UNIT-3

Ignition System

Objectives

- Describe the functions of ignition system parts
- Explain the operation of points, electronic, and computer ignition systems
- Give an overview of the different spark advance methods
- Describe distributorless and conventional ignition distributor variations and operation
- Draw a wiring diagram showing the primary and secondary ignition systems

Introduction

- Ignition system
  - Turns the engine on and off
  - Creates a timed spark and distributes it to the cylinders
    - Spark is distributed to the spark plugs
    - Jumps the gap and ignites air-fuel mixture
    - Timing of the spark varies with engine speed
    - Amount of time for fuel to burn in the cylinder is constant

Basic Ignition System

- Modern vehicles have computer-controlled ignition systems
  - Main ignition system categories
    - Distributor ignition (DI)
    - Electronic ignition (EI) (i.e., distributorless, direct ignition, or coil over plug)
  - All ignition types use battery, switch, coil, switching device, and spark plugs
  - Circuits
    - Primary circuit: low-voltage (battery)
    - Secondary circuit: high-voltage (spark)

Primary Circuit

- Primary ignition system components
  - Battery and charging system
  - Ignition switch and coil primary windings
  - Switching device
  - Distributor cam lobes or crank/cam sensor
  - Ground return path
- Battery voltage converted to high voltage by ignition coil
  - Spark jumps across gap at end of spark plug
    - Spark timing is critical to power output

Ignition Switch

- Multiposition switch
  - Powers the ignition circuit on and off
  - Operates the steering wheel lock and a buzzer or light

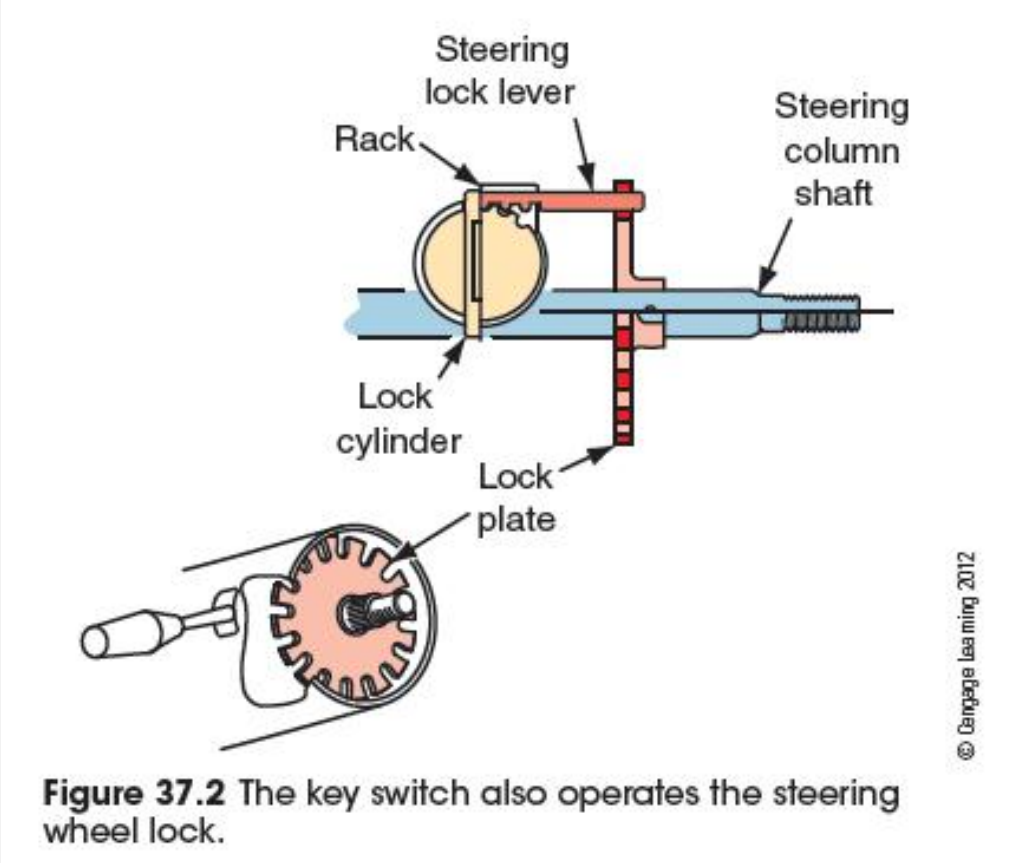


Figure 37.2 The key switch also operates the steering wheel lock.

Ignition Coil

- Heart of the ignition system
  - Has a low-voltage primary winding and high-voltage secondary winding
- Magnetic field
  - Collapses when current flow is interrupted in primary winding
- Magnetic lines of force
  - Cut across the secondary windings and create high voltage and low amperage

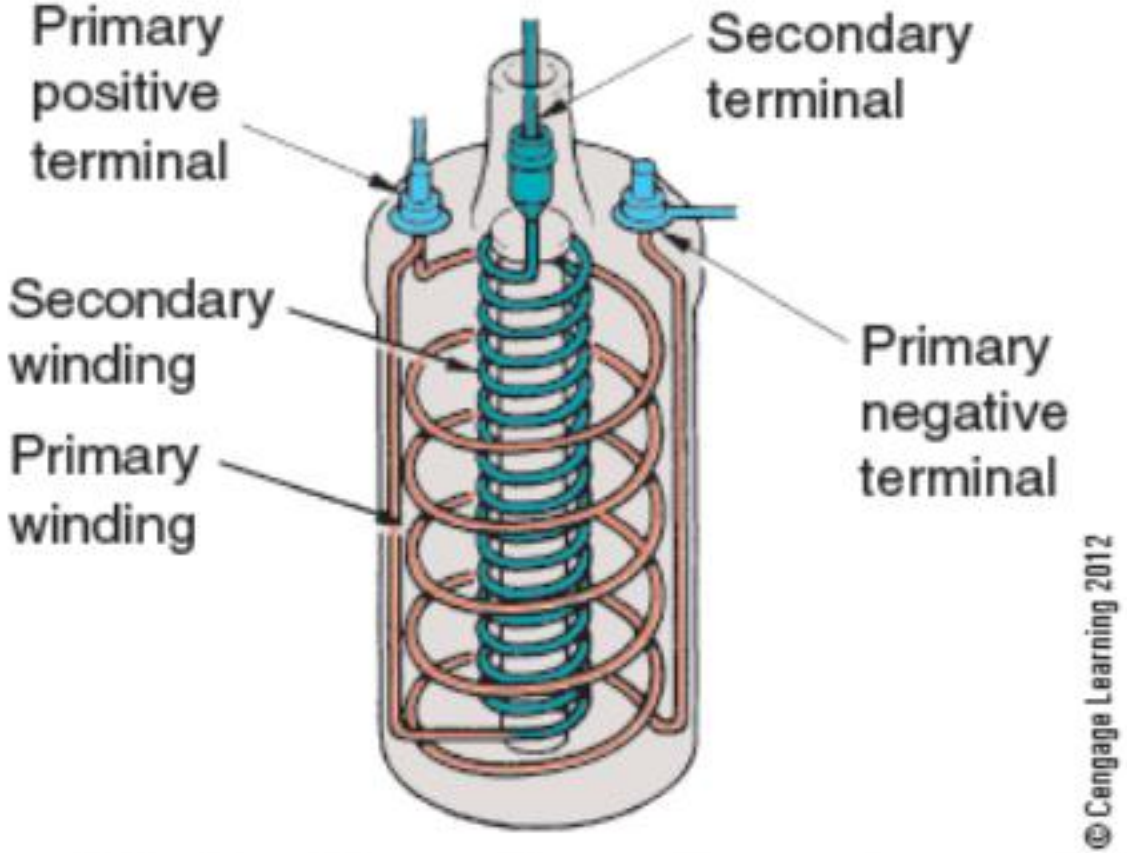


Figure 37.3 A coil has a low-voltage primary winding and a high-voltage secondary winding.

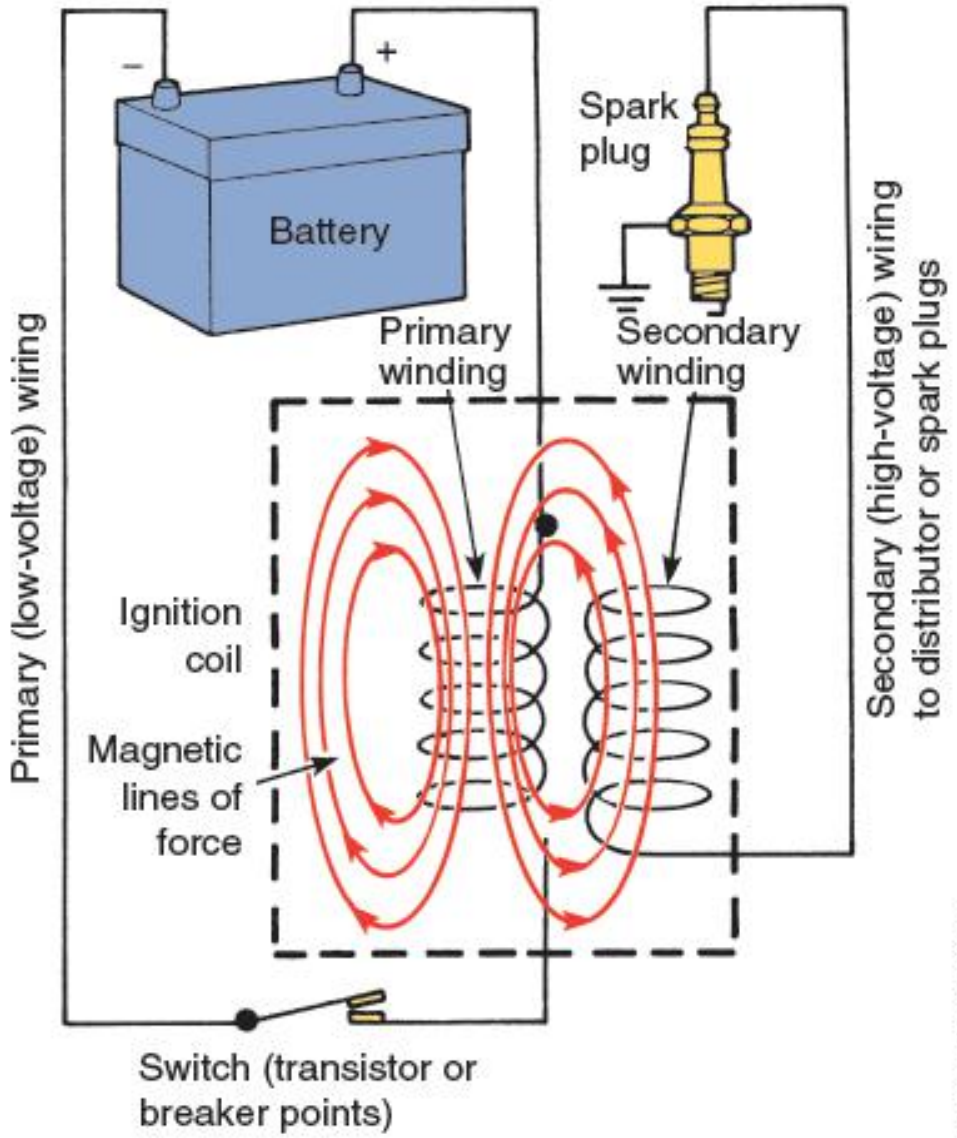


Figure 37.4 Current flowing in the primary coil winding creates a magnetic field.

Ignition Coil (cont'd.)

- Saturation
  - Coil is saturated when magnetic field finished its buildup inside coil
  - Coil saturation time depends on amount of current in primary winding
- Dwell
  - Length of time current flows in primary winding
  - Determined by ignition control module
  - Electronic ignition varies dwell time

Secondary Ignition Parts

- Secondary circuit
  - Delivers high voltage from coil to spark plugs
- Distributor ignition (DI) system components
  - Cam
  - Distributor cap and rotor
    - DI systems: electricity flows from coil to distributor cap and rotor
    - Distributor rotates at one-half crankshaft speed
    - Spark plug cables are inserted in the distributor cap following engine firing order

Spark Plugs

- Spark ignites compressed air-fuel mixture
  - Length of threaded area called reach
  - Heat range indicates how fast heat travels away from the center electrode
    - Determined by how far ceramic insulator extends into combustion chamber
  - Spark plugs have a tapered seat or flat seat with a gasket to seal against cylinder head
  - There is controversy over long-life spark plugs
    - Precious metals are used to prolong life

Spark Plugs (cont'd.)

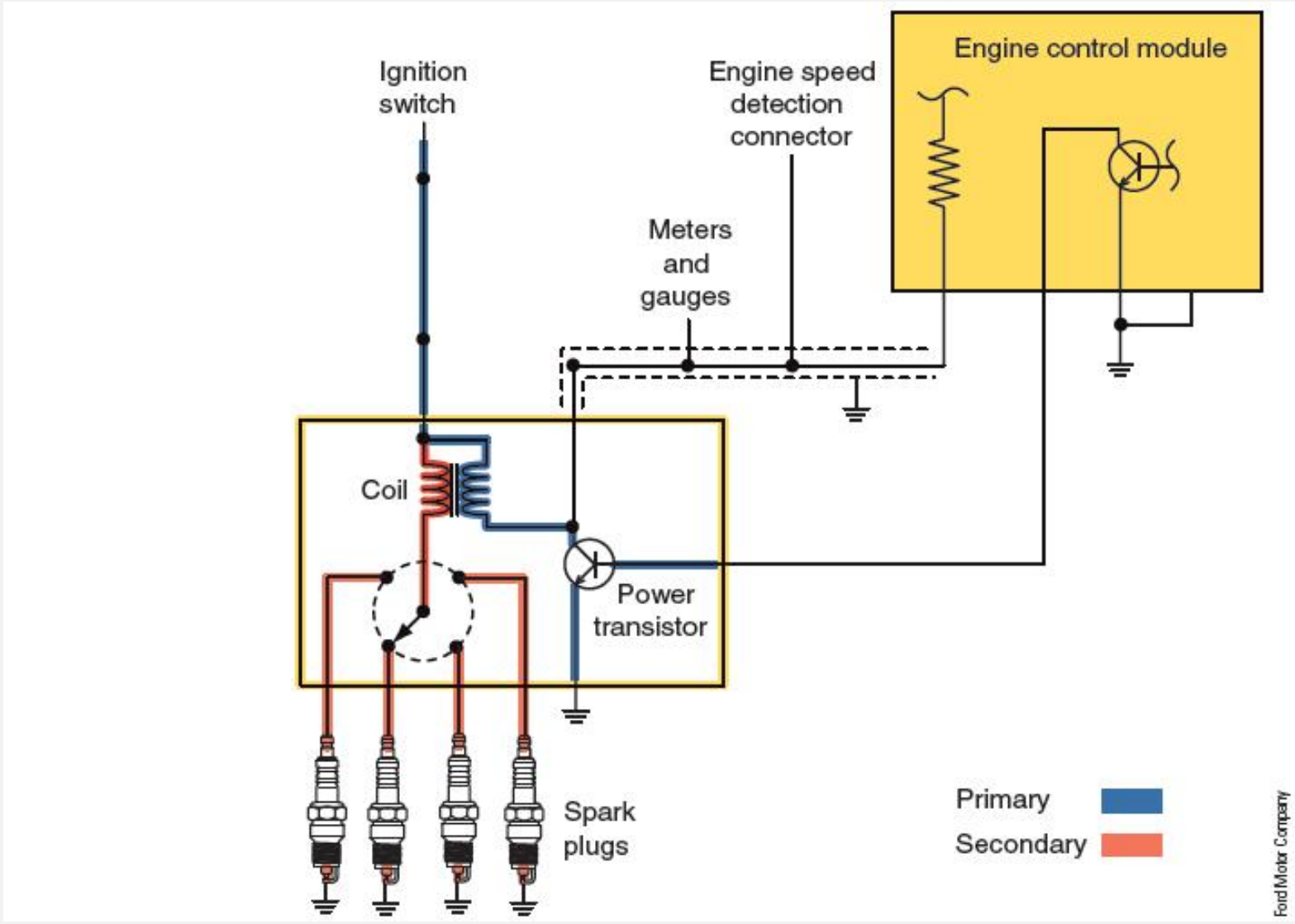
- Resistor plugs and wires
  - Resistance added to secondary ignition system with spark plugs or spark plug cables
  - Resistor inside spark plug raises firing voltage required by the output coil
- Spark plug cable
  - Resistor cables are very fragile
  - Secondary wiring must be well insulated
  - Leak in insulation will cause a spark to short to ground

Electronic Ignitions

- Trigger mechanism
  - Controls current flow in primary coil winding
- Nonelectric ignition systems
  - Used mechanical contact points
    - Alternately energized and then opened primary ignition circuit
  - Contact points require periodic replacement
    - Experience wear to rubbing block that rides against the distributor cam

Electronic Ignition Operation

- Transistor triggers buildup and collapse of magnetic field
  - Housed in an ignition module or in PCM
- Transistor
  - Electronic switch or relay
    - Power transistor: controlled by driver transistor
    - Components: emitter, collector, and base
  - Switches when a small amount of current is applied to its base



Power transistor switches the coil on and off

Electronic Ignition Variations

- Common electronic trigger: permanent magnet (PM) AC generator pickup
  - Works like an alternator
  - Pickup coil: wrapped around iron pole piece
  - Trigger wheel: attached to distributor shaft
    - Low magnetic reluctance
    - Reluctor tooth moves away from pole piece and magnetic field becomes weaker
  - Ignition module: alternating signal from PM generator is converted to DC

Hall-Effect Pickups

- Most popular electronic ignition triggering device
  - Has a stationary sensor and rotating trigger wheel
  - Signal is a rise in voltage followed by a drop
  - Components: permanent magnet, Hall element, and cupped metal ring
  - Creates a small analog voltage signal strengthened by an amplifier
    - Converted to square wave by Schmidt trigger
  - Generate rpm signals and are very accurate
  - Used as a crankshaft position sensor

Magnetoresistive Sensors

- Create a square wave digital signal
  - Includes two MR pickups phased a small distance from each other
  - Creates its own five-volt reference signal
  - Permanent magnet is sandwiched between two sideways magnetic reluctance pickups
    - One pickup gets the signal sooner than the other
    - Differential signal switches a Schmidt trigger

Optical Sensors

- A beam of light controls primary circuit
  - Sensor shines beam on one side of slotted disc
  - Disc interrupts the light: voltage stops
- Automotive engine use
  - Called crank angle sensors
  - Computer determines crankshaft position, cylinder identification, and rpm from openings

Ignition Modules

- Newer ignition modules functions
  - Turn primary current on and off
  - Limit current
  - Vary dwell
- Current limiting system
  - Has variable resistance within an ignition module
    - Ignition module turns current flow off as soon as coil primary winding is saturated

Ignition Timing

- Ignition is timed
  - So it occurs just before piston reaches top of compression stroke
- Ignition timing variation
  - Computer determines best ignition timing setting
    - Advanced or retarded in response to engine speed and load changes, altitude, and engine temperature
  - Intake manifold vacuum senses engine load

Ignition Timing (cont'd.)

- Computer systems continuously adjust spark timing to optimize power and emissions
- Some functions were not possible with mechanical distributors
  - Throttle position sensor determines throttle position
  - MAP sensor determines intake manifold pressure
  - Primary trigger interprets engine speed
  - Coolant temperature sensor allows adjustments for changes in engine temperature

Detonation Sensor

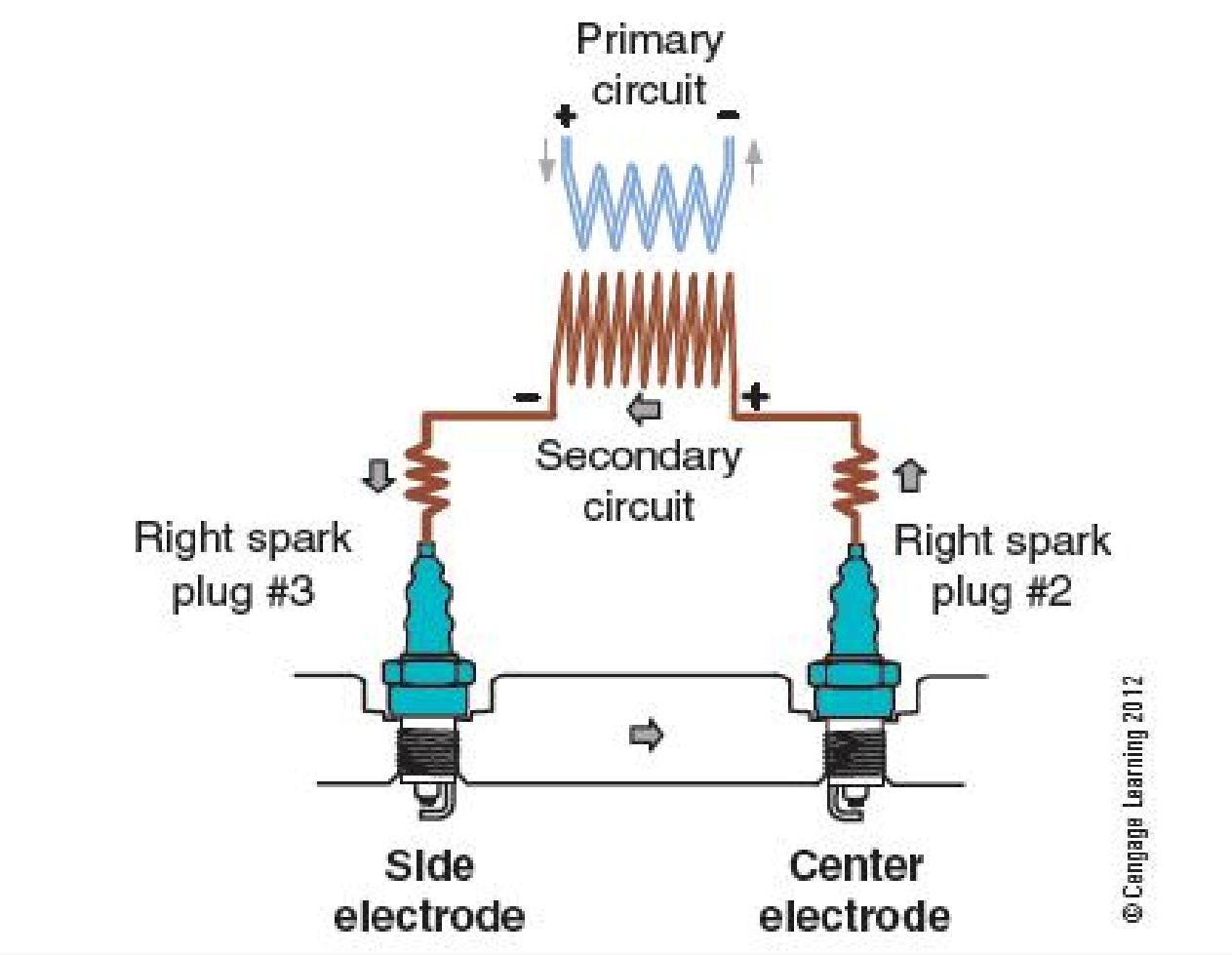
- Controls maximum spark advance
  - Piezoelectric crystal detects the frequency of spark knock
  - PCM retards timing in steps until vibration stops
    - Advances timing until knocking occurs
    - Checks if outside air temperature is high to prevent detonation

Distributorless Ignition

- Advantages of EI
  - Reduced cost and lower maintenance
    - No rotor, distributor cap, or spark plug cables
- Crankshaft position sensor
  - Determines engine speed and crankshaft position
- Camshaft position sensor
  - Gives information for sequencing fuel injection system and coil firing

Distributorless Ignition (cont’d.)

- Waste spark
  - One coil for every two spark plugs
- Some engines have two spark plugs per cylinder
  - One on the combustion chamber’s intake side
    - The other is on the exhaust side


Primary
circuit
+
-
Secondary
circuit
-
+
Right spark
plug #3
Right spark
plug #2
Side
electrode
Center
electrode
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THANK YOU