

Automotive Engines Theory and Servicing

Ninth Edition

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Theory and Servicing

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Chapter 18

Ignition System Operation and Diagnosis

ALWAYS LEARNING

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OBJECTIVES (1 OF 2)

18.1 Describe the purpose and function of the ignition system.

18.2 Discuss ignition switching and triggering.

18.3 Explain the purpose and function of distributor ignition systems.

18.4 Discuss waste-spark ignition systems and coil-on-plug ignition systems.

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OBJECTIVES (2 OF 2)

18.5 Discuss the purpose and function of knock sensors.

18.6 Explain ignition system diagnosis.

18.7 Explain spark plug construction, service, and how to conduct a spark plug wire inspection.

18.8 Explain ignition timing, and discuss the symptoms of a faulty ignition system.

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IGNITION SYSTEM (1 OF 3)

- The ignition system includes components and wiring necessary to create and distribute a high voltage and send to the spark plug.
- A high-voltage arc occurs across the gap of a spark plug inside the combustion chamber.
- The spark raises the temperature of the airfuel mixture and starts the combustion process inside the cylinder.

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IGNITION SYSTEM (2 OF 3)

- Background
 - Early ignition systems
 - Electronic ignition
 - Waste-spark system
 - Coil-on-plug (COP) system

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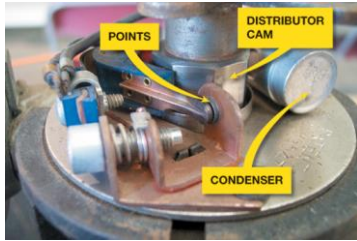
IGNITION SYSTEM (3 OF 3)

- Ignition Coil Construction
 - Secondary coil winding
 - Primary coil winding
- Ignition Coil Operation

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FIGURE 18-1 The points make and break electrical circuit of the coil primary winding in the ignition coil. The points are opened mechanically by the distributor cam. The condenser provides a path for the electrons to flow instead of arcing across the points when they open, preventing the points from burning.



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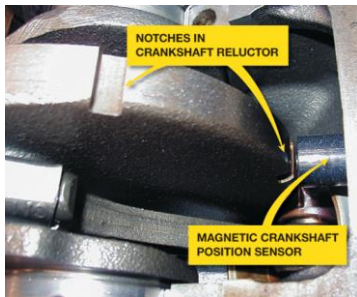
IGNITION SWITCHING AND TRIGGERING

- Switching
- Triggering
- Primary Circuit Operation
 - Magnetic sensor
 - Hall-effect switch

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FIGURE 18-6 A typical magnetic crankshaft position sensor.



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DISTRIBUTOR IGNITION (DI) (1 OF 2)

- The purpose of a distributor is to distribute the high-voltage spark from the output terminal of the ignition coil to the spark plugs for each cylinder.
- A gear or shaft drives the distributor that is connected to the camshaft and is driven at camshaft speed.

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DISTRIBUTOR IGNITION (DI) (2 OF 2)

- Most distributor ignition systems also use a sensor to trigger the ignition control module.
 - Magnetic pulse alternators, also called pickup coils
 - Hall-effect sensors located in the distributor
 - Optical sensors located in the distributor
- Operation of Distributor Ignition
- Firing Order

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FIGURE 18–12 The firing order is cast or stamped on the intake manifold on most engines that have a distributor ignition.



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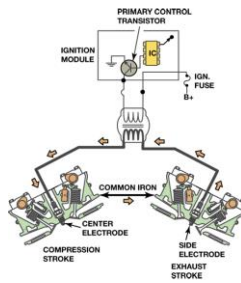
WASTE-SPARK IGNITION SYSTEMS

- Parts Involved
- Waste-spark System Operation
- Compression-sensing Waste-spark Ignition

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FIGURE 18-15 A waste-spark system fires one cylinder while its piston is on the compression stroke and into paired or companion cylinders while it is on the exhaust stroke. In a typical engine, it requires only about 2 to 3 kV to fire the cylinder on the exhaust stroke. The remaining coil energy is available to fire the spark plug under compression (typically about 8 to 12 kV).



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COIL-ON-PLUG IGNITION (1 OF 2)

- Coil-on-plug (COP) ignition uses one ignition coil for each spark plug.
- This system is also called coil-by-plug, coil-near-plug, or coil-over-plug ignition.

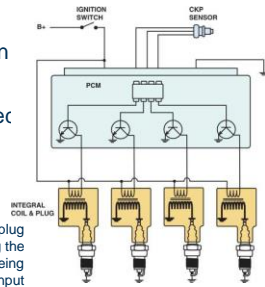


FIGURE 18-16 A typical coil-on-plug ignition system showing the triggering and the switching being performed by the PCM from input from the crankshaft position sensor.

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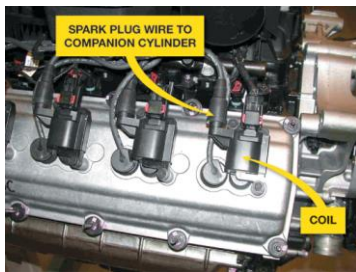
COIL-ON-PLUG IGNITION (2 OF 2)

- Advantages
- Types of Cop Systems
 - Two primary wires
 - Three primary wires
- Ion-sensing Ignition

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FIGURE 18–18 A Chrysler Hemi V-8 that has two spark plugs per cylinder. The coil on top of one spark fires that plug plus, through a spark plug wire, fires a plug in the companion cylinder.



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KNOCK SENSORS

- Knock sensors are used to detect abnormal combustion, often called ping, spark knock, or detonation.
- Diagnosing the Knock Sensor
- Replacing a Knock Sensor



FIGURE 18–20 A typical knock sensor on the side of the block. Some are located in the "V" of a V-type engine and are not noticeable until the intake manifold has been removed.

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IGNITION SYSTEM DIAGNOSIS

- Checking For Spark
- Ignition Coil Testing Using An Ohmmeter
- Magnetic Sensor Testing
- Testing Hall-effect Sensors
- Testing Optical Sensors



FIGURE 18–22 A spark tester looks like a regular spark plug with an alligator clip attached to the shell. This tester has a specified gap that requires at least 25,000 volts (25 kV) to fire.

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SPARK PLUG WIRE INSPECTION (1 OF 2)

- Spark plug wires should be visually inspected for cuts or defective insulation.
 - Faulty spark plug wire insulation can cause hard starting or no starting in rainy or damp weather conditions.

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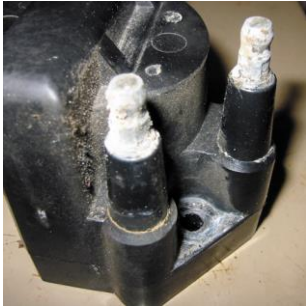
SPARK PLUG WIRE INSPECTION (2 OF 2)

- When removing a spark plug wire, be sure to rotate the boot of the wire at the plug before pulling it off the spark plug.
 - This will help prevent damaging the wire as many wires are stuck to the spark plug and are often difficult to remove.

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FIGURE 18–29 Corroded terminals on a waste-spark coil can cause misfire diagnostic trouble codes to be set.



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SPARK PLUGS (1 OF 2)

- Spark plugs are manufactured from ceramic insulators inside a steel shell.
- The threads of the shell are rolled and a seat is formed to create a gas-tight seal with the cylinder head.
- Resistor Spark Plugs
- Platinum Spark Plugs

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SPARK PLUGS (2 OF 2)

- Iridium Spark Plugs
- Spark Plug Service
- The physical differences in spark plugs include:
 - Reach.
 - Heat range.
 - Type of seat.



FIGURE 18–36 When removing spark plugs, it is wise to arrange them so that they can be compared and any problem can be identified with a particular cylinder.

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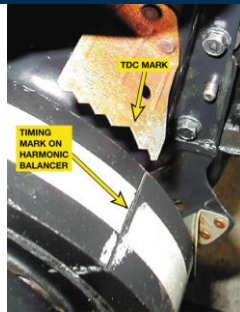
IGNITION TIMING

- Ignition timing is when the spark plug fires in relation to piston position.
 - The time when the spark occurs depends on engine speed and, therefore, must be advanced as the engine rotates faster.
- Follow exactly the timing procedure indicated on the underhood vehicle emission control information (VECI) decal.

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FIGURE 18–42 Ignition timing marks are found on the harmonic balancers on engines equipped with distributors that can be adjusted for timing.



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SUMMARY (1 OF 3)

- All inductive ignition systems supply battery voltage to the positive side of the ignition coil and pulse the negative side of the coil on and off to ground to create a high-voltage spark.
- If an ignition system uses a distributor, it is a distributor ignition (DI) system.
- If an ignition system does not use a distributor, it is an electronic ignition (EI) system.

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SUMMARY (2 OF 3)

- A waste-spark ignition system fires two spark plugs at the same time.
- A coil-on-plug ignition system uses an ignition coil for each spark plug.
- A thorough visual inspection should be performed on all ignition components when diagnosing an engine performance problem.

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SUMMARY (3 OF 3)

- Platinum spark plugs should not be regapped after use in an engine.

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