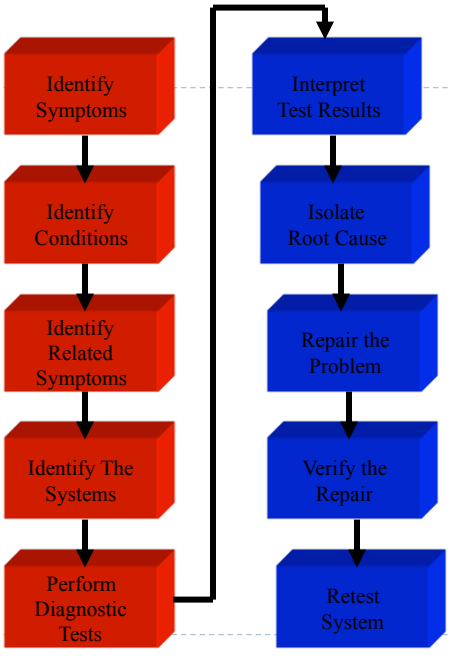
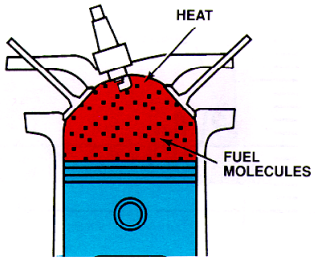
Ignition System Theory & Operation

Diagnostic Procedure

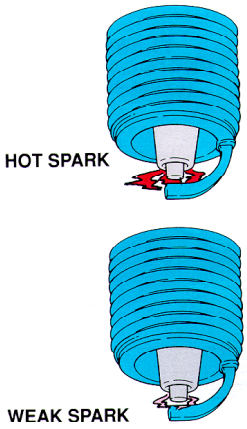


Spark Quality

- Heat to ignite fuel molecules
- Duration to last long enough so the the combustion process is started properly

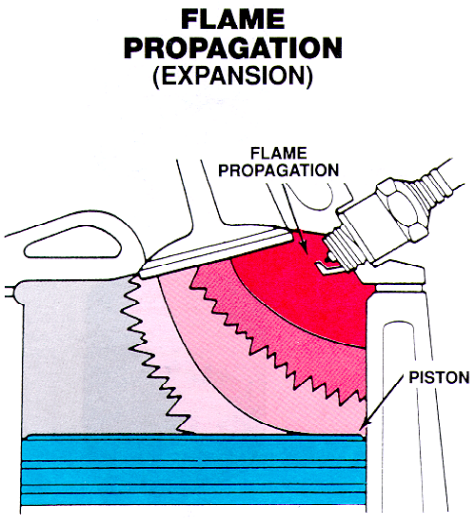


Heat



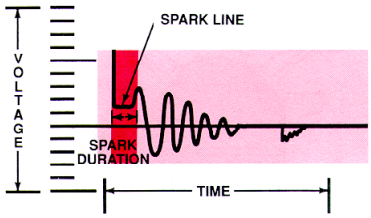
- Heat generated by electrons jumping a air gap
- More electrons hotter spark or more heat
- Less electrons weaker spark or less heat

Flame Propagation

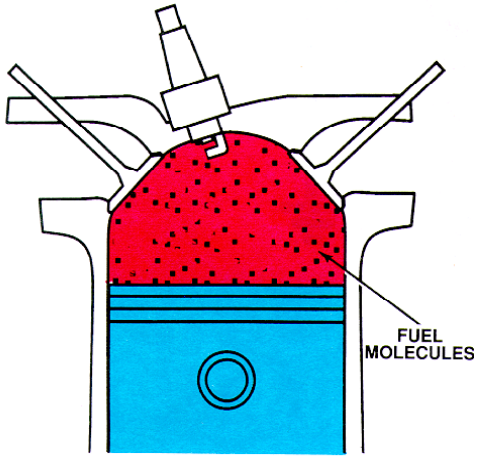


Spark Duration

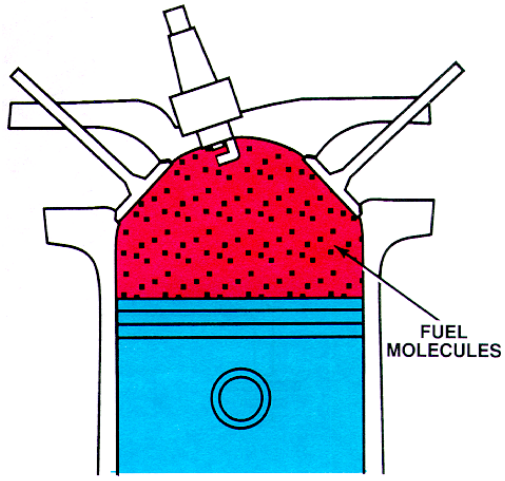
- Length of time spark is maintained
- Measured in Milliseconds (ms)
- Typically between .8 and 1.5 ms
- Needs to be long enough to allow proper Flame propagation



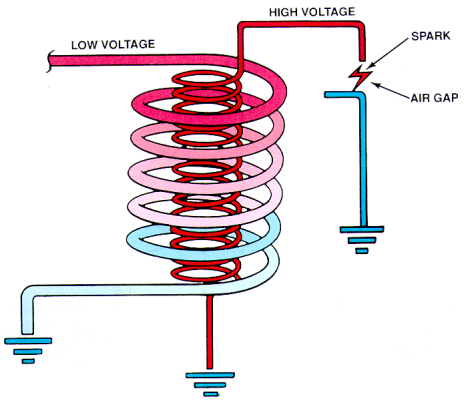
Lean Mixture



Rich Mixture



Voltage & Ignition

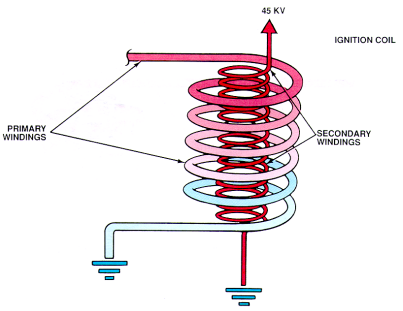


Ignition System Theory & Operation

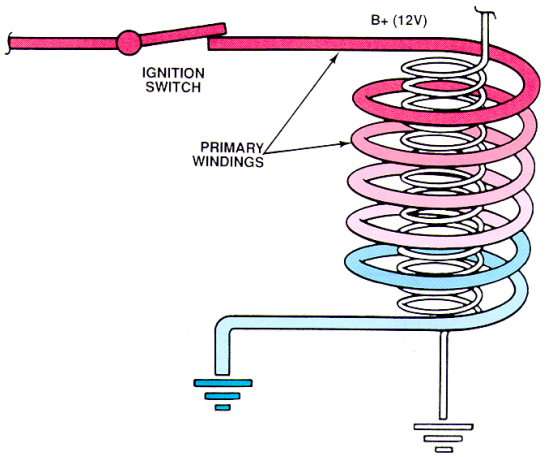
Basic Ignition

Ignition Coil

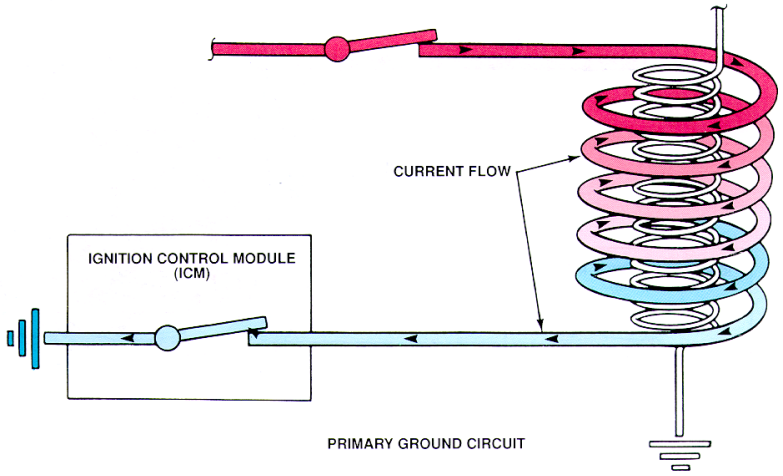
- Converts low voltage to high voltage
- Start with 12 - 14 volts
- Produce up to 40 Kv
- Typically work in the 20 - 25 Kv range



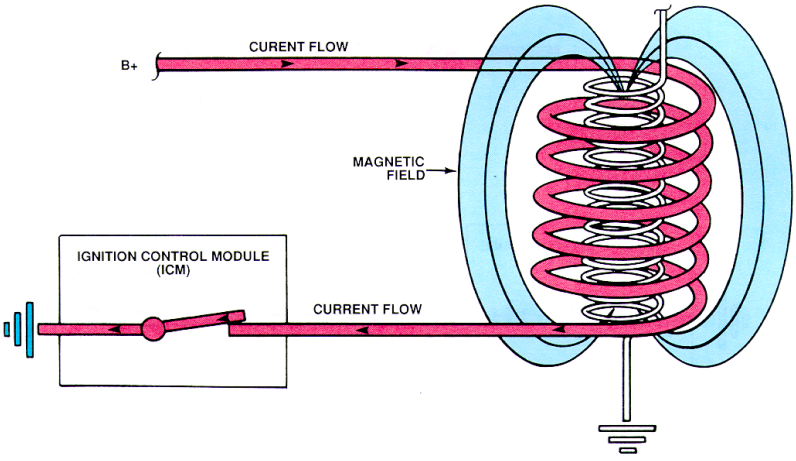
Primary Circuit Supply Side



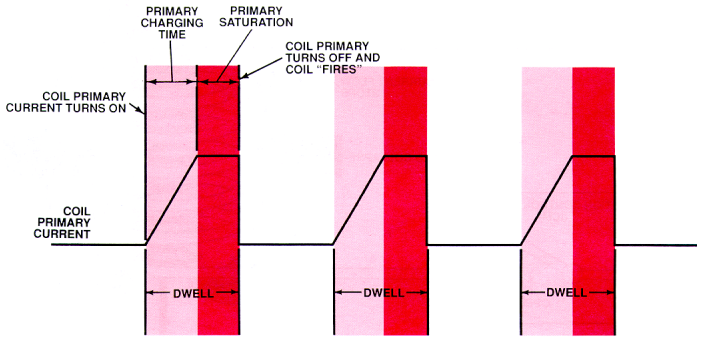
Primary Circuit Control side



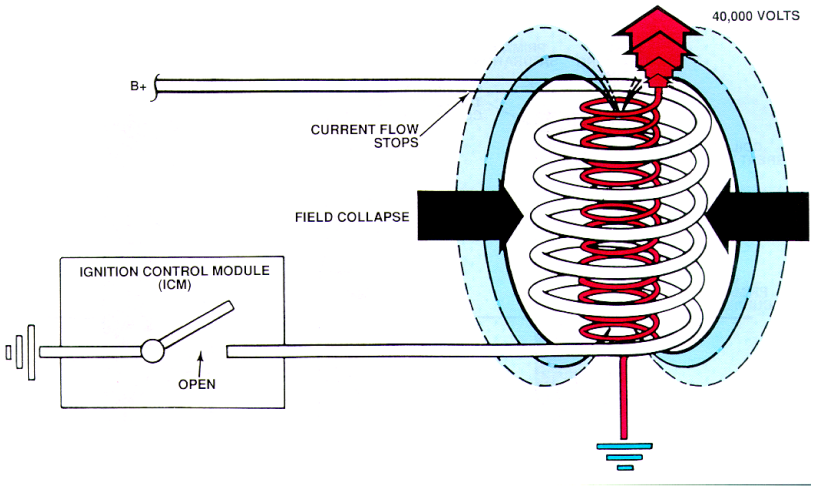
Current Flow & Coil Saturation



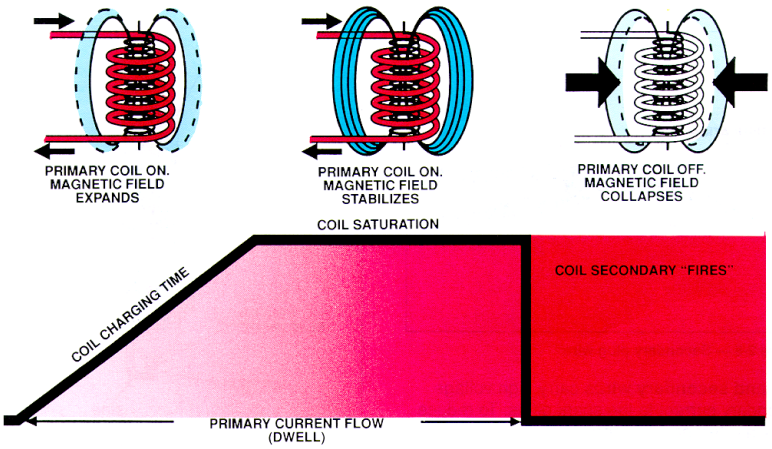
Primary Current Flow & Dwell



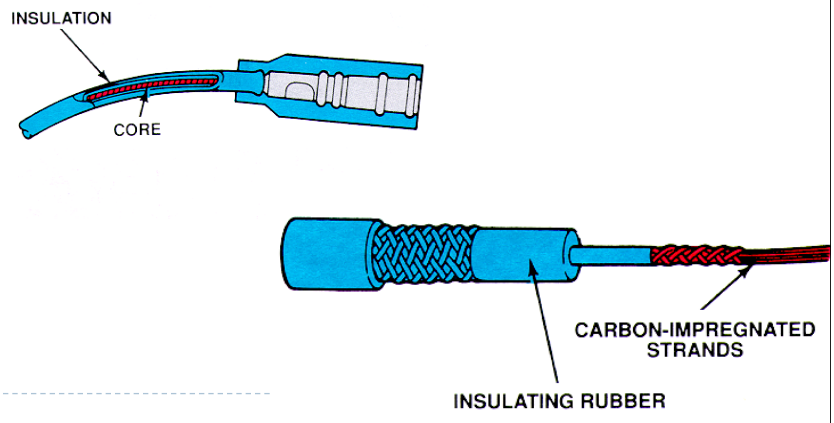
Primary Circuit Magnetic Field Collapse



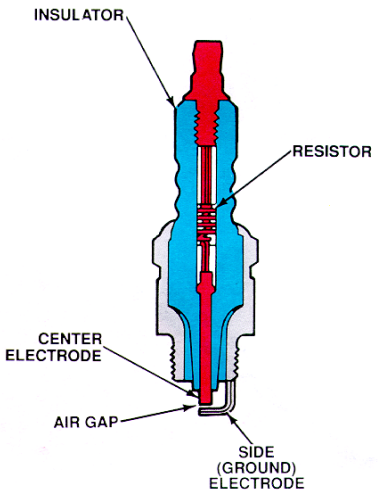
Secondary Circuit Voltage Induction



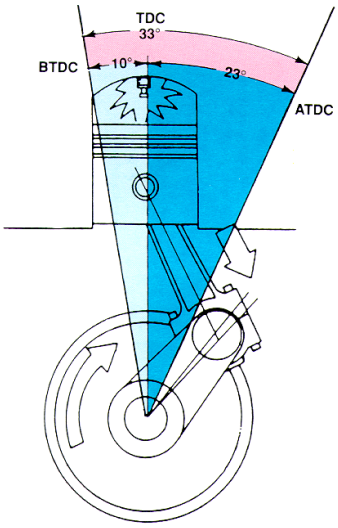
Coil Wire & Secondary Wires



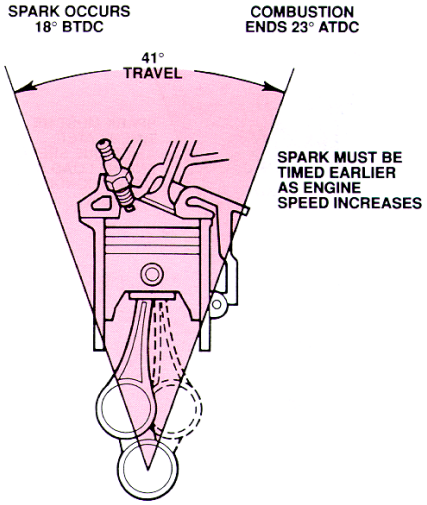
Spark Plugs



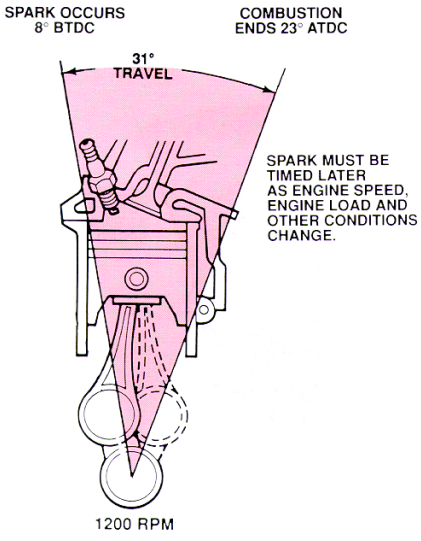
Ignition Timing



Spark Advance & Engine Speed Advancing Spark



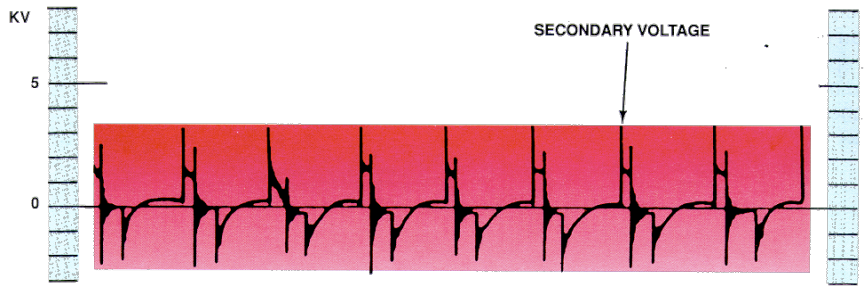
Spark Advance & Engine Speed Retarding Spark



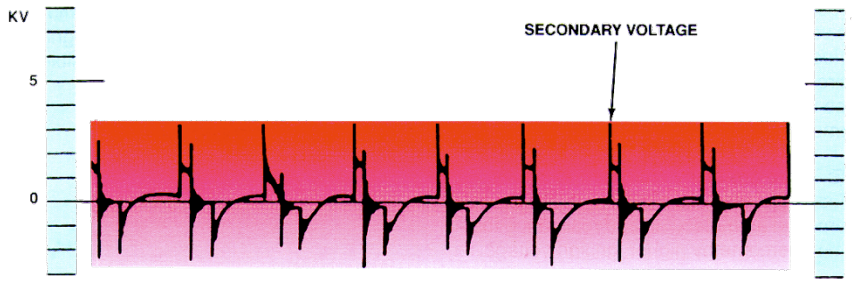
Ignition System Theory & Operation

Ignition Requirement & Operating Mode

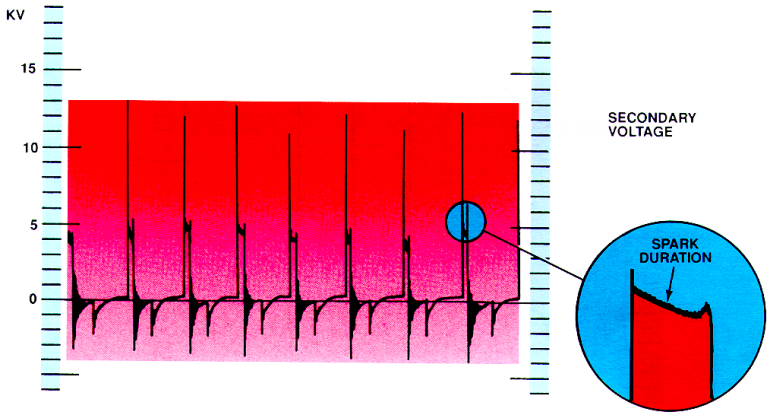
Cranking Mode



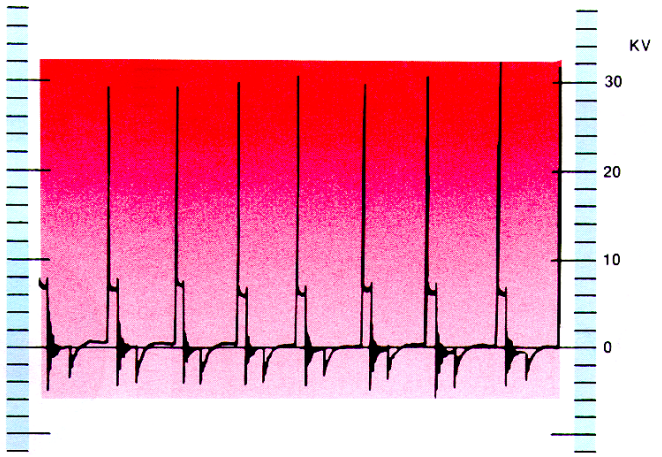
Idle Mode



Cruise Mode



Acceleration Mode



Ignition System Theory & Operation

Ignition Related Driveability Symptoms

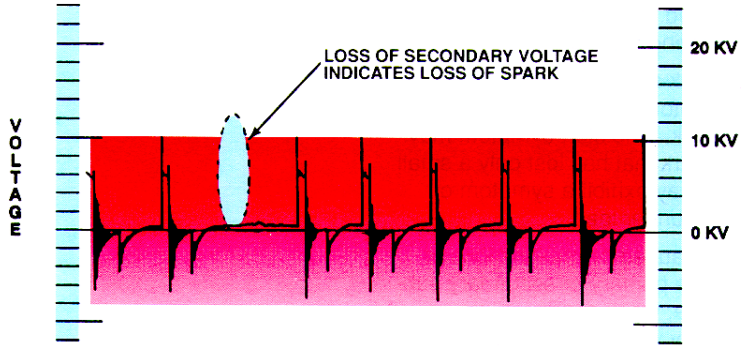
Ignition Conditions

- No spark
- Loss of spark
- Weak spark
- Improper timing

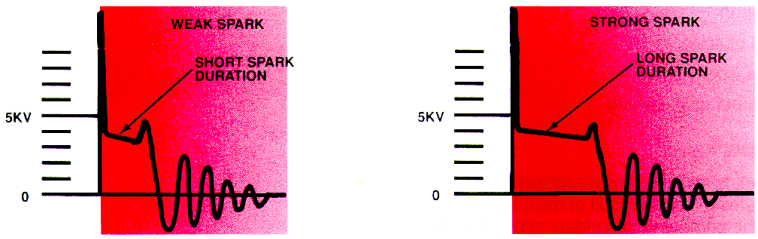
No Spark

- No spark present at the spark plugs could easily be found with a simple spark tester.
- A No Spark situation can be caused by no power applied to coil/s no crankshaft position sensor signal or no commanded ground from the module.
- If spark is not available on a single spark plug the cause may be due to faulty COP coil, spark plug wire, or cap/ rotor issue.

Loss of Spark



Weak Spark



Symptoms & Conditions

SYMPTOMS	CONDITIONS			
	No Spark	Loss of Spark	Weak Spark	Timing
No Start	✔		✔	✔
Hard Start			✔	✔
Quits After Start		✔		
Stalls		✔		✔
Idle-Fast/slow				✔
Misses/Rough Run		✔	✔	
Buck/Jerk		✔	✔	
Stumble			✔	
Induction Backfire				✔
Loss of Power			✔	✔
Spark Knock				✔
Poor Fuel Economy*		✔	✔	✔
Excessive Emissions*		✔	✔	✔

* In most instances other symptoms will be present.

Ignition System Theory & Operation

Basic Testing

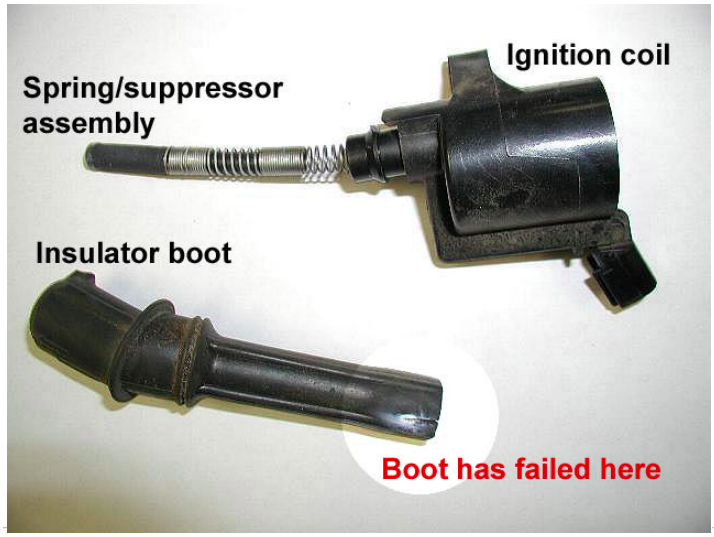
Primary Circuit Tests

- General circuit tests
- Coil supply voltage
- Coil primary circuit ground
- Coil primary resistance
- Coil dwell- saturation

TFI IV Coil

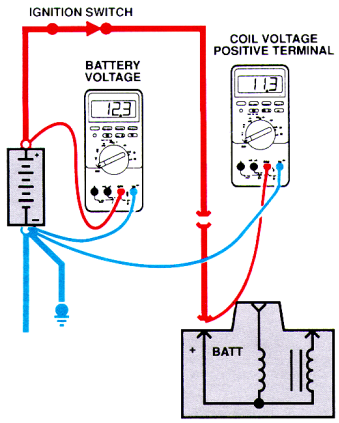
EI Coil

Coil On Plug

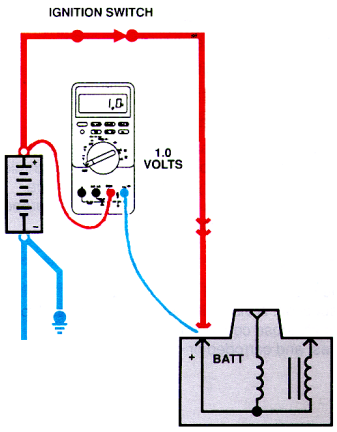


Voltage Supply Test

- Key on
- Battery voltage to coil positive terminal
- No power
  - check circuit back through connector and ignition switch

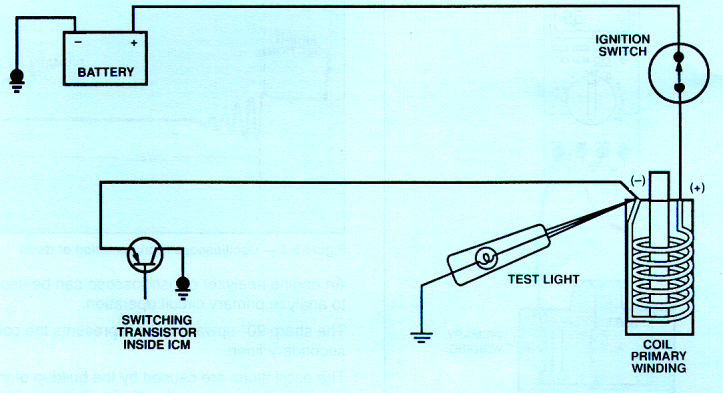


Voltage Drop Test



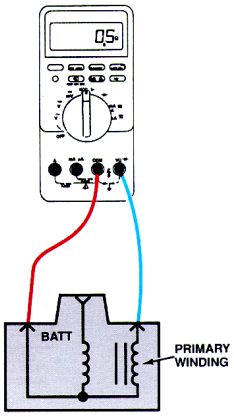
- Used to test for excessive resistance
- If voltage drop is found
  - work back through circuit

Primary Circuit Test

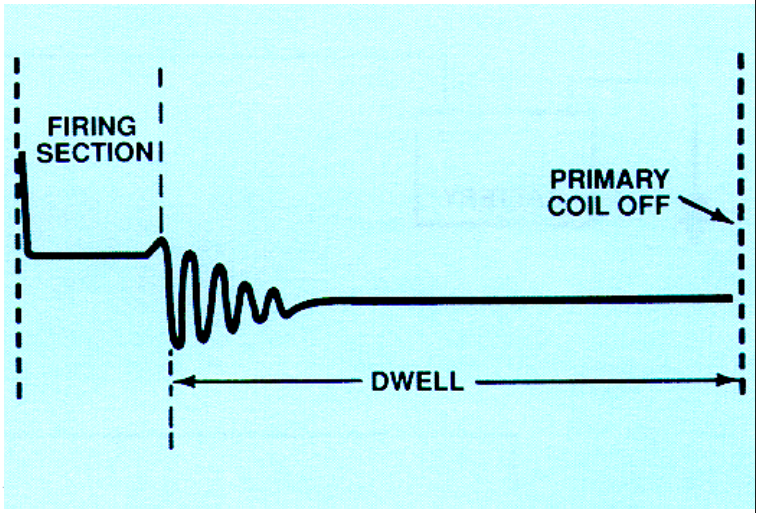


Primary Circuit Resistance

- Check resistance of coil primary circuit
- Check PCED for spec
- Windings should be at room temperature



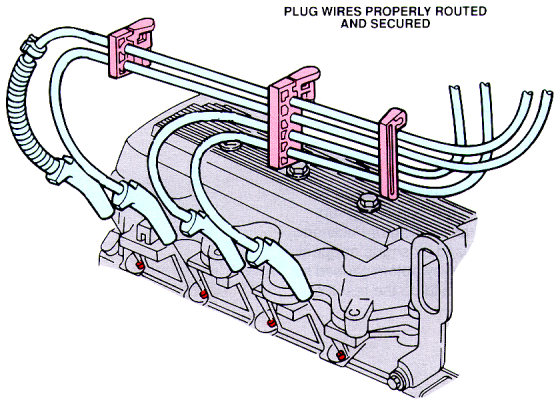
Oscilloscope Dwell



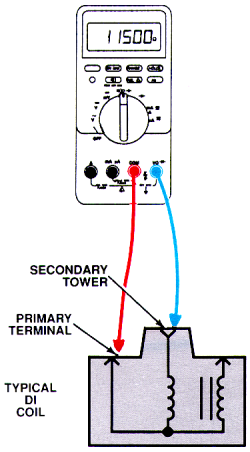
Secondary Circuit Tests

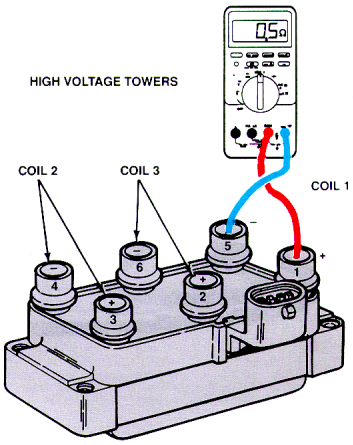
- General circuit condition
- Coil secondary resistance
- Secondary wire resistar
- Secondary required vol
- Spark duration
- Plug condition

Plug Wire Routing

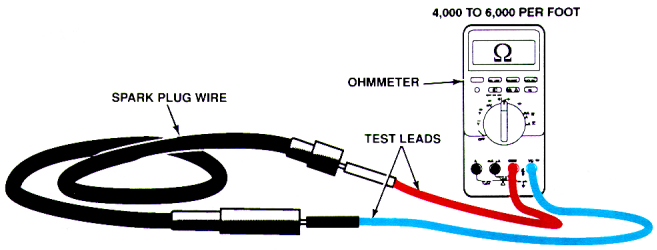


Secondary Resistance Tests

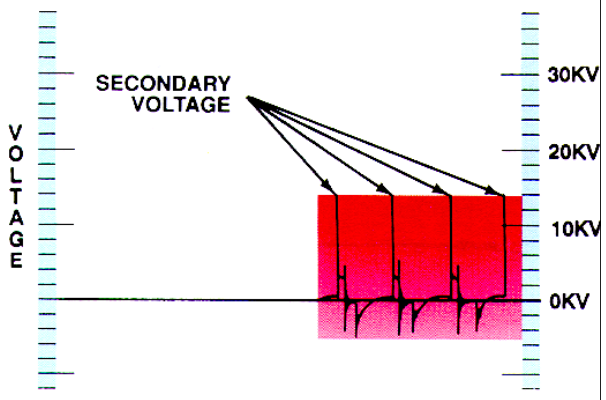




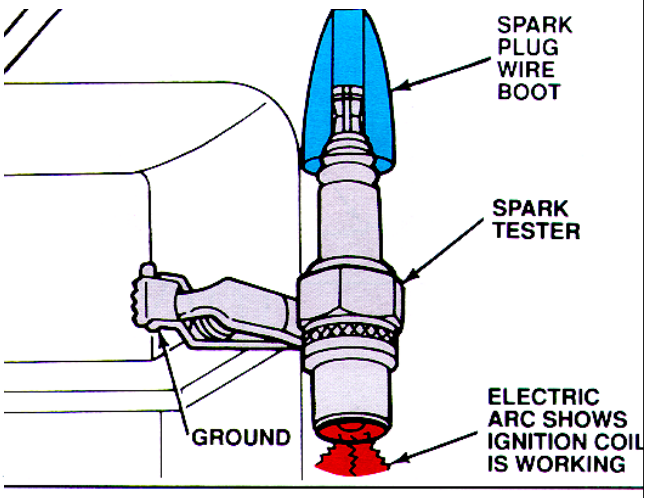
Secondary Wire Resistance



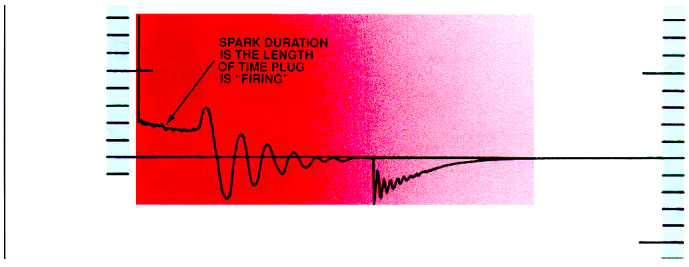
Secondary Required Voltage



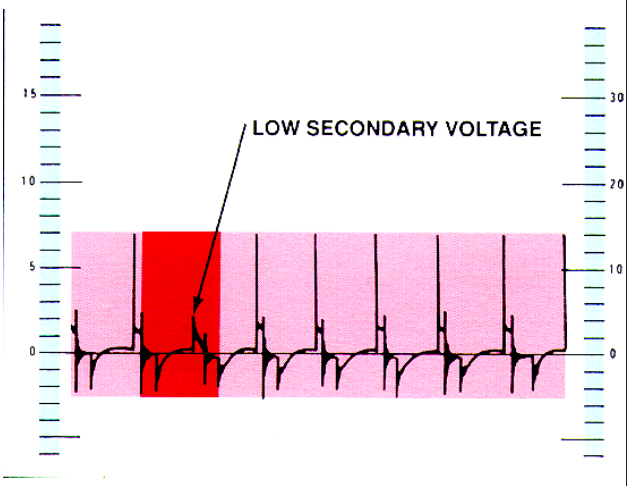
Spark Test



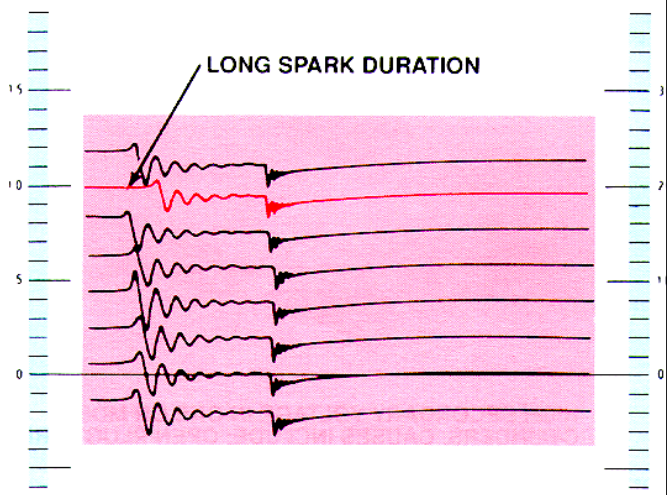
Secondary Operation



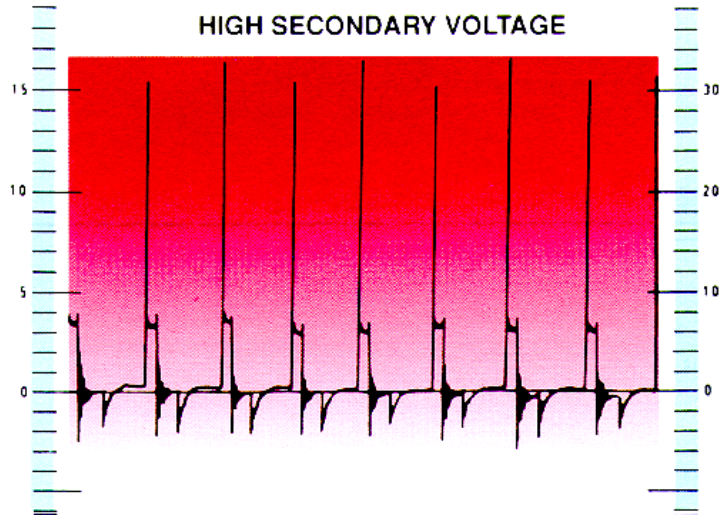
Scope Patterns



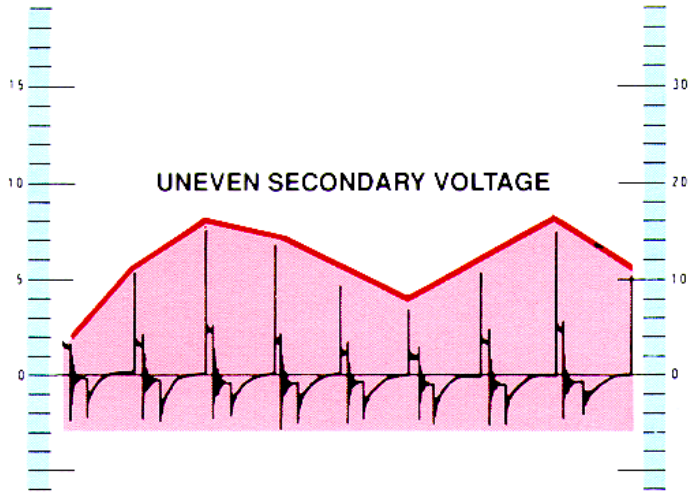
Scope Patterns



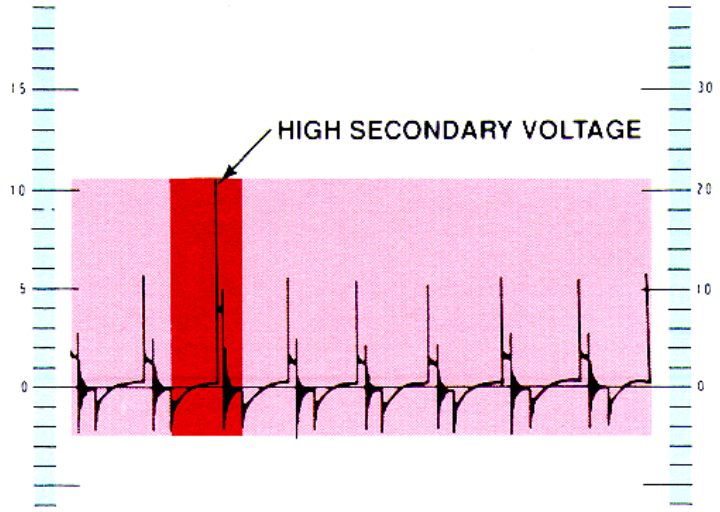
Scope Patterns



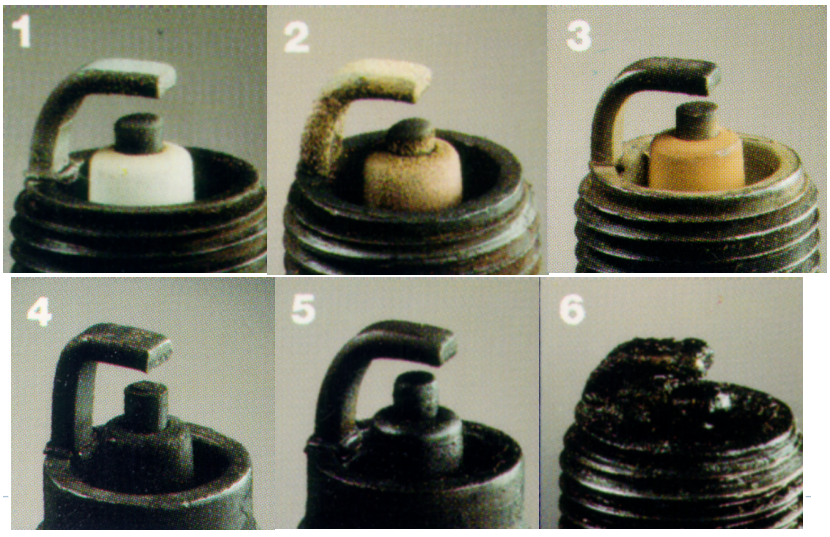
Scope Patterns



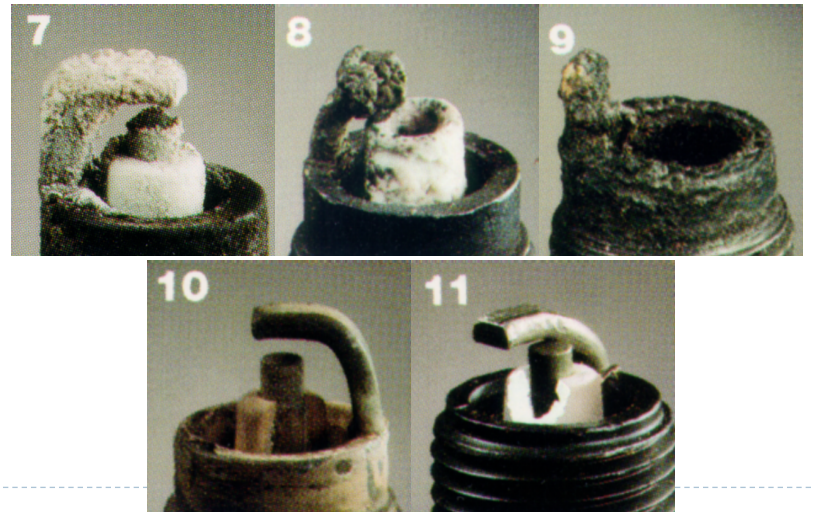
Scope Patterns



Plug Conditions

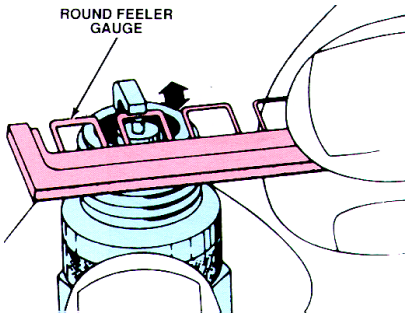


Plug Conditions



Plug Air Gap

- IMPORTANT!
  - Narrow
    - long duration
    - low voltage
  - Wide
    - short duration
    - higher voltage



Timing Light