Replacement Ignition Coil
How to Select and Install Correctly

In a recent attempt to replace the ignition coil in my 1931 Model A Fordor, I was astonished by the bad information and conflicting answers I ran into. I had a 12V system, however the part suppliers were showing 6V coils only and insisted that I must add an external ballast resistor. It’s a large unsightly gizmo mounted on the firewall, and not original to the Model A. There had to be a better way.

What I would discover through my research process was that there are really only two differences between ignition coils for 6V or 12V systems, and oddly enough the voltage is not a factor. Resistance and the Polarity are key however. To change polarity, positive ground to negative ground, you simply swap the wires connected to the coil. To eliminate the external resistor I had to find a coil that had the correct resistance built in.

I quickly found that the amount of resistance built into a coil is rarely listed and very few knew exactly what they were selling. After researching resistance of different coils, in some cases by taking my ohm meter to the parts store, I was able to build a fairly comprehensive list and cross-reference of ignition coils that will work with any Model A. Along the way I also learned where the coil fits in an ignition system, how that system works, and most importantly why it works.

This report shares that discovery …enjoy.

The Short Answer… skip the Why and get to it

You can skip to the Ignition Coil cross-reference table at the end of this report. It’s a one page table for How to Select and Install the correct coil for your Model A Ford.

The Long Answer… tell me Why It’s So
Keep reading…
The *Modern* Ignition System

An improved ignition system was developed by the Dayton Engineering Laboratories Co. (Delco) and introduced in the 1910 Cadillac. It consisted of a single ignition coil, points (the switch), a condenser (to prevent the points from arcing at break) and a distributor (to direct the spark from the ignition coil to the correct cylinder). This points/condenser system was used, basically unchanged, on American cars through about 1975 when electronic ignition was introduced.

![Ignition System Diagram](image)

**Ignition Coil**

The ignition coil is a step-up transformer that converts the vehicle's low voltage battery power (6v or 12v) to high voltage somewhere in the neighborhood of 24,000 volts. This high voltage is capable of reliably arcing across the gap on a spark plug to ignite the fuel/air mixture in a cylinder.

The coil transforms power to a high voltage, but in the process amperage is reduced.

The power equation describes this relationship. As the Voltage steps up 4000 times (24,000v ÷ 6v = 4000 step) the Current is reduced by the same amount and Power remains constant.

Since $P_{IN} = P_{OUT}$, then $V_{IN} \times I_{IN} = V_{OUT} \times I_{OUT}$.

As volts step up from 6V to 24 kV, the current drops from 4A to 1 mA.

This explains why the 24 kV shock you get when you touch a spark plug wire doesn’t kill you… just in case you were wondering.
The ignition coil consists of primary and secondary winding around an iron core. The primary winding uses a thick wire of copper having 200 to 300 turns insulated from each other. On the other hand the secondary winding is made up of thin copper wire with more than 3000 turns, insulated from each other by enamel on the wires and layers of oiled paper insulation.

With the points closed, a magnetic field builds in the coils primary circuit. When the points open by a cam arrangement, this magnetic field collapses and induces a very high output voltage (20 kV or greater) across the secondary winding. The high voltage produced in the secondary winding is transferred to the correct spark plug via the distributor to produce spark within the cylinder.

Condenser

The ignition coil builds up a powerful electrical field that is unleashed when the points open. This charge is naturally seeking the easiest path to ground. We want to direct the full power to the spark plug, and not through the primary coil circuit. However the point gap is smaller than the spark plug gap and would provide a more direct path to ground if not blocked.

It is the condenser's job to absorb the momentary charge to the points when they open. This effectively blocks the electrical path to ground of the primary coil circuit. Without the condenser, the coils energy would be expended as an arc across the points rather than a flash at the spark plug.

6v vs 12v

To say that there are 6 volt and 12 volt coils is a bit of a misnomer. The coil simply transforms the power we supply into high voltage. A power supply of 6 volts at 1.5 ohms resistance is the same as 12 volts at 3.0 ohms resistance. The input current is 4 amps either way, and any difference in coil output is insignificant.

In fact most of the replacement coils used on 6v systems will be labeled:

   12 V - USE WITH PRIMARY RESISTANCE WIRE OR EXTERNAL RESISTANCE.
Although voltage alone is not a factor, we can see that voltage used with the correct Resistance is essential. Using the correct Polarity is also important. Let’s take a look at these two relevant factors one at a time.

**Resistance**

Ohm's law states one of the fundamental relationships found in electronic circuits. For a given resistance (R), current (I) is directly proportional to voltage (V). In other words, if you increase the voltage through a circuit whose resistance is fixed, the current goes up.

\[ \frac{V}{R} = I \]

6 volts with 1.5 ohm resistance = a circuit with 4 amps current.

This is the standard current for the Model A ignition coil.

If we double the voltage with the same resistance we double the current.  
12 volts with 1.5 ohm resistance = 8 amps current.

This much amperage will damage the ignition system components. Excessive current can cause the ignition system to fail prematurely, burning out the points and overheating the coil. To lower the current to a safe operating range additional resistance is needed.

To increase resistance we can either add a ballast resister to the circuit or buy a coil with the correct internal resistance. Internal resisted ignition coils are more reliable and will eliminate a common trouble spot.

12 volts at 3.0 ohm resistance = a circuit with 4 amps, back to a safe operating current. The 12 volt coils listed in the table below have 3.0 ohms of internal resistance.

**Polarity**

Your Model A was built with a 6 volt positive ground system. This means that the negative (-) terminal of your battery is connected to the supply wiring and starter terminal. The positive (+) side of the battery is connected to the chassis and ground. This is opposite to all modern cars that use a negative ground. This difference leads to no end of confusion on the topic. Let’s try to unravel the mystery…

Most electrical components don’t care which way the current is flowing. Light bulbs will work connected either way as long as there is a closed circuit. The same is true for the starter, horn, windshield wiper and many of the electrical accessories we may add.

Some components however expect the flow in a certain direction. The alternator, amp meter and coil fall into this group.
In order to use a modern 12 volt alternator (negative ground) you essentially reverse the polarity on the entire system. When this is done, you will also need to reverse the wires on the amp gauge and the coil.

The coil circuit flows from the battery supply line to the distributor’s ground. Remember: The job of the points, in the distributor, is to open and close a path to ground.

We must connect the wire leading from the distributor (points), to the coil terminal (+ or -) that matches the system ground (+ or -). On the Model A this wire leads through the key switch to the coil. The other terminal is wired to the electrical supply line.

On Positive ground systems, connect the coil terminal marked (+) to the distributor. On Negative ground systems, connect the coil terminal marked (-) to the distributor.

Testing Spark Polarity

The wrong coil polarity requires approximately 5000 more volts to jump the spark plug gap as compared to the correct polarity. At idle this may not be a factor, but spark plug misfires can occur under load, at high RPM, or low battery conditions.

According to the NuRex Company, “Tests of hundreds of Model A’s at Model A events have revealed approximately half showed "reversed" coil polarity.”

With this much confusion on the topic, testing your cars coil polarity is probably a good idea. Several test methods are available:

The Old Pencil Test  ~5¢

To check coil polarity hold a pencil lead in the spark gap with the plug wire about a third of an inch away from the plug. You’ll see a FLARE on one side of the pencil lead. The flare should be on the spark plug side of the lead. If the flare is on the plug wire side, switch the two wires on the coil.

Tip: Hold the pencil with an insulated plyers to avoid a shock.

NuRex Sparklite  ~ $22

This device uniquely shows ignition spark presence and coil polarity while the engine is cranking or running. This thumb sized tool is placed between the ignition coil and distributor. It shows by high intensity flashing lights that the spark is present and the polarity is correct or reversed.
Gap makes a difference

The bigger the spark gap, the higher the coil voltage before discharge. Too large of a gap can cause the coil to overheat and result in early coil failure. Too small of a gap will result in a weak spark and more misfires during idle.

Recommended Model A spark gap specifications:
Spark Plug Gap .035
Rotor to Distributor Gap .025 - .035
Points Gap .018 - .022

Conclusion

It’s amazing to me that all this opening and closing of the points, collapsing magnetic fields and creating a high voltage spark needs to happen at exactly the correct time, in the correct cylinder, at up to 2600 times a minute. And yet, our Model A Fords have been doing just that, very efficiently, for more than 90 years with 1910 technology.

The most efficient power point is found when the piston is at top dead center in the cylinder, the air/fuel mixture is fully compressed and the piston has its full stroke of travel at combustion. The rotating distributor directs the spark to the correct cylinder. The spark occurs when the points open and break the electrical circuit in the coil. Adjusting the system so that combustion occurs exactly when the cylinder is at top dead center is referred to as “Ignition Timing”. It is also a full discussion topic of its own, to be covered in a separate technical report.

Author's note: This paper is a compilation of articles, online reports, and vendor information pertaining to the related topic. Very little, if any original work is included. Instead the confusing, conflicting, and sometimes inaccurate topic information readily available has been heavily edited until it is in a form that seemed relevant and made sense to me. I hope it makes sense to you also. -Willie
Model A Ford Ignition Coil Cross Reference Table

The following table lists replacement coil part numbers that are compatible with the Model A for both 6V and 12V systems. These coils have the proper internal resistance and eliminate the need for an external ballast resistor.

All the major Model A parts suppliers carry a 6 volt coil for around the same price. Snyder’s is listed as they still use the original Ford part numbers for cross reference. They also carry the “Ford script” coil for an original show quality appearance. Birdhaven carries both 6v and 12v coils in their catalog.

Napa carries 2 lines; their Echlin brand and an economy line noted with the SB suffix. No one I asked could explain the difference other than ~$18. Their part numbers, IC12 or IC14, will cross reference to any major auto parts store if you need a replacement in an emergency.

### Ignition Coil - 6 Volt system, 1.5 ohm resistance

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<th>Supplier</th>
<th>Part Number</th>
<th>*Price</th>
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<tbody>
<tr>
<td>Napa</td>
<td>IC12</td>
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<td>O'Reilly</td>
<td>MPI 2-5195</td>
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<td>Summit Racing</td>
<td>SMP-UC12</td>
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<tr>
<td>Birdhaven</td>
<td>T-5007-6V</td>
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<tr>
<td>Snyder's Original Script</td>
<td>A-12000-SC</td>
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<td>Replacement Coil</td>
<td>A-12000</td>
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Coil Polarity

On **Positive** ground systems, connect the terminal marked (+) to the distributor.

### Ignition Coil - 12 Volt system, 3.0 ohm resistance

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<td>Birdhaven</td>
<td>T-5007-12V</td>
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Coil Polarity

On **Negative** ground systems, connect the terminal marked (-) to the distributor.