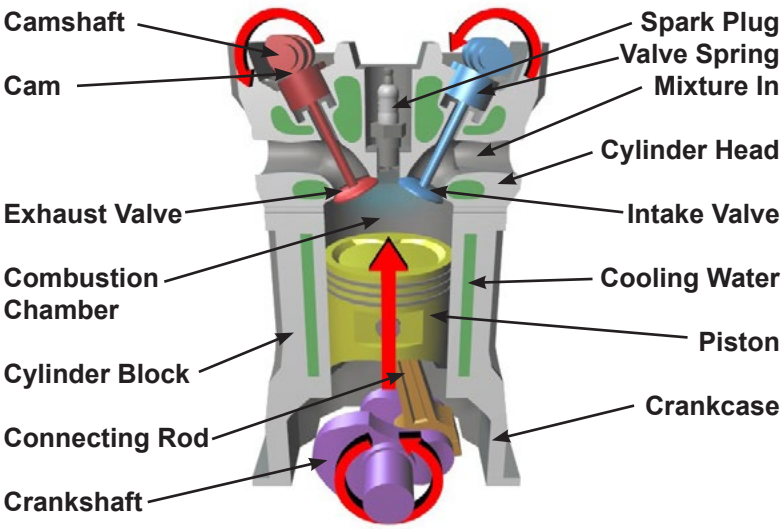
Corvette Ignition Explained
Sparking Your Interest

Simply put, an ignition system activates a fuel-air mixture to create energy. The first ignition system to use an electric spark is thought to be Alessandro Volta's toy electric pistol, ca. 1780. We've come a long way since that toy pistol! Today, the most commonly used ignition is the 4-stroke internal combustion system found in almost all vehicles, including your Corvette. Mid America Motorworks takes a look at the evolution of the ignition system, from early vehicles to the powerhouse Corvettes of today.

Ignition – Why You Need A Spark

In a 4-stroke internal combustion system, the spark is where the magic happens. The spark ignites the air-fuel mixture to create a burst of energy that moves your Corvette down the road. Just as the name implies, this happens in a sequence of 4 steps that continually repeat.



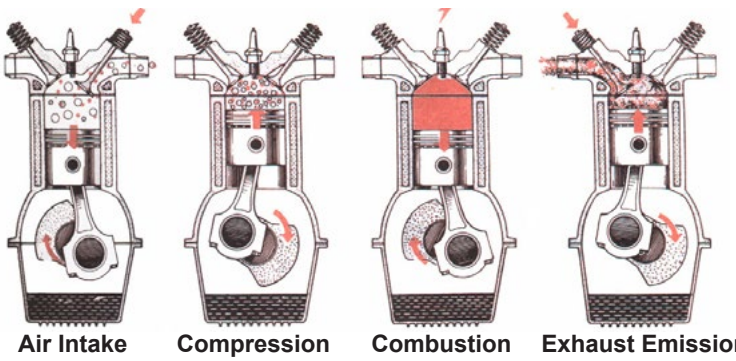
Stroke 1: The piston's Intake Valve opens to suck fuel and air into the cylinder.

Stroke 2: The Intake Valve closes capturing the fuel and air. The engine compresses the mixture, creating a large amount of potential energy.

• **SPARK:** When the piston reaches the top of the cylinder, the spark from the spark plug causes the mixture to explode.

Stroke 3: The explosion forces the piston back downward, releasing the potential energy as power.

Stroke 4: The Exhaust Valve opens and the piston forces exhaust out of the cylinder.



The Main Components

Distributor

The Distributor routes high voltage from the ignition coil to the spark plugs in the correct firing order. It consists of a rotating arm, or rotor, inside the distributor cap. The distributor cap is driven by a gear on the camshaft and contains a cam that operates the contact breaker. When electronic ignition became common, the primary breaker points were replaced by an optical sensor. This non-contacting device eliminated a great amount of point maintenance and replacement.

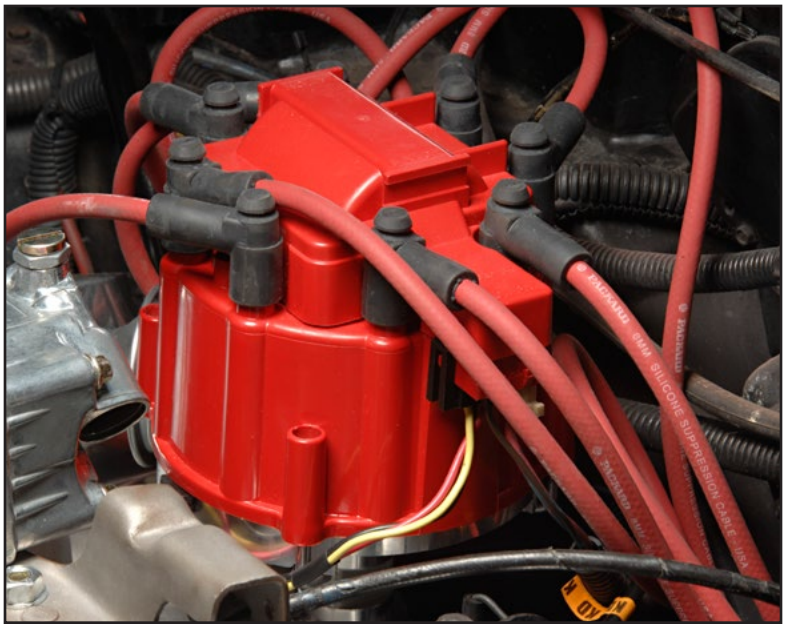
Distributor Cap

The Distributor Cap covers an engine's distributor and internal rotor. It has one post for each cylinder. In mechanically-timed ignition, there is also a central post for the current from the ignition coil back into the distributor. However, on General Motors High Energy Ignition (HEI) system, there is no post and the ignition coil sits on top of the distributor.

Spark Plugs

The Spark Plug forces electricity to travel across a gap, similar to lightning during a thunderstorm. Voltage at a spark plug can range from 40,000 to 100,000 volts. Spark Plugs have a ceramic insulation to carry the voltage from the distributor to the ground electrode. The voltage flows from the connector, through the central electrode and out to the ground electrode where the spark takes place. A difference in voltage between the central electrode and the ground electrode cause ionization, which creates the spark.

Spark Plugs can be considered hot or cold, depending on the size of the contact area. Hot Plugs have a smaller contact area and thread farther into the engine's combustion chamber. Cold Plugs have a larger contact area that diffuses the heat.

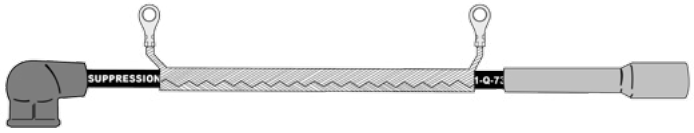


Spark Plug Wires

Spark Plug Wires deliver the voltage to the Spark Plug, so they are an important piece of the ignition puzzle. Several aspects of the Wires come into play to improve your Corvette's efficiency and performance.

Wire Length – There are three common options when it comes to Spark Plug Wire length: OE Replacement, Universal and High Performance. OE Replacement Spark Plug Wires came with your Corvette from the factory. If you like to keep your Corvette original, these are the wires for you. Universal Spark Plug Wires are designed to fit an array of vehicles, including your Corvette, so they may be longer than your stock wires. They are the most commonly-stocked wires at most automotive stores and offer a good replacement for a no-frills daily driver. High Performance Spark Plug Wires are designed to give you the most efficiency and performance. They are customized by length, color and diameter to meet your needs.

Wire Diameter – Standard Spark Plug Wires are 7-8mm in diameter. However, there are options to increase the diameter to as much as 11mm. A thicker Spark Plug Wire can deliver a higher voltage load, thereby increasing performance and response.



Date-Coded Spark Plug Wires – If your Corvette makes the rounds during show season, make sure your Spark Plug Wires have the correct date code. In January 1961, GM began dating coding spark plug wires for their own internal identification. Research has shown that most Corvettes had spark plug wires that were dated from 1 to 12 months prior to the build date of the car. Dated wires were dated by quarter and provide the finishing touch on restorations.

Custom Colors – Whether your intent is to match or contrast with your Corvette, there are plenty of color options available to make your underhood pop. Almost every color of the rainbow is available, and for those who want a more aggressive look, braided Spark Plug Wires are also an option.

The Remix to Ignition – Changes Over Time

Mechanically-Timed Ignition

Early Corvettes were powered using mechanically-timed ignition. In this system, current flows from the battery to the ignition coil. From there, it flows through the primary windings of the ignition coil, to the contact breaker inside the distributor. A cam opens and closes the contact breaker points, causing the current to break. This break in the current causes an EMF in the secondary winding of the ignition coil, which exponentially increases the battery's voltage.

This high voltage is transferred to the distributor, where a rotor distributes the voltage from the distributor to the spark plug terminal, via a high tension cable. A voltage difference is generated between the central electrode and the ground electrode of the spark plug, which creates a spark.

The disadvantage of mechanical ignition was the wear to the breaker points where they ride the cam to open and shut. The contact surfaces were also subject to oxidation and burning from constant sparking.

Electronic Ignition

Electronic ignition was introduced in the 1970s, eliminating the problems associated with mechanical ignition. An armature replaced the breaker point system of the mechanical transmission, which sends signals to the ignition module to make and break the circuit. A current flows from the battery through the ignition switch to the primary windings of the ignition coil. The armature includes teeth, which generate a voltage signal when they pass directly in front of the pickup coil. The electronic ignition module senses the signal and stops current flow from the primary circuit. As soon as the armature tooth moves away from the pickup coil, a timing circuit inside the ignition module turns the current flow on again.

This continuous on/off of the current creates a magnetic field inside the ignition coil, which produces an EMF in the secondary winding of the ignition coil, once again elevating the voltage thousands of volts above the 12V battery. This high voltage is transferred to the distributor, where a rotor distributes the voltage from the distributor to the spark plug terminal, via a high tension cable. A voltage difference is generated between the central electrode and the ground electrode of the spark plug, which creates a spark.

Electronic Ignition is not only more efficient, it also increases the amount of power created within the engine.

High Energy Ignition

Known as HEI, High Energy Ignition was a form of Electronic Ignition designed by the Delco-Remy Division of General Motors and introduced in 1974 on most Corvette engines. It remained in use through the mid-1980s and is characterized by the ignition coil being incorporated into the distributor cap. With this design, a control module and magnetic pickup are mounted in the distributor, eliminating the ignition points and coil wire.

Optispark Ignition

Corvettes with LT1, LT4 and L99 engines use the GM Optispark Ignition, an optically-triggered ignition distributor. The "opti" has two parts: a low-voltage optical section and a high-voltage cap-and-rotor section. The optical section consists of a disk containing 360 slots that represent the 360 degrees of crank rotation. A small laser/eye unit throws a beam through the slots and reads the pulses created as the beam passes through the disk. This tells the PCM the precise location of the crank at all times. Spark pulses are timed through the cap/rotor side.

Coil Over Plug Ignition

Since 1997, Corvettes have been using a Coil Over Plug Ignition System. The system has many aliases – Distributorless Ignition Systems (DIS), Coil-On-Plug (COP) or Coil-Per-Cylinder (CPC) Ignition System, and Coil-Near-Plug (CNP) Ignition System – and was chosen to combat packaging, performance, emissions and maintenance issues. Placing individual ignition coils directly over each spark plug reduces radio frequency interference and potential misfire problems by eliminating long, bulky spark plug cables. This Each coil uses less energy to fire a spark and can be smaller and lighter. From a performance standpoint, having a separate coil for each cylinder creates

a hotter spark, because each coil has more time to recharge between cylinder firings. This also reduces emissions, improves gas mileage, increases horsepower, reduces spark plug fouling, and adds to the life of the spark plugs.

Maintenance Matters

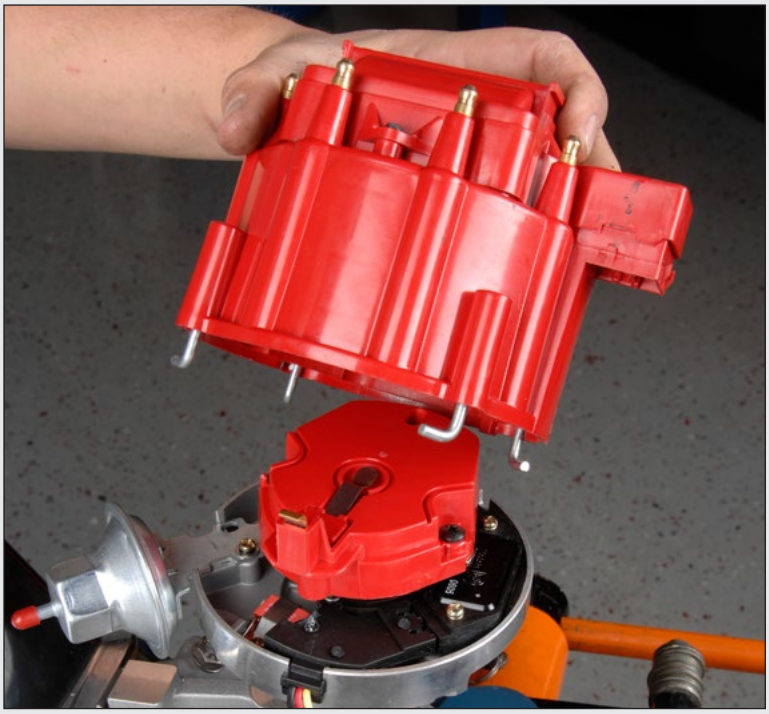
Regular maintenance for your ignition system will avoid problems that can lead to reduced fuel efficiency and poor performance. Here are some tips on what to look for to improve your Corvette engine's performance.

Spark Plugs

The process of inspecting your Spark Plugs is known as "reading" them for characteristic markings on the firing end that can indicate certain conditions within the engine. This is typically the only way to learn what is happening inside an engine running at peak power.

When reading your Spark Plugs, look for a light brownish discoloration of the tip of the plug. This indicates proper operation. However, a sandblasted look to the tip of the spark plug means persistent, light and often unheard detonation is occurring. The damage that occurs to the tip of the spark plug is also occurring on the inside of the cylinder. On the other hand, heavy detonation is not easily heard, but can cause outright breakage of the spark plug insulator and internal engine parts before appearing as sandblasted erosion. If your Spark Plug is firing too cold, there will be deposits on the nose of the plug. Conversely if the Plug is firing too hot, the porcelain will be porous looking, almost like sugar. The material which seals the central electrode to the insulator will boil out. Sometimes the end of the plug will appear glazed, as the deposits have melted.

Keep in mind that an idling engine will have a different impact on the spark plugs than one running at full throttle. Spark Plug readings are only valid for the most recent



Distributor Cap

The Distributor Cap should be inspected carefully to see how the sparks are arcing. Make sure that both the internal and external surfaces of the cap are clean. No erosion should be on the surface and the firing points should be free of rust or corrosion.

Be sure to check the rotor too, as this is the point where high-tension spark moves from one distributor cap terminal to another and it must be in pristine condition. Check for burns, traces of carbon and a secure fit.

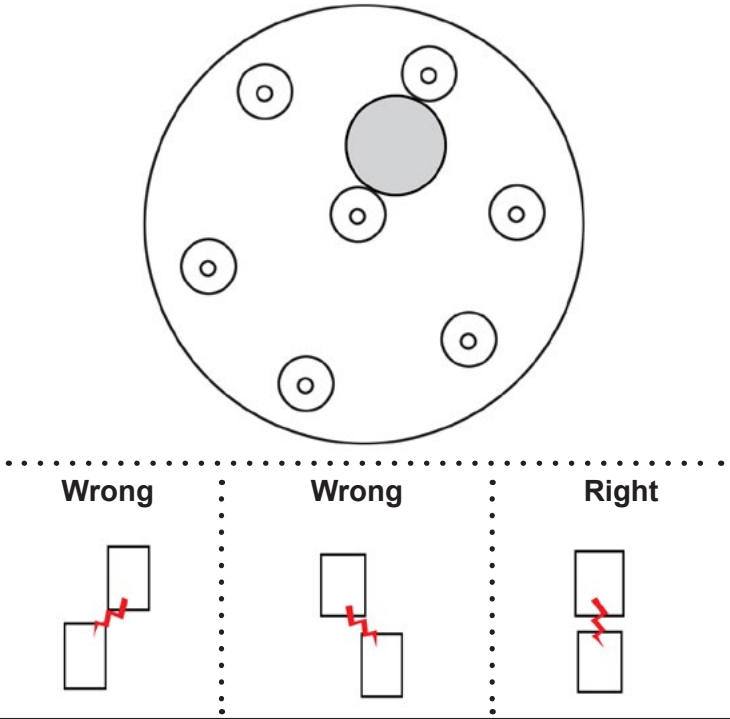
Sometimes, the issue is a slight buildup of carbon inside the distributor. This carbon trace can conduct electricity that could short out the coil voltage and cause a faulty connection inside the terminal of the distributor cap. The result is a misfire in the spark plugs. Look for any cracks or carbon trace in the cap.

engine operating conditions and running the engine under different conditions may erase or obscure marks previously left on the Spark Plugs. The most valuable information is gathered by running the engine at high speed and full load, immediately cutting the ignition off and stopping without idling or low speed operation and removing the plugs for reading.

Improving Spark Plug Performance

The practice of "Indexing" Spark Plugs is used mainly in high performance or racing applications. It involves installing the Plugs so that the open area of the spark gap that is not shrouded by the ground electrode faces the center of the combustion chamber, towards the intake valve, as opposed to the wall.

Cap & Rotor indexing by drilling a hole in an old cap and align the contact properly. This may take some tweaking to get the best alignment.



Some technicians believe that indexing will maximize the exposure of the fuel-air mixture to the spark, ensuring that every combustion chamber is even in layout, resulting in better ignition. Others believe indexing is useful only to keep the ground electrode out of the way of the piston in ultra-high-compression engines if clearance is insufficient.

No matter which theory you follow, indexing is accomplished by marking the location of the gap on the outside of each plug, installing it and noting the direction that the mark faces. Remove the plug and add washers to change the orientation of the tightened plug.

Ignition Coil

The Ignition Coil delivers power to your Corvette's spark plugs, which ignite the fuel and make your vehicle run. If your Corvette has stopped running smoothly or is behaving erratically, your Ignition Coils could be failing. Luckily, there are some tell-tale signs that your ignition coils are failing.

Backfiring – Backfiring can be an early indication that your Ignition Coil is failing. A backfire is caused when unused fuel is emitted through the exhaust system, resulting in a loud backfire, black smoke, a smell of gasoline and costly repairs.

Fuel Economy – Have you seen a sudden drop in miles per gallon? When less power is reaching the spark plugs, your Corvette has to work harder to make up for the lack of power transfer, which results in poor fuel economy.

Starting – If your Corvette has trouble starting in cold weather, this could indicate an Ignition Coil problem. Check the high tension leads that run between the distributor and the spark plugs to ensure that a spark is traveling from each lead to the spark plug.

Vehicle Stalling – As a result of coil failure, your Corvette will emit irregular sparks from the plugs to keep it running. This leads to stalling. If your Corvette shuts off when you come to a complete stop, it's time to check the Ignition Coils.

Engine Misfiring – Starting your car when the Ignition Coils fail makes for a rough ride. Your Corvette will cough and splutter regularly, vibrate when you are idling at a stop sign or intersection, and jerk and spit when you drive at high speeds.

Worn Spark Plugs – Worn out spark plugs force the Ignition Coils to operate at a much higher output. Keeping your sparks plug in optimum condition can reduce your chances of having ignition coil problems. Normal erosion can cause the gap in your spark plugs to widen, which leads to an increased voltage required to create a spark in the chamber. That increased voltage ultimately overloads the primary transistor, damaging the Ignition Coils.

Timing

For older Corvettes with Mechanically-Timed Ignition, timing refers to the setting that causes your Corvette's spark plugs to fire. If your timing is not correct, speed and efficiency will be negatively affected. Signs that your timing is off include pinging or running too rich or too lean. Luckily, you can adjust your timing rather easily.

Click here to learn how to check your timing and, if need be, adjust it for optimal performance.