



Automotive Ignition System Basics

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First Edition

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Introduction:

The history of the distributor dates back over a hundred years.

Charles Franklin Kettering invented the automotive distributor as part of his ignition system for automobiles.

Kettering was an inventor at Delco, a company he founded after leaving National Cash Register. The distributor was part of the Kettering ignition system, which was introduced in 1912 Cadillacs.

The distributor's job is to direct high voltage electricity from the ignition coil to the spark plugs in the correct order. The Kettering ignition system was popular for many years because it was simple and inexpensive. The Kettering ignition system was also known as the Delco ignition system, the points and condenser ignition, or the breaker point ignition. By the 1980s and 1990s, electronic ignition systems had mostly replaced distributors. Modern engines use individual coil packs instead.

Electronic Ignition Modules are an excellent ignition option as there are no moving parts and they can last for years without the need to re-time the engine.

Your Safety:

There are many hazards in an Engine Compartment! The numerous moving parts can cause serious hand and finger injuries and should not be taken lightly!

Keep hands and fingers away from Pulleys and Belts if they are in motion and the engine is running. Keep hands and fingers away from the fan and once the engine is warm, beware of the heat from the top of the radiator!

Take caution with the spark plug wires, the coil and the distributor when the engine is running as you may get shocked by the energy from the coil. Getting zapped may not kill you, but it is highly unpleasant. People with pacemakers and bad hearts should be extra careful.

If two or more people are working on a car, always call out to everyone before you start the car, that you're going to do that. Do not surprise anyone by cranking the motor as they may get injured.

If you are using a bump starter, take the same precautions and make sure the bump starter wires are clear of the fan belts and the exhaust manifolds.

Make sure the car or truck is in Park if an Automatic or in Neutral with the parking brake applied if it's a Manual Transmission. If standing outside of the car with a bump starter, don't stand in front of the car, while bumping the engine until you're absolutely sure the car or truck won't move.

Points type Ignition and the Coil

Nearly every single ignition system uses a coil to produce a spark and how it does this is amazing. It takes a lowly 12 Volts into it and out of it comes 25,000 Volts. It is almost magic, but simple physics make this happen. The usual appearance of it, is a solid, black cylinder that you can hold in your hand, with two wire posts and an output socket out of the center. The two wire posts are for the input and the center socket is for the output that goes to the distributor, by which it's named, distributes this 25,000 Volts+ to the spark plug or even plugs if there's more than one cylinder.

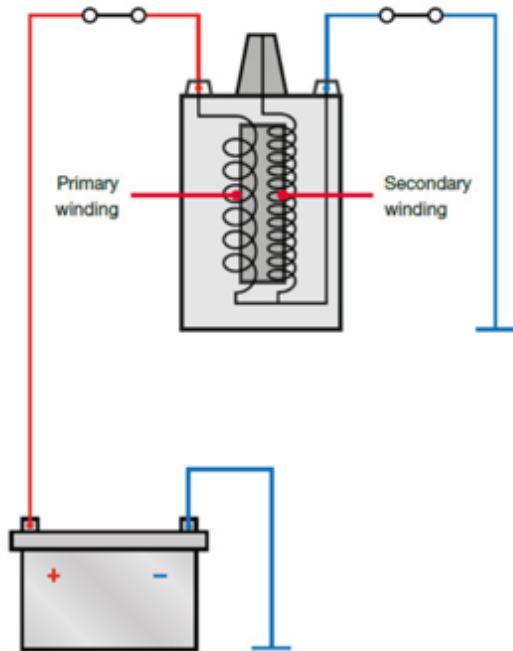


One post is marked (+) for Positive and the other is (-) for Negative and this supplies the 12V needed to operate and this configuration applies to the modern 12V Negative Ground electrical system.

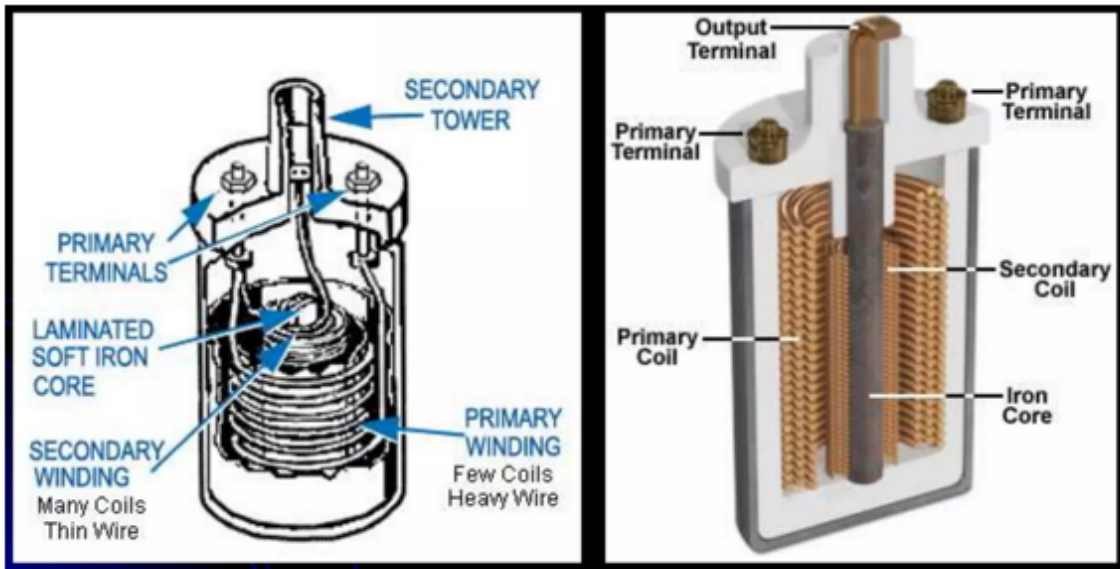
Note, before 1955, many cars and trucks were 'Positive Ground' The positive cable went to the frame or engine and acted as the 'ground'. It still worked exactly the same, the current just flowed in the opposite direction. Your coil should match the polarity of the vehicle. If you don't have the coil connected correctly, you may see a far lower spark from your ignition system.

The Coil

How the coil is constructed.



The simplified diagram on the left, is the same as the two cutaway views below.



There are actually TWO sets of Coils inside the Coil! A big heavy coil on the outside and a smaller one on the inside, surrounding an iron core. They are separated from each other by a small gap.

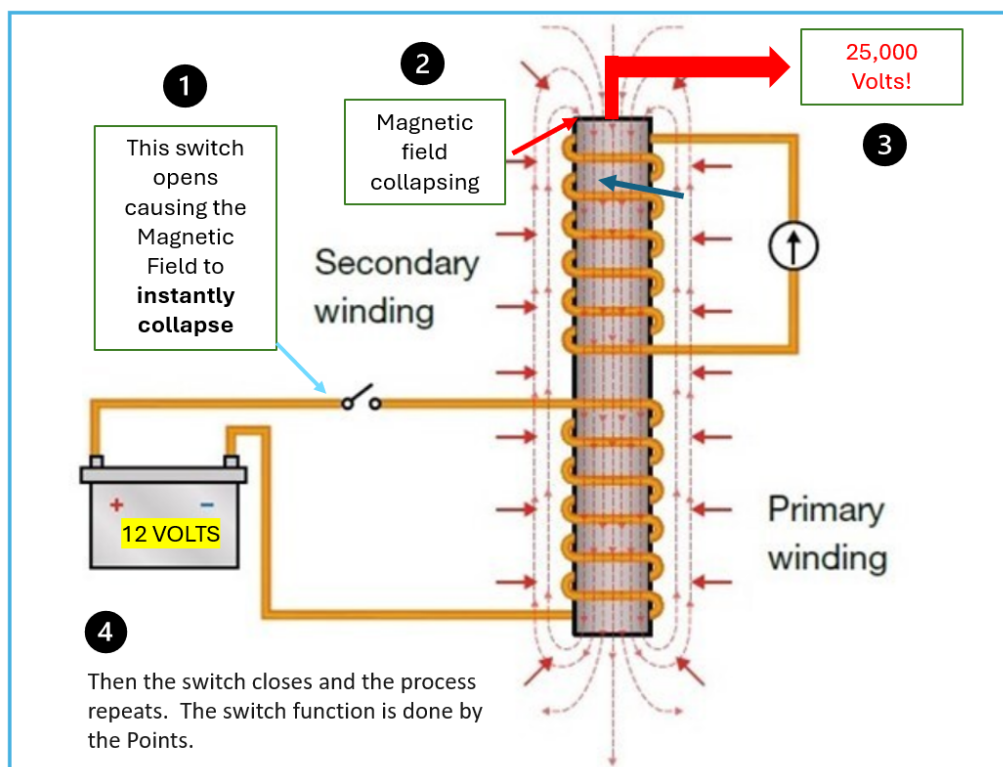
The Coil

How the Ignition Coil works

Let's talk about the two coils. The outer one has big heavy copper wires, about 150 to 300 turns. The inner one has much smaller wires and has 15,000 to 30,000 turns! Why so many?

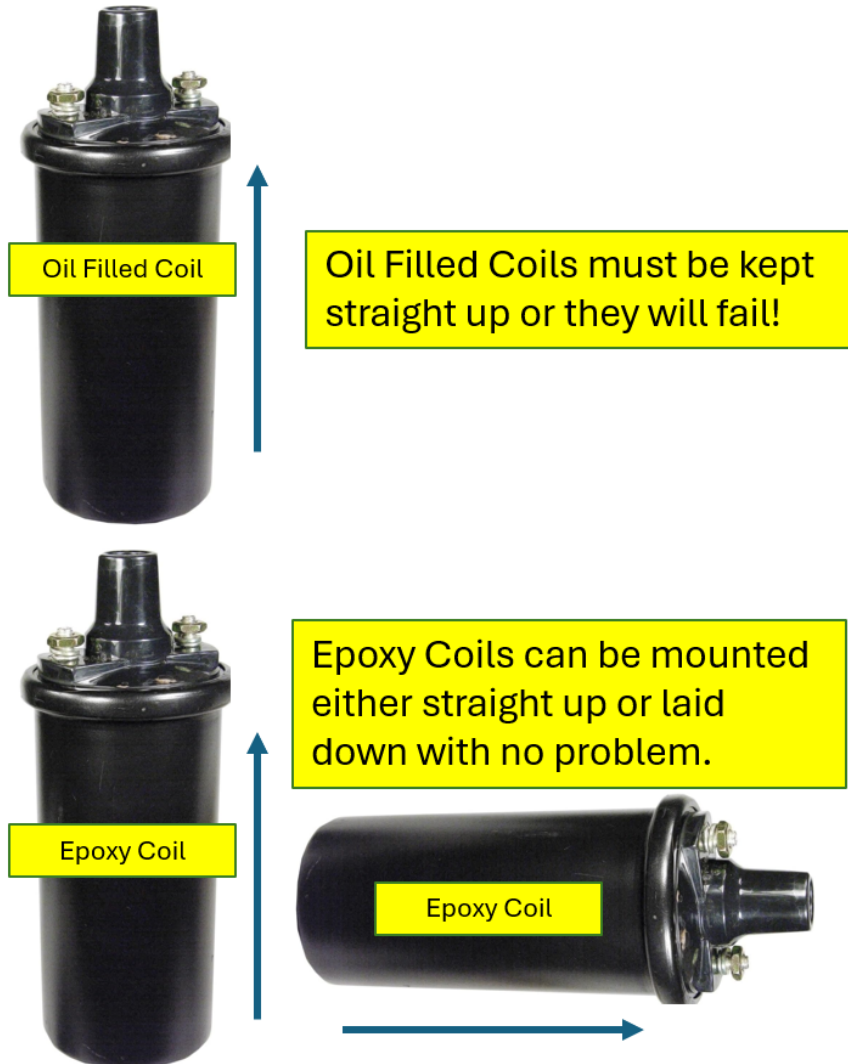
Because the difference between the outer coil and the inner coil is what makes the high voltage spark! It starts with the 12 Volts being applied to the primary terminal and this creates a **huge invisible magnetic field** all around the Primary Coil.

When that 12V gets cut off by the points opening, that invisible **magnetic field instantly collapses**. That magnetic field crosses those 15,000 copper turns on the Inner Coil and it makes that Inner or Secondary Coil jump with a huge amount of HIGH VOLTAGE to the spark plugs.



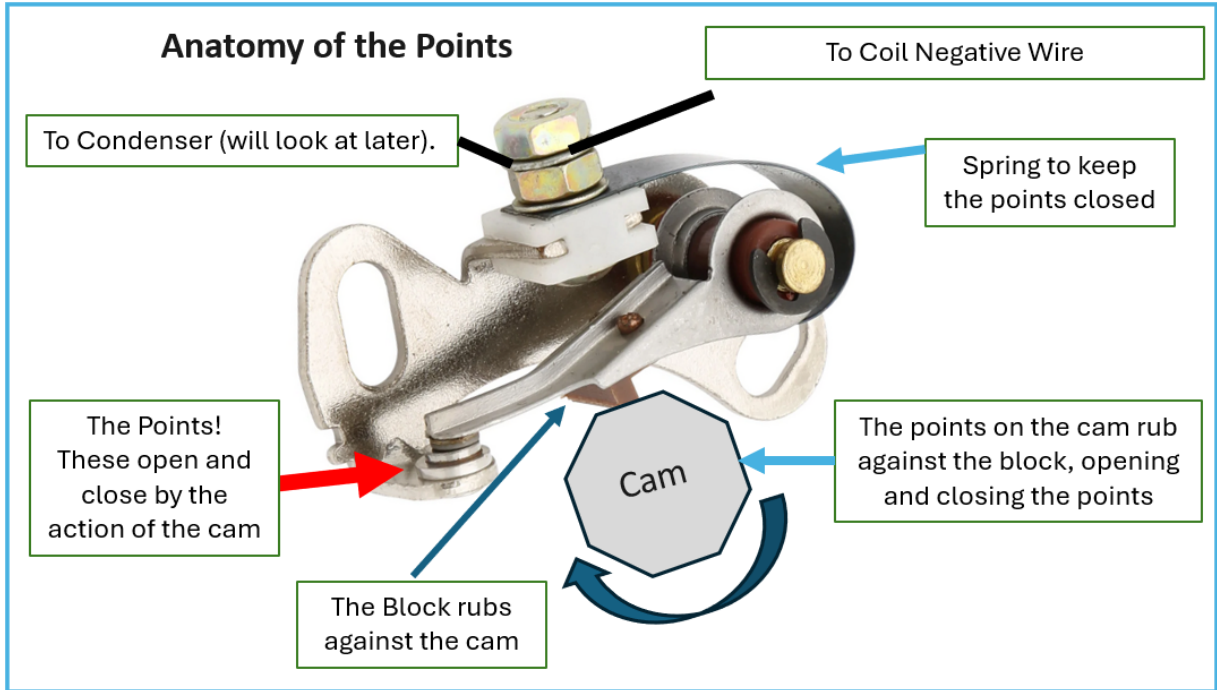
The Coil

Coils are filled with either oil or epoxy to cool and stabilize the inner coils from vibrations. If oil filled, you want to keep the coil mounted straight up or vertically. Epoxy filled coils can be side mounted or inverted. The reason not to invert oil filled coils is they can leak and also will tend to run hotter due to the air gap created when inverting.

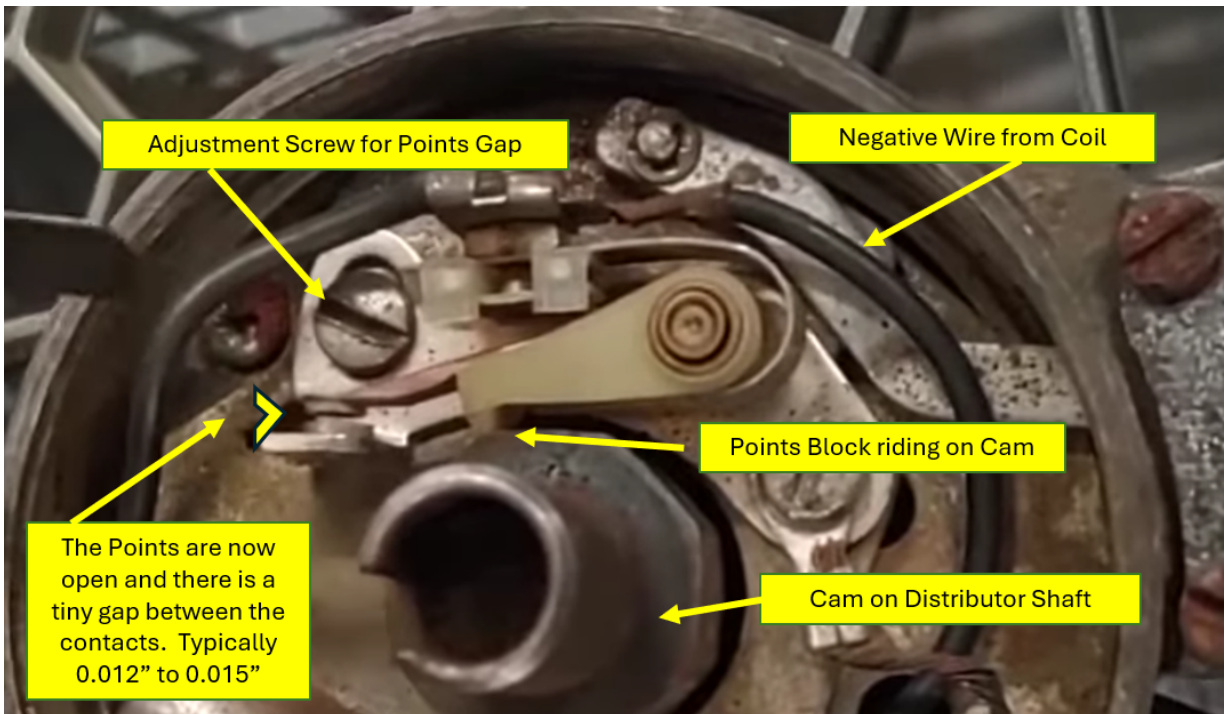


When a coil overheats and gets hot, it will quit working and suddenly you'll have no spark. You'll know this happens when the coil cools down and the car starts again. If this happens, your coil is likely damaged and it's a good idea to replace it. This can happen to either oil or epoxy coils. Keep them away from high temperature heat sources in the engine compartment.

The Points are a Rapid On/Off switch for the Coil.



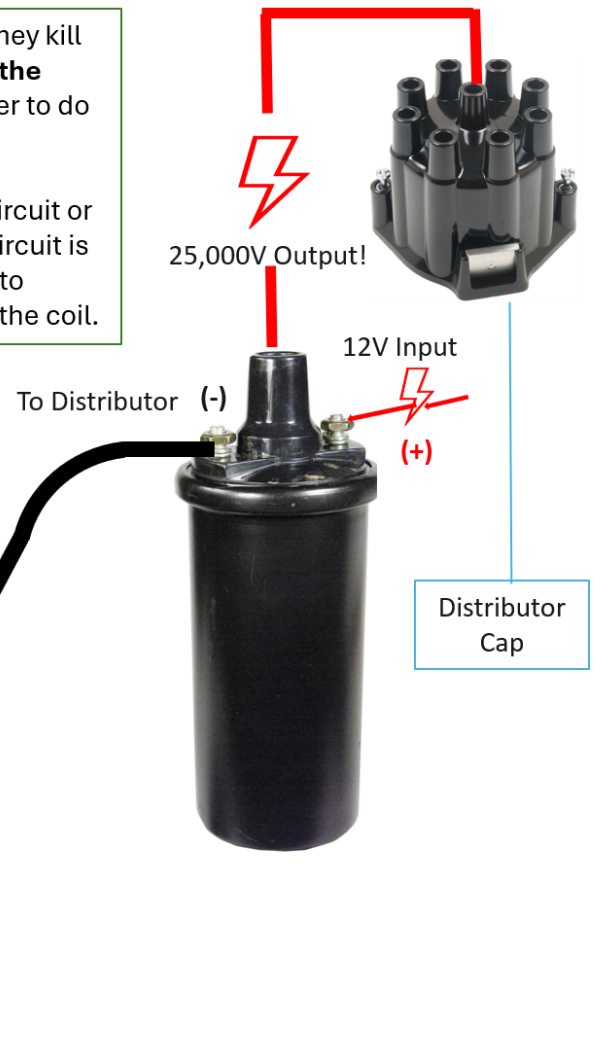
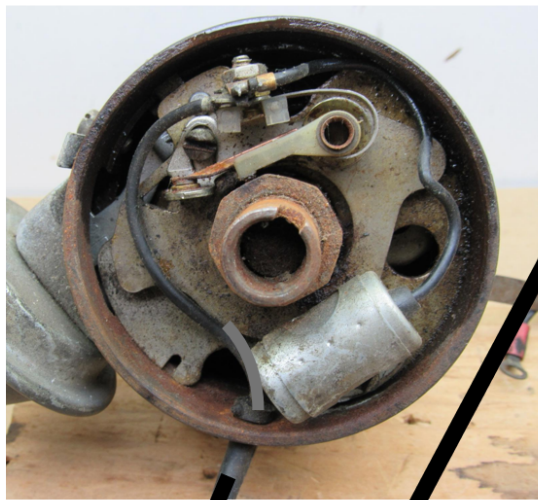
As long as the points are closed, the circuit is still at 12 volts. When the points are **forced open, by the action of the cam**, that interrupts the 12V to the coil and the magnetic field surrounding the Primary coil, collapses creating the 25,000 volts from the Secondary Coil.



The Points and how they are hooked up to the Coil:

Here are the Points as they sit inside the distributor. They kill the 12V input circuit, **through the negative wire from the coil**. They could kill it on the input, but it is much easier to do it here, by **opening the points inside the distributor**.

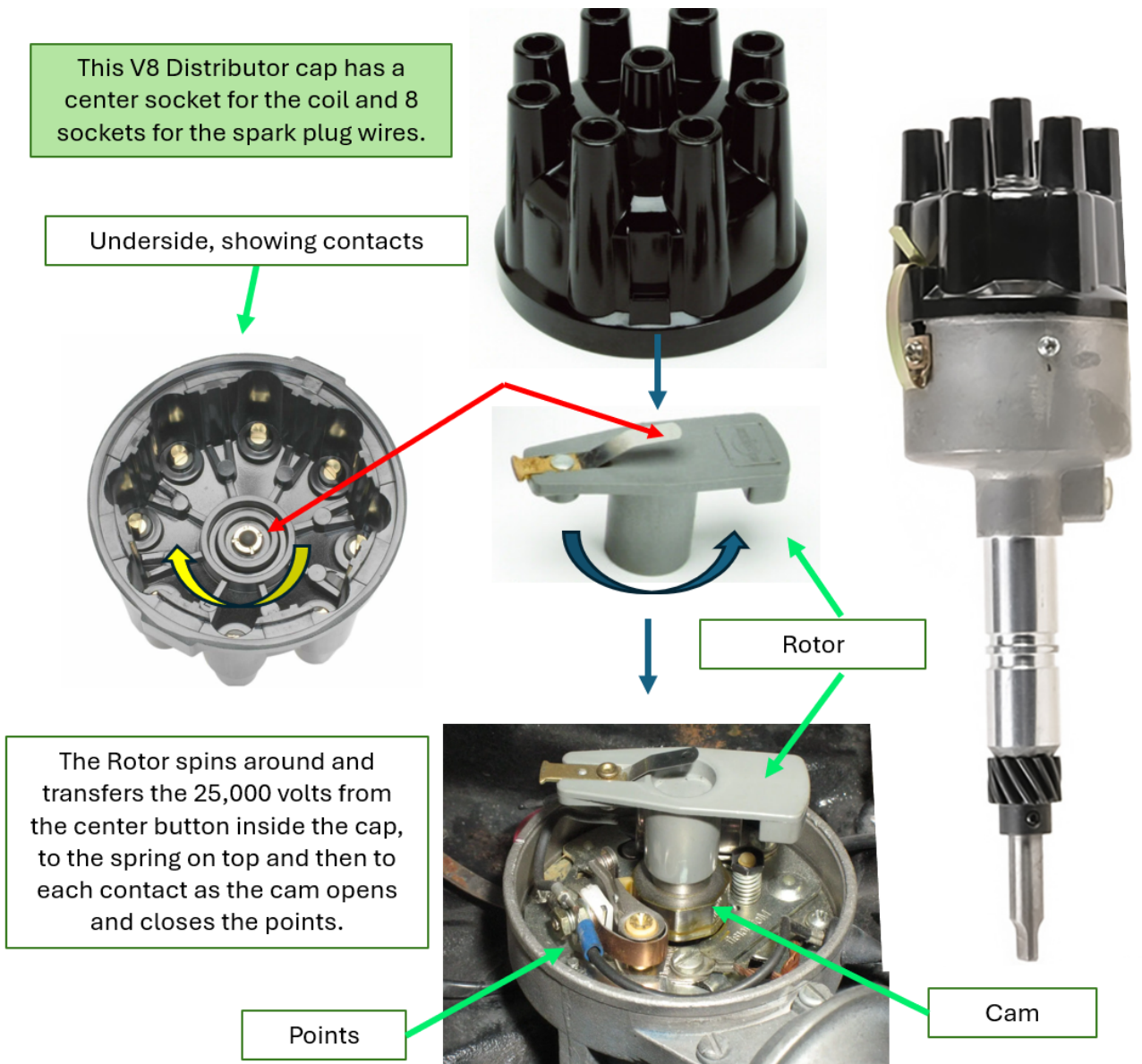
The black wire goes to the points and completes the circuit or loop. When the points open, that's when the loop or circuit is interrupted and that's what causes the magnetic field to collapse, creating an instant 25,000V out of the top of the coil.



The Condenser as seen above acts as a **shock absorber for the Coil Voltage**. The coil may kick back a voltage spike that will damage and shorten the life of the points making them arc and damaging them. Instead, the Condenser soaks up that shock and extends the life of the points. It also **stabilizes the voltage**, smoothing out the voltage going to the spark plugs.

It's a good idea to carry an extra set of points and condenser in your glove box as condensers have an oil film that will dry out and cause a short shutting down the ignition system.

The Distributor Cap and Rotor for Points:



The Rotor sits under the cap and spins at $\frac{1}{2}$ the RPM of the Engine (the engine spins twice for each firing cycle). The spring loaded tab on top of the rotor is supposed to touch the little button on the underside of the distributor cap. The clips on the side of the distributor cap make it easy to remove and look inside.

Ignition Resistance:

The Ballast Resistor and the later Resistance Wire in many cars and trucks had the same purpose: To limit the CURRENT to the points with resistance to the current. The Ballast Resistor and the Resistance Wire were simply different approaches to limiting the current, while the engine was running.

This is important, because excess current will shorten the life of the points considerably. Depending on the engine and design, a typical amperage to the points falls somewhere between 3 to 8 amps, with roughly 4 to 5 amps as an ideal number.

When starting the engine, the ballast resistor or the resistance wire is often bypassed by the ignition system, so that the coil can get full voltage, helping to start the engine. The starter pulls a lot of current while starting and bypassing the resistance makes sense. When the engine is running the resistor will heat up which increases the resistance and lowers the current to the points.

Use the chart below to select the correct coil:

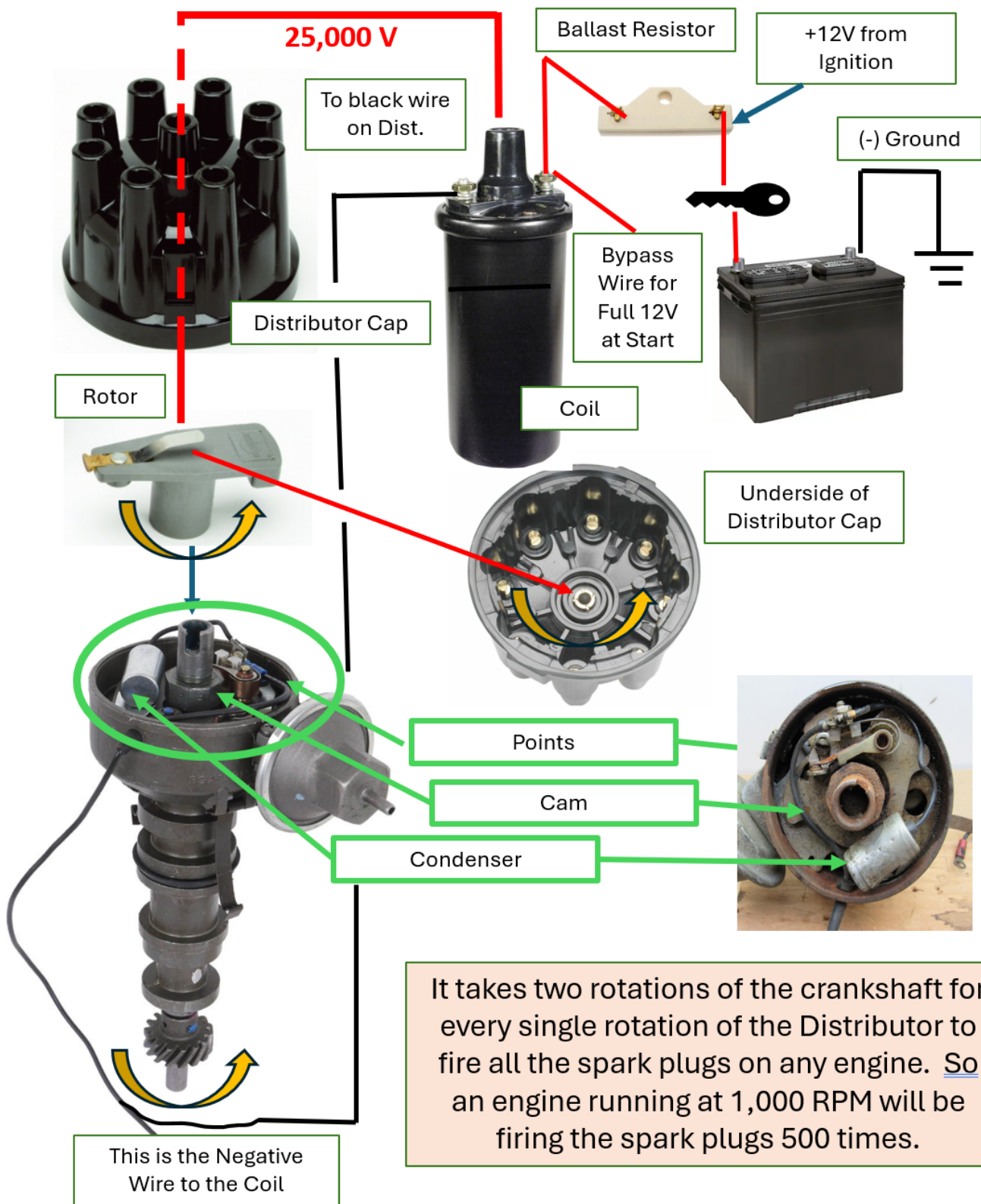
[Click here for coils](#)

Voltage 12V	Cylinders	Resistance Target	Ballast or R/Wire	Coil	Total	Calc Amps	Note
12V	4 or 6	3	1.5	1.5	3	4	Ballast Resistor / Coil Combination
12V	4 or 6	3	0	3	3	4	3 ohm coil, no ballast resistor needed
12V	8	2.5	0.8	1.5	2.3	5.2	GM R Wire = 0.8 ohms from firewall (1960's up)

Voltage 6V	Cylinders	Resistance Target	Ballast or R/Wire	Coil	Total	Calc Amps	Note
6V	4 or 6	1.5	0	1.5	1.5	4	No ballast resistor required if running a 1.5 coil
6V	8	1.2	0.5	0.7	1.2	5	If using a 0.5 ohm coil, 0.7 ballast is needed
6V	8	1.2	0	1.2	1.2	5	If using a 1.2 ohm coil, no ballast is needed

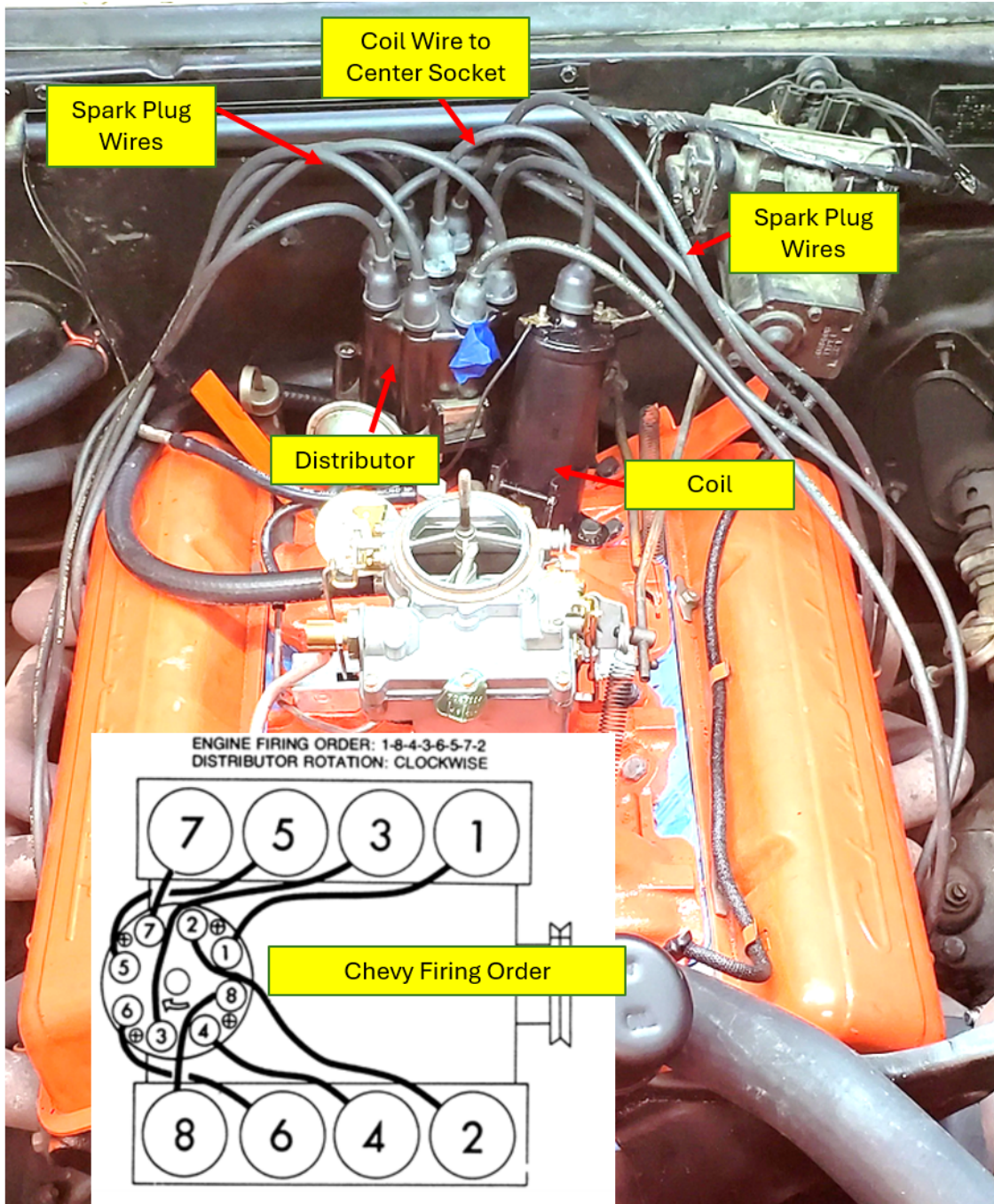
Note: Mechanical Points are capable of operating between 2 Amps to 8 Amps, with 4 to 5 Amps being the best compromise between performance and point deterioration and longevity. Any combination of Coil and Ballast Resistor is possible, as long as the Resistance Target is met.

Putting it all together to make that spark happen:



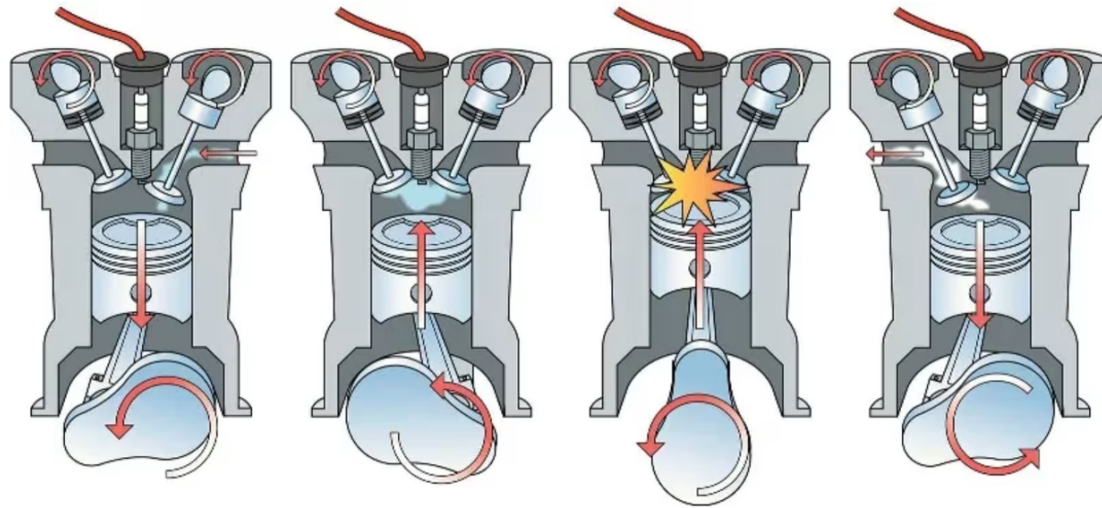
The Points Type Ignition System as it's mounted on the Engine.

The distributor may sit on the front, rear or even the side of the engine block. As the rotor turns it sends the spark to each cylinder in a firing order, through the spark plug wires. Some distributors spin clockwise (CW) and some go the other way (CCW).



Timing the spark is very important:

Typical 4 Stroke Engine Cycle



After TDC

Intake, pulling the Air Fuel Mix in with a vacuum as the piston moves down

Before TDC

Compression, so that mix will be compressed as tight as possible

At TDC

Ignition, lighting off that compressed fuel air mix with a powerful explosion, driving the piston down

After TDC

Exhaust. The crankshaft now pushes the piston back upwards and pushes the exhaust out of the combustion chamber

The Spark must happen JUST Before Top Dead Center, not at Top Dead Center

TDC or Top Dead Center is the position of the piston at the very top of its upward travel. The initial timing is set at this point and for many cars, it's usually between 10 degrees and 12 degrees **Before TDC** or **BTDC**.

Because the spark has to happen **just before** the piston gets to the top allowing the air fuel mixture to **fully combust**. If the spark happens at exactly TDC, it is too late for the spark and the performance suffers.

Why is it timed in degrees? Because that's related to the rotation of the crankshaft at the bottom of the engine. The round harmonic balancer at the front of the engine is attached to the crankshaft and often TDC for the #1 Piston is marked on that balancer with a small gap cut into the surface.

Points Distributor and Advancing the Timing:

The Initial Timing at idle of 10-12 degrees is only the start of what the distributor has to do, to keep up with the demands of the engine and its workload.

As the engine speeds up, the timing has to happen sooner and sooner, until the engine hits its maximum RPM or Revolutions Per Minute and at that point, the distributor has advanced the timing as much as possible.

A common reference point for how far the timing is advanced at max RPM is 36 degrees, all in. This may vary depending on the engine and the car or truck that it's put in. It may happen sooner or later. Your Factory Shop Manual or the Vehicle Specification Chart that is sold by Vintage Auto Garage with exclusive information on tuning and specifications.

There are two types of timing advance that are often built into the distributor. Some distributors only have one or the other, some have both. There is the Mechanical Advance and the Vacuum Advance.

The Mechanical Advance advances the timing with a pair of spring-loaded weights attached to the distributor shaft and as the engine speeds up, the centrifugal force pulls them outwards. This is ideal for advancing the engine timing through the RPM range but doesn't take into account the load on the engine.

The Vacuum Advance takes into account, the load on the engine as well as timing at low speeds or at cruise, the vacuum advance will work to advance the timing based on engine vacuum and makes for more efficient use of the timing at low speeds, helping gas mileage.

They both work together to accommodate different driving conditions and make the best use of the timing needed at that point in time, whether it's at the stop light or full throttle with a heavy load.

[Need ignition tune-up parts click here](#)

Simple Troubleshooting of any Ignition System:

FAS or “Fuel – Air – Spark” is what it takes to make an engine run. If any of those three are missing, it won't run or won't run right

Fuel: With the engine off, take off the air cleaner and look down into the carburetor, then take ahold of the throttle linkage at the carburetor and give it a good twist. You should see the fuel squirt from the accelerator pump, down into the carb. If you don't see the fuel, it's either because it hasn't ran for a long time and the fuel bowls are empty, or possibly a clogged fuel filter. Anything else will be a carb related issue, but the engine has to have fuel, right from the get-go to get started.

Air: An extremely dirty air filter can cause all kinds of problems, including over-rich fuel mixture, poor fuel economy and poor acceleration. With the engine off, remove the air filter, if dirt and dust are freely falling from it, that's one dirty filter! If not, hold the fuel filter up to the Sun and see if you can see light through it. If it's very dim, because of build up of dirt, then either blow it out, or better yet, replace it with a new one.

Spark: With the engine off, remove the coil plug from the distributor socket and place the end of it, as close as possible to a good metal ground on the engine block. Next, you're going to have someone crank the engine while you watch it and see if a spark jumps the ¼ inch gap that you have from the metal part of the coil to the ground. **DO NOT HOLD THE COIL WIRE OR SPARK PLUG WIRES** while doing this, you will get a nasty electric shock.

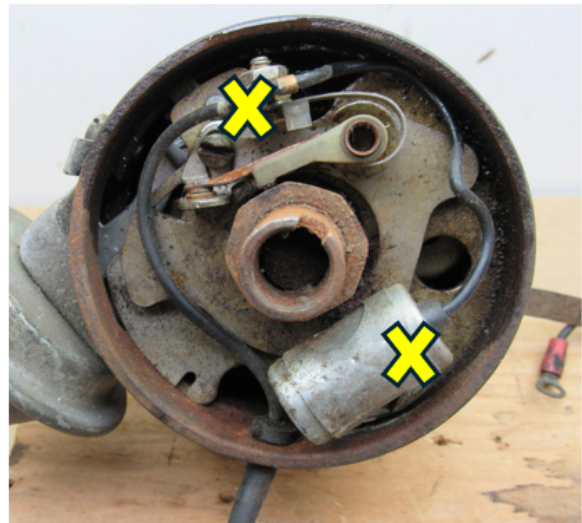
If you have an inductive spark plug tester, that's even better, because you can put it in line, with any spark plug wire and see if you get an orange light going inside the clear part of the tester.

Electronic Ignition.

Electronic ignition replaces the points and performs exactly the same function, but with no moving parts. It eliminates many of the problems that points have, such as arcing between the points, which causes pitting and burning, eventually leading to the demise of the points. It also eliminates the cam and block mechanism that bumps the points open, so block wear is no longer a consideration.



The module and (sometimes) sleeve replaces the point and condenser. Very easy to install and connect to the coil.



Points and Condenser are eliminated.

The module also eliminates the condenser, as there is no shock absorption needed, because the voltage spike from the coil is eliminated from the action of the points opening. In other words, it makes for a much more reliable car or truck. Depending on the quality of the ignition system, these systems can last for years.

Finally, electronic pick-ups are not affected by high RPM's the way points are. The points at high RPM can bounce and start to have problems and that's why many high-performance automobile ignitions in the past came with dual points.

Electronic Ignition.

The one caution with electronic ignition is if the ignition switch is left on with the engine not running the pick-up will overheat from the constant current being put through it and it will fail.

These systems are quite easy to install in most distributors and the connections to the coil are simple. Depending on the distributor, there may be a magnetic sleeve or not. These sleeve is sometimes needed, because the distributor cam was either too far from the pick up, or that the magnetic action needed for the Hall Effect to work wasn't there.

In the case of a Pertronix brand a part number with an "LS" suffix, means that there is no black sleeve (or you can think of it as "Less Sleeve"). If it doesn't have the LS, that means you'll be getting a black sleeve to push down on your distributor shaft. The LS actually means "Lobe Sensor" and the module with the LS doesn't need a sleeve. Example 1168LS does not have a sleeve and the 1183 requires one.

Some Tech Tips you can follow:

- When installing the Pertronix Module the wire slack inside should not touch the sides of the case. The right length is important not to cause interference and make sure the external wires are not touching any heat source and get fried.
- Remove the Ballast Resistor from the ignition system as these modules need full voltage to work (ballast resistors are only used in points systems and can be found between the ignition switch and coil.
- When running the wires out to the coil use proper fasteners supplied to attach them to the coil. This will ensure there is a good connection.

Electronic Ignition.

- In 12V Negative Ground systems, the Red Wire goes to the (+) side of the coil and the Black Wire goes to the (-) side. It's that easy.
- Voltage is important! If the battery is below 12.6 volts to begin with or your alternator is not at least 13.5-14.1 volts, you may have ignition problems. These modules require a solid 12.6V to run correctly.
- If the vehicle has not been started in a while, may take a while to get fuel to the carb bowls, make sure engine is getting fuel before thinking that there's no spark from the new module. Prime if necessary and make sure the initial timing is set properly.
- ***Never leave the ignition on when engine is not running, this can damage the module and coil.***
- Spark plug wires matter, never use solid core plug wires with these modules as they will give off RF (Radio Frequency) that will interfere with the operation and possible misfires. [Only use Low RF plug wires.](#)

Vintage Auto Garage sells a wide range of Pertronix Ignitors for many vintage cars and trucks. Your distributor will have a number plate somewhere on it and with that number you can [look up on our website](#) the matching Pertronix Ignition Module.

The end

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