotion of education, professionalism and integrity."



# WELLS

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## Hot off the Wire

### Wells Introduces 2000 Fuel Injection Catalog

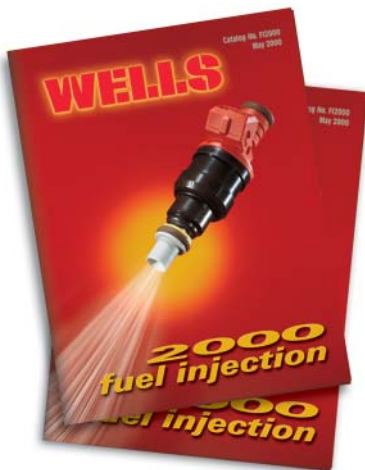
Wells Manufacturing Corp. has recently released a new 2000 Fuel Injection catalog for import and domestic cars and trucks built up to and including year 2000 models. The new 224-page

Fuel Injection catalog contains Wells' full line of fuel injection parts. Added this year are 300 new part numbers. Comprehensive coverage includes: fuel injectors, fuel-pressure regulators, throttle body kits, cold-start valves, MPI throttle-body gaskets and more.

Wells' Fuel Injection catalog features a new easy-to-read format and buyer's guide index. To facilitate stocking, re-ordering, fast access and inventory control, the fuel injection catalog utilizes an alpha-numeric planogramming system.

Technicians can get a copy of Wells' new Fuel Injection catalog, or any other Wells catalog, by calling their Wells supplier.

Recently Wells won its ninth National Catalog Managers Association President's award for catalog excellence.



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