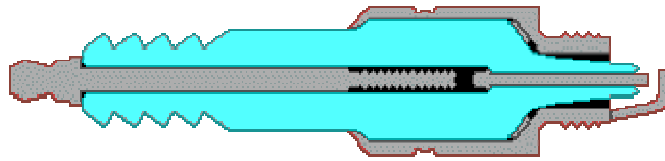
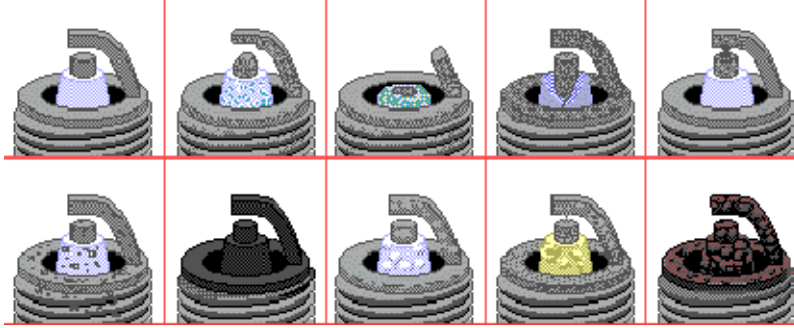


## Spark Plugs Do Tell A Story!



Below is an overview of spark plug conditions and causes.

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### Spark Plugs

A spark plug is a device, inserted into the combustion chamber of an engine, containing a side electrode and insulated center electrode spaced to provide a gap for firing an electrical spark to ignite air-fuel mixtures.

The high-voltage burst from the coil via the distributor is received at the spark plug's terminal and conducted down a center electrode protected by a porcelain insulator. At the bottom of the plug, which projects into the cylinder, the voltage must be powerful enough to jump a gap between the center and side electrodes through a thick atmosphere of fuel mixture. When the spark bridges the gap, it ignites the fuel in the cylinder.

### Spark Plug Wear

The spark plugs ignite the fuel mixture in the cylinders by means of a burst of high-voltage electricity carried from the distributor. The ability of the spark to ignite the fuel is badly affected if the plugs are damaged or the spark gaps are abnormal. It is therefore important to examine used spark plugs closely and to clean them periodically. The gaps of old and new plugs should also be checked before installing them. There are three basic types of spark plug fouling: "carbon" fouling, "high speed" or "lead" fouling, and "oil/carbon" fouling.

Carbon fouling is caused from low-speed operation or a fuel mixture that is too rich. It causes missing or roughness and creates soft black soot that is easily removed. Lead fouling is caused by tetraethyl lead used in some fuels and by extended high speed operation. Lead compounds which are added to the gasoline have a bad effect on some spark plug insulators. At high temperatures, it is a good conductor and may give good results under light loads, but often fails under full loads and high combustion temperatures. In some cases, it is possible to run the engine at a speed just below the point where missing will occur; then, increase the speed (always keeping below the missing speed) to burn off the lead fouling. Lead fouling appears as a heavy, crusty formation, or as tiny globules.

The third type of fouling is found on engines that are so badly worn that excess oil reaches the combustion chamber past the piston ring, or the valve guides.

In all cases of fouling or wear, it is best to replace the plugs. To avoid having to replace plugs one at a time as they wear out, always replace the entire set, even though only one plug may be bad. Plugs should normally be replaced about every 12,000 miles.

## **Coil**

The coil is a compact, electrical transformer that boosts the battery's 12 volts to as high as 20,000 volts. The incoming 12 volts of electricity pass through a primary winding of about 200 turns of copper wire that raises the power to about 250 volts. Inside the distributor, this low-voltage circuit is continuously broken by the opening and closing of the points, each interruption causing a breakdown in the coil's electromagnetic field. Each time the field collapses, a surge of electricity passes to a secondary winding made up of more than a mile of hair-like wire twisted into 25,000 turns. At this point, the current is boosted to the high voltage needed for ignition and is then relayed to the rotor.

## **Ignition Circuit**

The distributor is separated into three sections: the upper, middle, and lower. In the middle section, the corners of the spinning breaker cam strike the breaker arm and separate the points some 160 miles an hour. (standard ignition) High-voltage surges generated by the action of the coil travel to the rotor that whirls inside a circle of high-tension terminals in the distributor cap. At each terminal, current is transferred to wires that lead to the spark plugs. Two other devices - the vacuum advance and the centrifugal advance - precisely coordinate the functions of the points and the rotor assembly as the requirements of the engine vary.

An ignition circuit consists of two sub-circuits: the primary, which carries low voltage; and the secondary, which carries high voltage. The primary circuit, controlled by the ignition key, releases 12 volts of electricity from the battery or alternator through the coil to a set of breaker points in the lower part of the distributor, or to the relay in electronic ignition applications. When the points or relay are closed, current flows through the chassis back to the battery, completing the circuit. When the points or relay are open, the flow stops, causing a high-voltage surge to pass from the coil through a rotor in the top of the distributor to the spark plugs. Once the car has started, the voltage regulator protects the battery from

being overcharged by the alternator. The condenser absorbs part of the low-voltage current when the points are open.

## **Computerized and Electronic Ignition**

In an electronic ignition, a rotating reluctor and magnetic-pickup coil replace the traditional cam, breaker points and condenser in the distributors of cars equipped for electronic ignition. This system reduces the time between tune-ups. The high spots of the reluctor interrupt the magnetic field of the pickup coil and the permanent magnet. These interruptions, or pulses, are transmitted from the pickup to a nearby electronic control unit. There, the pulses signal a transistor to break the low-voltage sub-circuit and release high voltage from the coil to the spark plugs.

The short-lived electronic ignition system was a transition from the points and condenser system to the computerized ignition system. It came into widespread use in the mid-1970s, but there are still a few engines that use electronic ignition.

## **Starting Circuit**

The starter circuit is activated when the ignition switch is turned on. This opens a second switch in the solenoid, permitting a second flow of electricity from the battery to the starter motor.

The engine cranking circuit is made up of a battery, starting motor, ignition switch, and electrical wiring. When the ignition switch is placed in the "start" position, the solenoid windings are energized and the resulting shift lever movement causes the drive pinion gear to engage the flywheel ring gear, and cranking takes place. When the engine starts, an overrunning clutch (part of the drive assembly) protects the armature from too much speed until the switch is opened. At this time, a return spring causes the pinion gear to disengage from the flywheel.

## **Spark Plug Wires**

The spark plug wire carries 20,000 or more volts from the distributor cap to the spark plug. Spark plug wires are made of various layers of materials. The fiber core, inside the spark plug wire carries the high voltage. The older design of spark plug wires used a metallic wire to carry the high voltage. This caused electrical interference with the radio and TV reception. Some spark plug wires have a locking connection at the distributor cap. The distributor cap must first be removed and the terminals be squeezed together, and then the spark plug wire can be removed from the distributor cap.

To reduce interference with radio and TV reception, ignition systems are provided with resistance in the secondary circuit. Resistor spark plugs or special resistor type ignition cable may be used.

To work effectively in modern ignition systems, it is important that the resistor ignition cable is capable of producing a specifically designed resistance. The cable must also have enough insulation so that it can withstand heat, cold, moisture, oil, grease, and chafing. High tension electricity passing through a cable builds up a surrounding electrical field. The electrical field frees oxygen in the surrounding air to

form ozone, which will attach to the rubber insulation if it is not properly protected. Ozone causes the rubber to deteriorate and lose its insulating qualities. Electrical losses will seriously weaken the spark at the plug gap.

## **Distributor Cap**

As the rotor rotates inside the cap, it receives the high voltage from the ignition coil, then passes it to the nearest connection, which is a metal projection in the cap, which is connected to a spark plug.

The distributor cap should be checked to see that the sparks have not been arcing from point to point within the cap. The inside of the cap must be clean. The firing points should not be eroded, and the inside of the towers must be clean and free from corrosion.

## **Distributor Rotor**

A distributor rotor is designed to rotate and distribute the high tension current to the towers of the distributor cap. The firing end of the rotor, from which the high tension spark jumps to each of the cap terminals, should not be worn. Any wear will result in resistance to the high tension spark. The rotor with a worn firing end will have to be replaced.

Rotors are mounted on the upper end of the distributor shaft. In this connection, the rotor must have a snug fit on the end of the shaft. On another design, two screws are used to attach the rotor to a plate on the top of the distributor shaft. Built-in locators on the rotor, and holes in the plate, insure correct reassembly. One locator is round; the other is square.

The rotor is driven directly by the camshaft, but is "advanced" (turned) by the centrifugal advance mechanism. Advancing the spark timing allows the engine to run efficiently. A vacuum advance is also fitted on some cars for the same reason.

## **Condenser**

Primary current produces a magnetic field around the coil windings. This does not occur instantly, because it takes time for the current and the magnetic field to reach maximum value. The time element is determined by the resistance of the coil winding or the length of time the distributor contacts are closed. The current does not reach the maximum because the contacts remain closed for such a short time, and more so at higher engine speeds. When the breaker points begin to open, the primary current will continue to flow. This condition in a winding is increased by means of the iron core. Without an ignition condenser, the induced voltage causing this flow of current would create an arc across the contact points and the magnetic energy would be consumed in this arc. As a result, the contact points would be burned and ignition would not occur. The "condenser" prevents the arc by making a place for the current to flow. As a result of condenser action, the magnetic field produced and continued by the current flow will quickly collapse. It is the rapid cutting out of magnetic field that induces high voltage in the secondary windings. So, if the condenser should go bad, the high voltage needed to jump the gap at the

spark plugs will not be possible. This could cause a no-start condition or a driving problem.

### **Breaker Point (Standard) Ignition**

The ignition distributor makes and breaks the primary ignition circuit. It also distributes high tension current to the proper spark plug at the correct time. The distributor is driven at one half crankshaft speed on four cycle engines. It is driven by the camshaft. Distributor construction varies with the manufacturers, but the standard model is made of a housing into which the distributor shaft and centrifugal weight assembly are fitted with bearings. In most cases, these bearings are bronze bushings.

In standard ignition, the contact set is attached to the movable breaker plate. A vacuum advance unit attached to the distributor housing is mounted under the breaker plate. The rotor covers the centrifugal advance mechanism, which consists of a cam actuated by two centrifugal weights. As the breaker cam rotates, each lobe passes under the rubbing block, causing the breaker points to open. Since the points are in series with the primary winding of the ignition coil, current will pass through that circuit when the points close. When the points open, the magnetic field in the coil collapses and a high tension voltage is induced in the secondary windings of the coil by the movement of the magnetic field through the secondary windings.

The design is to provide one lobe on the breaker cam for each cylinder of the engine; i.e., a six cylinder engine will have a six lobe cam in the distributor; and an eight cylinder engine will have an eight lobe cam, so every revolution of the breaker cam will produce one spark for each cylinder of the engine. However, on a four cycle engine, each cylinder fires every other revolution so the distributor shaft must revolve at one half crankshaft speed. After the high tension surge is produced in the ignition coil by the opening of the breaker points, the current passes from the coil to the center terminal of the distributor cap. From there, it passes down to the rotor mounted on the distributor shaft and revolves with it. The current passes along the rotor, and jumps the tiny gap to the cap electrode under which the rotor is positioned at that instant. This cap electrode is connected by high tension wiring to the spark plug. As the rotor continues to rotate, it distributes current to each of the cap terminals in turn.