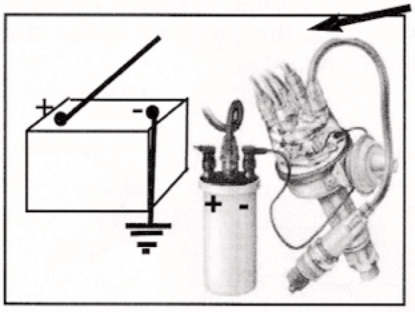
Is Correct Coil Polarity <u>Really</u> Important?

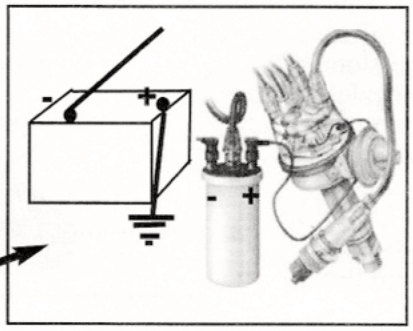
A recent Internet Forum discussion group for one of the car clubs was on coil polarity. The discussion went off in many directions, often not addressing the basic question: Does it really matter whether the positive or the negative terminal of the coil is connected to the distributor?

Unfortunately, there is not a simple answer. Some cars will run adequately well with the polarity reversed, while others will experience all kinds of problems, from a high-speed miss to loss of power. An excerpt from an article posted on the internet (original source unknown) explains the detrimental results of an incorrectly wired coil: "A coil with reversed polarity will have about a twenty percent lower output which may not show up at idle and low rpms, but can cause an engine to miss or stumble under load and at higher engine rpms."

Orest Lazarovich summed up the situation very succinctly in the April 2009 issue of *SK*: "*The coil primary must be connected into the primary circuit so that the coil polarity (+ or -) marks correspond to those of the battery. If the battery negative post is grounded, the negative terminal on the coil must be connected to the distributor, where it will ground through the breaker points. In this way the center electrode of the spark plug will assume a negative polarity. On positive-ground systems, the positive primary terminal is connected to the distributor. Most coils have the polarity signs imprinted on the coil cap by each terminal.*"



If the battery negative post is grounded, the negative terminal on the coil must be connected to the distributor.



On positive-ground systems, the positive primary terminal is connected to the distributor.

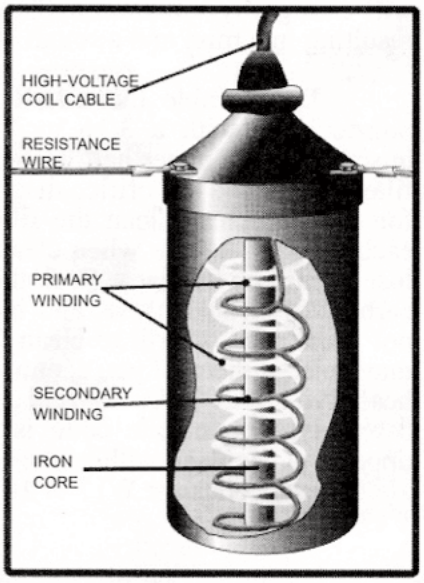
Since, over the past several years we have published quite a bit about ignition coils, this might be the right time to bring a number of those references together in one issue.

Let's begin with an excerpt from Fritz Hennig's <u>On the Fritz</u> from the October 2007 issue on what an ignition coil is and what it does.

Ignition Coil Construction

"A cylindrical ignition coil is composed of a core, two windings, and a metal case. The core usually consists of thin soft iron strips or laminations. Its purpose is to increase the efficiency and output of the coil by promoting faster and complete coil magnetic saturation. The soft iron core readily conducts magnetic lines of force, so less energy is used than if the magnetic lines of force had to travel through an air core.

"The two windings are identified as a primary winding and a secondary winding. The primary winding consists of approximately 250 turns of relatively heavy wire, which is insulated with a special varnish. The secondary winding is wound inside the primary winding and consists of approximately 20,000 turns of very fine varnished wire.



"The many layers of the secondary windings are insulated from each other by high dielectric paper. One end of the secondary winding is connected to the high tension tower, while the other end is connected to one of the primary terminals inside the coil.

"Ignition coils are often filled with oil or a special compound to provide

additional insulation and to help dissipate the heat that is created by the transformation of battery voltage. The dissipation of heat is very important in an ignition coil as heat tends to weaken the insulation. A breakdown of the insulation will result in partial or total coil failure.

Ignition Coil Action

"When the ignition switch is turned on and the breaker points are closed, current flows in the primary circuit. As current flows through the primary winding of the ignition coil, a strong magnetic field is produced, with the aid of the core.

"When the breaker points open, current ceases to flow through the primary windings of the coil and causes the magnetic field to collapse across the many thousands of turns of wire in the secondary winding. This action induces a very high voltage in the secondary circuit, which forces current to jump the rotor and spark plug gaps.

"The rotor gap plays an important part in ignition, as it helps to intensify the current going to the spark plug. Many years ago, 'spark intensifiers' - also called 'transformers' - were sold as aftermarket devices. Attached to top of the spark plug, they were an additional gap for the current to jump. Some of the advertised benefits included a decrease in gasoline consumption, greater power, and reduced carbon deposits. They would allegedly fire fouled and dirty plugs, fire in oil and grease, and fire plugs with cracked porcelain.

"Let's get back to coils. When a length of wire is connected across a source of voltage, current will immediately reach a maximum value determined by the resistance of the wire itself. But this is not true when the same wire is wound into a coil, as in the primary winding of the ignition coil. That is why this ignition component is called a 'coil.' This characteristic of a coiled conductor is called 'reactance,' or 'electromotive force,' and is due to the self-induced voltage in the coil.

"When the breaker points close, current begins to flow in the primary winding. As the magnetic field begins to build up, the lines of force cut through the primary winding and induce a voltage that opposes battery voltage.

"Therefore, it takes a definite period of time for the primary current to reach a maximum rate of flow after the breaker points close. This period of time is called a 'buildup' time. When maximum current is flowing in the coil winding, the maximum magnetic field is present and the coil is now fully 'saturated.'

"If the breaker points remain closed for too short a period of time, maximum current flow will not be reached in the primary circuit, and the maximum magnetic strength will not be attained. As a result, when the breaker points open, there will be less lines of force to cut through the secondary winding and coil output voltage will be reduced. This can cause the engine to misfire under certain operating conditions.

"Reactance or counteractive electromotive force not only opposes the buildup of current through the primary circuit, but also opposes any attempt to stop the flow of current. As the breaker points open, the magnetic field starts to collapse.

"The lines of force cut through the primary winding, but in the opposite direction from the buildup. This causes an induced voltage in the primary winding, which is in the same direction as battery current and tends to keep current flowing.

Ignition Coil Replacement

"As previously stated, the ratio of coil secondary turns to primary turns is approximately 100 to 1. Therefore, a typical cylindrical coil for a standard breaker point ignition system will have 200 turns of primary winding and 20,000 - 26,000 turns of secondary winding.

"The coils used in the 1970s transistorized (electronic) ignitions and other pointless systems have a turns ratio of either 275 to 1 or 400 to 1. Because of the high current-carrying capacity of the heavier gauge transistor coil primary winding, approximately 95 turns of primary winding will be used in a coil having 26,000 turns of secondary winding.

"Thus, it is very important when replacing a coil to use the proper one. Mixing standard and pointless system coils, or coils of the wrong polarity, will result in less than desirable engine performance and possible ignition failure. Also, coils used with ballast resistors are different from coils used without ballast resistors."

This article prompted several letters, but one was of particular interest and was reprinted in the Restoration Forum column in the January 2008 issue.

"Dear Editor:

"I did very much enjoy the October issue of SK, especially the article by Fritz Hennig on the condenser.

"I have a question about the ignition system that I haven't had answered in many years. In the primary circuit of the points and condenser type ignition system, the battery is the source of power. The current comes out of the positive terminal, goes to the ignition switch, through the resister, to the coil primary winding, and on to the distributor and grounds at the points. The circuit is completed through the ground back to the negative terminal of the battery.

"In the secondary circuit, the secondary winding is the source of power, not the battery. The current leaves the winding at the center coil tower, goes through the coil wire to the distributor center, to the rotor, back out the side terminal of the cap, through the plug wire, to the plug, where it jumps the gap to ground. My question is what completes the circuit back to the other end of the secondary winding? How does this current, small as it is, get back to the other end of the secondary wiring? I've read a lot of technical stuff on ignition systems and nobody touches on this. Can you help?

"I always look forward to Skinned Knuckles (the magazine, not the injury). Keep up the good work.

John P Grove
Luray, VA"

A response from Fritz Hennig:

"Dear John,

"Mucho thanks for your inquiry on coils. To answer your question as to what completes the circuit back to the other end of the secondary winding, let's look at a coil wiring diagram while following the ignition coil action. This 'long' answer is for the benefit of others should the editor choose to run it in Restoration Forum.

"With the ignition switch on and the breaker points closed, current flows into the primary circuit, as you know. As the electrical current is whizzing around the +/- 250 turns of heavy wire in the primary winding, a super-duper magnetic field is produced, with the aid of the core.

"The core usually consists of thin 'soft'-iron strips or laminations that readily conduct magnetic lines of force. The purpose of the core is to increase coil output by promoting faster and more complete magnetic saturation of the coil.

"When the breaker points open, current no longer flows through the primary winding. This abrupt stop causes the magnetic field to collapse across the +/- 20,000 turns of fine wire in the secondary winding. This induces a very high voltage in the secondary circuit, forcing the current to jump the rotor and spark plug gaps.

"When the high voltage has been discharged to ground via the spark plug, the circuit is completed.

"Now, looking at the wiring diagram, note that the primary and secondary windings are connected together. When the secondary circuit discharges, any residual current may possibly feed back to the primary side through this 'back door' and become part of the next cycle.

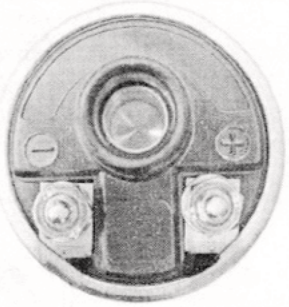
"However, some coil diagrams do not show this wire. Because we are talking about induction here, there may be no need for this small amount of current to return to the other end of the secondary coil. Or perhaps the condenser absorbs it.

"There are a lot of factors that can enter the picture, especially when comparing coils to transformers, so I don't even pretend to know all the answers. If one starts looking too deep, it can boggle one's mind . . . well, mine, anyway.

Fritz Hennig"
On The Fritz Restoration Forum, January 2008

Let's jump back to the On the Fritz column back in October 2007. Fritz offered a method for testing the polarity of a coil:

Coil Polarity Test



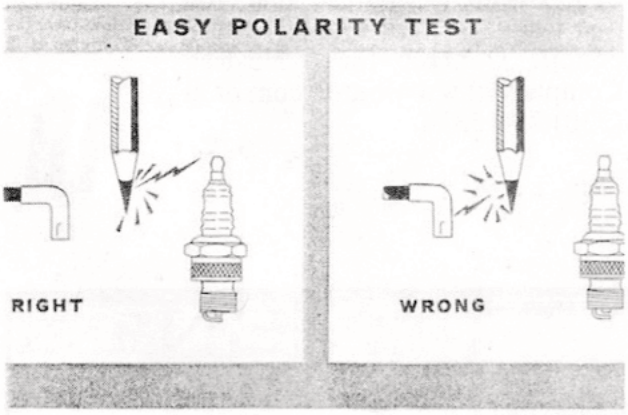
Some British cars mark the terminals CB and SW rather than (+) and (-).

"If the LT ignition coil connections are reversed, then the polarity will reverse. It takes roughly 40% more voltage to fire the spark plugs on an ignition system with incorrect polarity. Polarity is occasionally crossed on positive ground '50s and '60s English cars with coils that are marked SW and CB instead of + and -. The 'SW' marking means that this lead goes to the ignition SWitch. 'CB' goes to the distributor (Contact Breaker).

"Anyway, one coil lead is positive and the other is negative. To test polarity, fire up the engine, remove a spark plug high-tension (HT) wire, and put an ordinary lead pencil ¼" between the wire end and its spark plug. If the spark snaps from the pencil to the spark plug, the polarity is correct. If the spark is between the HT lead and the pencil, the polarity is wrong, i.e., backwards. Correct by switching the primary leads on the coil.

<u>On the Fritz</u> October 2007

A note on the above mentioned Forum points out a liability in testing with a pencil: "I



tried the pencil between the plug wire and the plug - I had so much spark jumping around I really could not tell where the spark was going. Since the coil was wired correctly, I left it at that...."

What is the reason for correctly wiring the coil? An internet article, unfortunately the original source is unknown, explains the reasons for taking the time to assure that the coil is properly wired into the system.

"COIL POLARITY: One of the major causes for hard starting or spark plug misfiring under load results when the ignition coil lead wire to the distributor is installed on the wrong side of the coil. This condition causes reversed coil polarity.

"Voltage at the spark plug terminals should always be negative. Whether it is or not depends on how the primary leads are attached to the coil. Remember primary lead hook-up directly affects coil polarity, which in turn determines whether voltage at the spark plug terminals is negative or positive. The distributor wire to the coil should always be placed on the negative side of the coil if the electrical system is negative grounded, or on the positive side if the electrical system is positive grounded. If the primary leads are incorrectly attached, the direction of current flow through the coil is reversed.

"Consequently, coil polarity is reversed, resulting in positive voltage being supplied to the spark plug terminals.

"What difference does it make whether positive or negative voltage is supplied to the spark plug terminals? It directly affects the amount of voltage required to fire the spark plugs. When polarity at the spark plug terminals is positive, it's harder for the voltage to jump across the air gap than when polarity at the plug terminal is negative. Just why this is so is related to a pair of electrical theories--the electron theory and the theory of thermionic emission.

"According to the electron theory, all current flows from negative to positive. The theory of thermionic emission states essentially it's easier for electrons to leave a hot surface than a cold surface.

"Combining the two theories, one finds that electrons will always leave a negative charged surface for a positive charged surface, and they will leave the negatively charged surface with more ease when the surface is heated.

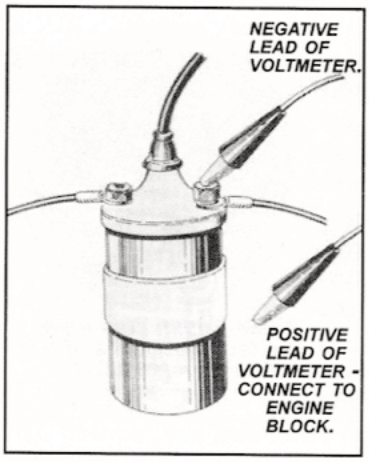
"Spark plug design is such that the center electrode almost always operates at a higher tem-

perature than the ground electrode. Since it's easier for electrons to leave a hot surface, it is preferred to have the electrons "jump" from the hotter center electrode to the cooler ground electrode.

"When the center electrode is negatively charged (negative voltage at the spark plug terminals), this is what happens. Stated another way, putting the negative charge on the hotter center electrode causes the gap to be ionized at lower voltage. (Ionization is necessary to permit passage of the spark through the high resistance of the gases in the cylinder.)

"When positive voltage is supplied to the plug terminals, which happens when coil polarity is accidentally reversed, the hotter center electrode becomes positive charged. Consequently, electrons must leave the negative charged ground electrode and move to the positive charged center electrode. But, since the ground electrode is cooler than the center electrode (and remember, it's easier for the electrons to leave a hotter surface), it takes more voltage to make the current jump the gap-in fact, up to 45 percent more."

I think, at this point, we can all agree that it is desirable to be sure that the coil is wired correctly into the system. One test calls for connecting a voltmeter to the coil. Connect the negative lead to the negative (-) terminal of the coil, and the positive lead to the engine block. Set the meter on the highest voltage range (whether you have a positive ground system or a negative ground system). Crank the engine - but do not start it - and watch the voltmeter needle. If it swings upward to the plus or positive side, the coil is correctly connected. If it tries to swing downward, the connection is backward. Reverse the coil primary leads and retest.



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Finally the Nu-Rex Company in Akron, OH, specializing in Model A Ford parts, manufactures and sells a very simple coil tester called a Sparklite. Even simple enough for me! It is a cylinder about 5/8" in diameter and about 2 ¾" long. One end (obviously) is designed to fit into the center tower of the distributor cap, while the other end has a recess into which the coil high voltage output wire fits. It comes with complete (and easy-to-understand) instructions. Essentially, start the engine at low speed and look at the lights on the side of the cylinder: a flashing upper light indicates that everything is okay with the spark and the polarity. A flashing lower light indicates that the coil primary wires are reversed. Switch them around and retest. (No flashing light means no ignition spark. How you would get the engine to run in that situation is beyond me.) The Sparklite is listed on their website at a cost of $23. Cheap enough so that you don't have to fool around with a pencil. Contact the Nu-Rex Company at www.nurex.com or at (330) 784-5334.

S.K.

COMING ATTRACTIONS:

A look at some of the things that Skinned Knuckles has scheduled and planned for next month, and for the months that follow....

Packard's First Cruise Control
What is MIG Welding?
Permatex' Adhesive and Sealers
More from Jay Leno's Big Dog Garage
The 1933 DeSoto
This Month in (*Automotive*) History
Care of Inner Tubes
The Pogue Carburetor
What Went Wrong?
A Project for an Afternoon

And so much more...

EVENTS

OREGON

Albany, Nov 14, Swap Meet, Linn Cty Exposition Center, by Enduring As. Info 541-926-3972

WASHINGTON

Bremerton, Nov 7-8, Swap Meet, Kitsap Cty Fairgrounds, by Olympic Village Auto Club. Info 360-638-2404