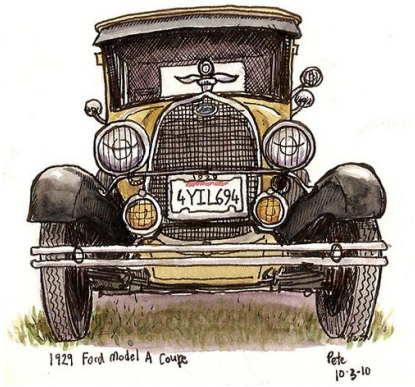
Model A Ford Ignition System Basics

How It Works and What to Check When It Doesn't



MAFAC Beaver Chapter Technical Seminar

Part Two

Two Part Seminar

- Part One – General Discussion
  - Component descriptions and function
  - Why some configurations work better than others
  - Troubleshooting
- Part Two - Live Demonstrations
  - Condenser measurement
  - Low voltage measurement
  - High voltage measurement

Model A Electrical Circuits

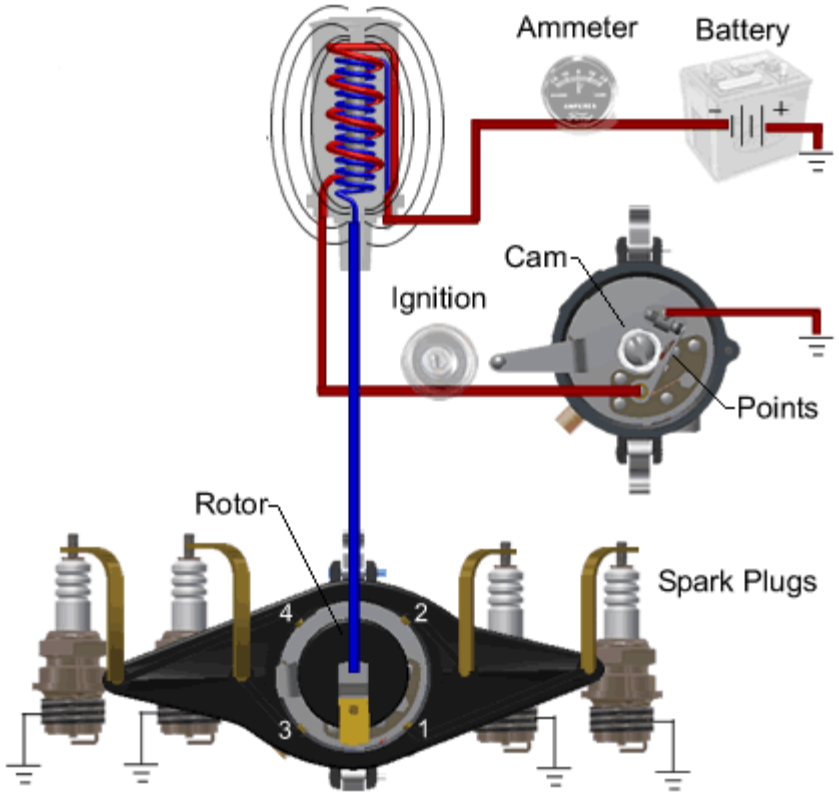
1. Starting Circuit
2. Charging Circuit
3. Lighting Circuit
4. Horn Circuit
5. Ignition Circuit

General Electrical Comments

- The Model A Ford uses a 6 volt, positive ground, electrical system.
  - Yellow wires are generally battery supply or charging.
  - Red wires are generally grounded.
  - Green wires are brake lights.
  - Black wires are generally a power source.
- The positive battery cable is (grounded) bolted to the cross member.
- All circuits must electrically connect to the battery ground point on the cross member
- The grounding path for the primary ignition circuit – coil, ignition switch, armor cable, lower distributor plate, plate connecting wire, points, upper distributor plate, distributor housing, engine, rear motor mounts, frame, and finally the positive post of the battery. Quite the trip.
- Model A ground faults are common. Rust and corrosion are poor conductors. Clean, bare metal is the best conductor. Dielectric grease prevents corrosion and enhances connectivity.

Ignition Circuit Components

1. Battery
2. Fuse / Battery cutout
3. Amp meter
4. Coil
5. Ignition switch
6. Distributor
7. Spark plug connectors
8. Spark plugs



Electricity is pretty much like plumbing. Electricity uses wires instead of pipes, switches instead of valves, volts instead of pressure, amps instead of a flow meter, and a battery instead of a water tower. They both use a ground to complete the circuit.

Primary Plumbing Circuit

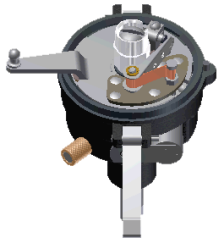





Primary Ignition Circuit





Electrical Terms

- Direct Current (DC) – current flows in one direction
- Volts – electrical pressure, measured with a meter, or detected with a test probe.
- Amperes – quantity of flow, measured with a meter
- Resistance – measure of the difficulty to pass a current, measured with a meter.
- Continuity – electrical path between two points, measured with a meter.
- Capacitance – the ability to store a charge, measured with a meter

Model A Ignition Simulator

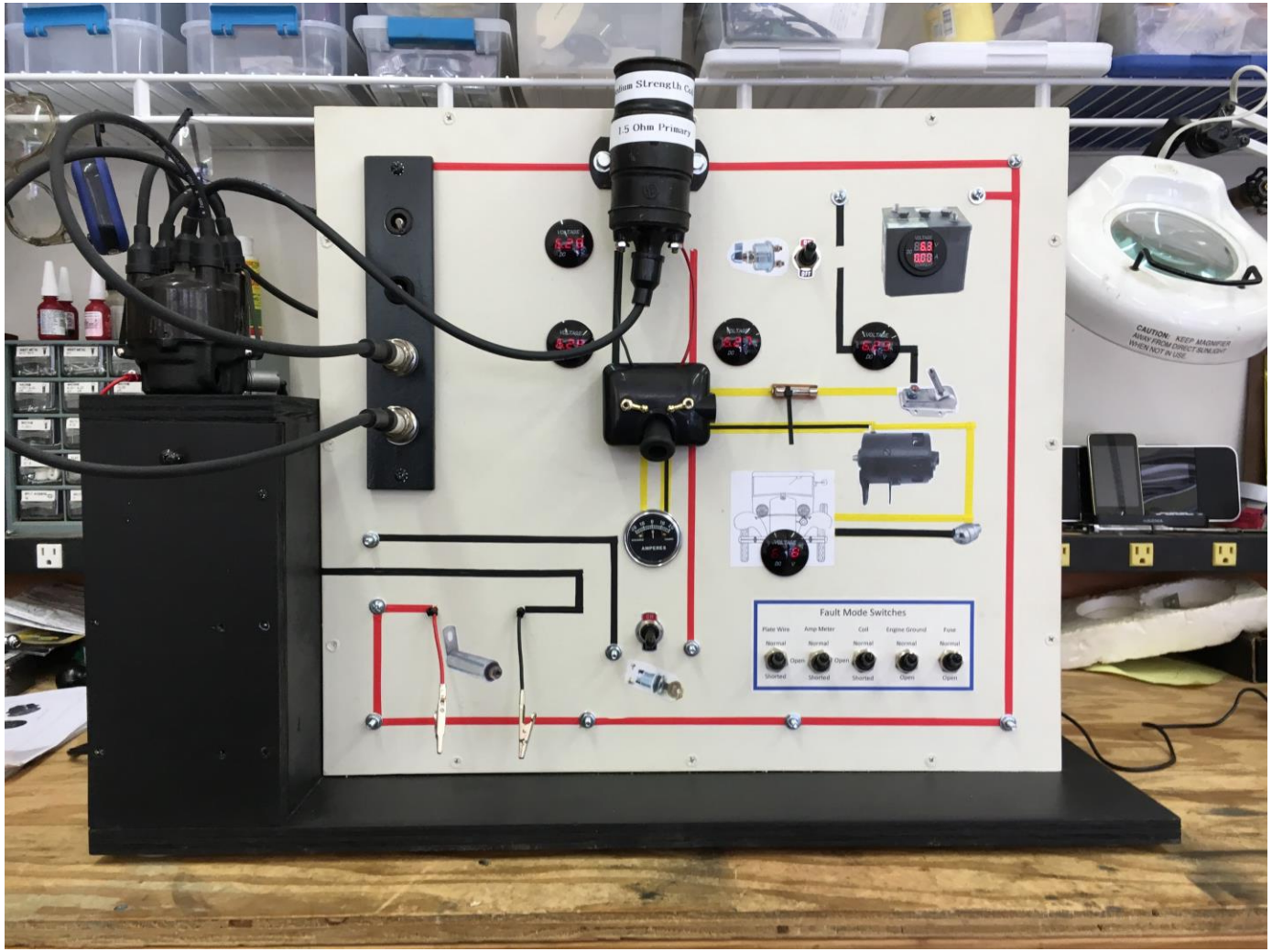
What this simulator is not:

- This is not a coil tester – many defective coils will function normally when cold, but fail when hot.
- This is not a spark plug tester – spark plug testers need to both heat and pressure to perform a valid test.
- This is not a condenser tester – while it can simulate condenser failure modes, condensers should be tested with high voltage to measure capacitance, and to check for voltage leaks.

What this simulator is intended to demonstrate:

- How to identify test points and expected voltages
- Common component failure modes
- Use of meters and test equipment

Model A Ignition Simulator



6 Volt Battery

- Model A's use a positive ground system. A good ground is required to supply full voltage.
- For longer battery life, batteries should remain charged. Generally speaking, the less you discharge the battery before recharge, the longer the battery will last.
- Battery terminals and cables should be kept clean of corrosion.
- Non-sealed batteries should be filled with distilled water.
- Battery voltage drops during a load, and running the starter motor counts as a load. This translates to a lower voltage to the coil.
- The starter motor is grounded through the engine to the frame. If this is not a good ground, the additional resistance will result in a lower voltage to the starter.

Battery Failure Mode

Low voltage output

- Corrosion on terminals
- Poor electrical ground
- Low generator/Alternator output

Failure to hold a charge

- Current draw from charging, lighting or inverter circuit
- Bad battery cell
- Bad ground

Fuses and Battery Cutout

Automotive electrical systems were widely used during the time of the Model A's production. Like many things, Henry had his own ideas about electrical standards and practices.

- No fuses – most Model A's today have at least a single fuse located on the starter motor. Another owner option is to install a fuse block on the passenger, or engine side, of the firewall. Remember, the starter motor will still run with a blown fuse, but the engine will not start.
- Electrical components are hot all the time – the coil, the horn, the lights, and brake switch. The Model A electrical system generally interrupts the ground not the power source. There is some anti-theft logic to this, but some fire risk as well.
- Always disconnect the battery before working on the electrical system. A battery cutout switch provides a fast, safe, method of disconnecting battery power from the car. All electrical systems are disabled if this switch is off.

All Model A's Should Carry An Accessible Fire Extinguisher

Fuse Failure Mode

Blown fuse

- Short in lighting circuit
- Short in generator
- Short in owner added circuit – inverter/turn signals

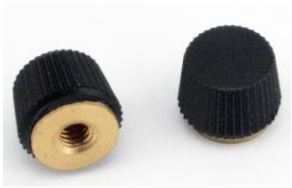
Trouble shooting

- Disconnect light and charging circuit at generator
- Install new fuse
- Reconnect generator wire
  - If the fuse blows again the problem is in the generator – disconnect the generator wire
  - If the fuse does not blow the problem is in the lighting circuit – disconnect the lighting wire
- Install new fuse if blown
- Drive home and repair faulty component

Ampere Meter

- Simple method to measure current flow to and from the battery
- Amp meter wires should be installed using insulated meter nuts.
- The meter is connected with two yellow wires, one to each side of firewall terminal block.
- Left side of meter scale indicates battery discharge.
- Reverse wires to achieve correct polarity.

Note: During engine start, the amp meter will indicate a slight discharge as the points close and return to zero as they open. This is good indication that the primary ignition circuit is working correctly.



Ampere Meter Failure Mode

Open circuit – no voltage

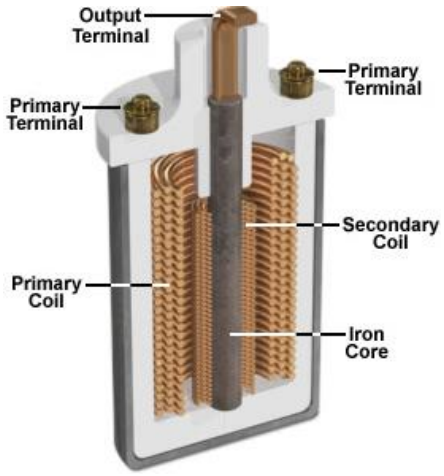
- Jumper out amp meter by connecting a wire between the two posts on the terminal box.

Voltage drop

- Jumper out amp meter by connecting a wire between the two posts on the terminal box.

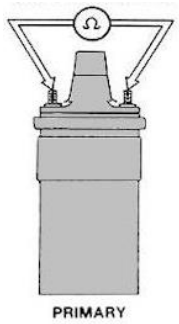
Coil

- Coils basically consist of a primary winding, a secondary winding, an iron core and an isolation housing.
- The primary windings is switched on/off by the points.
- The secondary winding is a high voltage circuit suppling power to the spark plugs via the distributor.
- The primary coil terminals are marked positive and negative. The negative terminal (black wire) provides power from the amp meter. The positive terminal (red wire) connects to the ignition switch. **Polarity Matters**

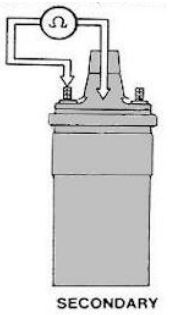


Coil Failure Mode

Loss of high voltage output



- Heat is an issue. Coils that perform well when cold can fail when hot. Very hot coils are likely shorted.
- Verify primary circuit resistance
  - Les Andrews 1.6 – 1.8 Ohms. This equates to 3.7 – 3.3 Amps.
  - Steve Pargeter 1.0 – 3.0 Ohms. This equates to 6 - 2 Amps.
- Verify secondary circuit resistance 6K – 12 K Ohms
- Ensure Coil wire is firmly connected to coil and cap
- Install spare coil



Weak Spark

- Verify terminal polarity

Ignition Switch and Armor Cable

- The ignition switch function is to electrically connect the positive terminal of the coil to the armor cable.
- When the switch is off, there is no electrical ground for the coil primary circuit – and no spark
- The armor cable's function is to provide an electrical connection between the ignition switch and the distributor lower plate.
- Original pop-out switch
- Reproduction Re-pop switch
- Other reproduction switches

Note: Reproduction switches have exposed connections. Care should be taken with these switches to ensure that the gas tank area behind the switch is electrically insulated.

Ignition Switch Failure Mode

No voltage at points with current draw indicated on Amp meter

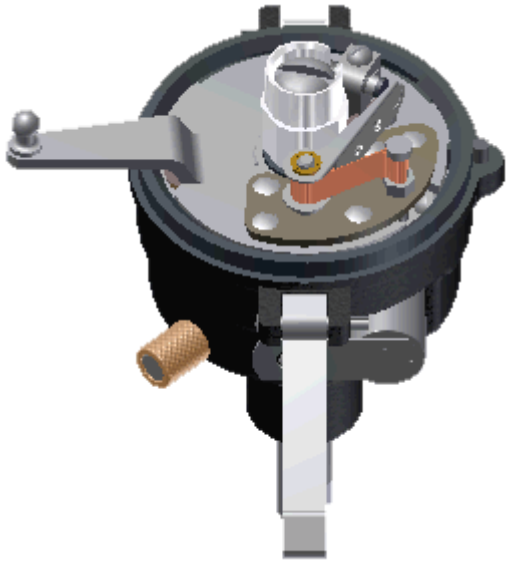
- This is likely a short at: the back side of the ignition switch, armor cable shorted on lower distributor plate, or shorted lower plate connecting wire.

No voltage at points without current draw indicated on Amp meter

- This is likely a failed switch or broken connecting wire.

Distributor

- Distributor housing
- Shaft type
- Shaft bushings
- Lubrication requirements
- Lower plate type
- Upper plate type
- Condenser type
- Cam type
- Rotor
- Distributor cap
- Distributor body



Original Distributor Components

- The points on an original top plate are easier to adjust than a modern points upper plate. Points are set at .018 to .022”
- The Model A distributor weak point is the unreliable nature of the wiring between the upper and lower plate.
- Failure of the plate connecting wire results in an open circuit, or a short to ground.
- An open circuit has the same effect as turning off the ignition switch – no spark
- A direct short also results in no spark, but has the added problem of over heating the coil as current is continuously flowing as long as the ignition switch is on.

Modern Distributor Components

- The points on a modern top plate can be a little more challenging to adjust.
- The sometime troublesome wire link between the upper and lower plate is eliminated.
- The two plates are electrically connected by a friction foot. If not adjusted correctly this foot can result in intermittent connection between the upper and lower plate.
- Failure of the foot generally results in an open circuit.
- An open circuit has the same effect as turning off the ignition switch – no spark
- I have found that I get better results if I remove the distributor from the car and make the point and foot adjustment on the bench. A meter can be used to verify continuous electrical contact across the spark advance range.

Distributor Failure Mode

No voltage to points

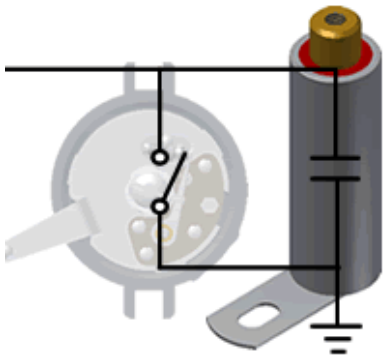
- With the key on, hold points open and check for voltage on non-movable side of points
- Check for loose or broken wires
- Check connecting wire on original style plates
- Check connection foot on modern style plates

No high voltage output

- Coil is very hot to touch – coil is likely shorted
- Verify point gap 0.018 – 0.022 inches

Condenser

- Original style condensers are subjected to high heat.
- Early condensers used oiled paper as an insulator and suffered high failure rates.
- Currently available condensers use a plastic film for insolation and are very reliable.
- The most likely failure mode is an internal short resulting in loss of spark.
- Good condensers should have a value of about .3 microfarads.



Condenser Failure Mode

No high voltage output with voltage at points

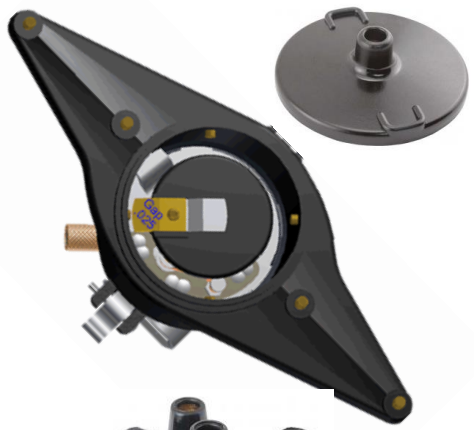
- Condenser open

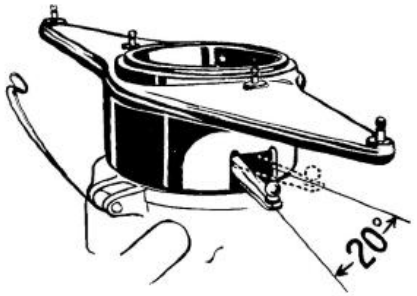
No high voltage output no voltage at points

- Condenser shorted
- Any sign of bulge in the case indicates a failed condenser.

Distributor Cap and Body

- The distributor cap electrically connects the high voltage coil wire to the rotor.
- The rotor connects the cap to the body. The spring top should make good connect with the cap. The rotor should also be free of pitting and maintain a .025” clearance at all four contact points.
- The distributor body connects the rotor and the spark plug connectors.
- Modern distributor caps use modern spark plug wires, but are functionally equivalent to original components. The use of a modern cap and wires will greatly reduce radio interference.
- Both styles of distributor bodies are designed to limit upper plate spark advance. Remember that 20 degrees distributor advance equals 40 degrees of crankshaft advance.





Coil, or Coil Wire Failure Mode

No high voltage output

- Coil is very hot to touch – coil is likely shorted and should be replaced
- Coil wire is not properly set in coil or distributor cap
- Coil wire ends are loose or missing

Weak spark

- Coil polarity could be reversed

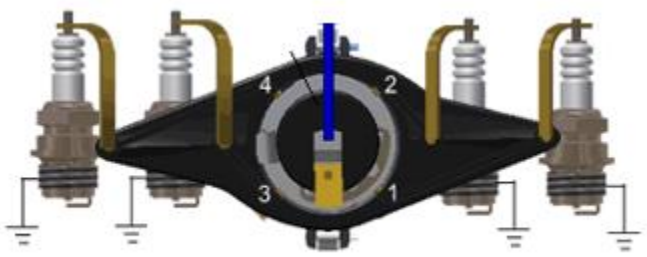
Cap, Body, and Rotor Failure Mode

No or reduced high voltage output

- Cap – cracked, carbon trail, coil wire not properly seated, or connector on bottom of cap is missing.

- Rotor – pitted or burned appearance, or spring top not making good connect with the cap.

- Distributor body – cracked, carbon trail, or not properly seated on housing.



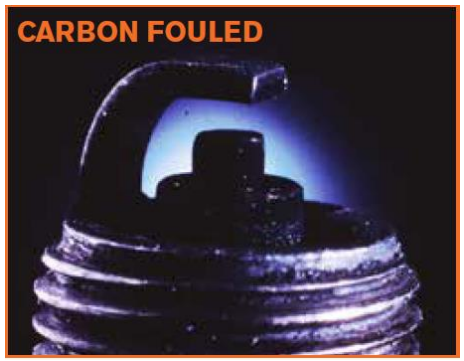
Spark Plug Connectors

Three available lengths

1. Straight Bronze, 3 1/8”
   1928 – June 1930
2. Offset Bronze, 3 1/4”
   June 1930 - 1931
3. Offset Bronze, 3 13/16”

Note: Desired connector length is dependent on spark plug selection. Short plugs like Motorcraft TT10 may require longer connectors to achieve solid electrical connection

Understanding Spark Appearance



Normal – Grayish-tan to white in color. No unusual signs of deterioration or coatings.

Carbon fouled – Dried, soft, black, sooty coating. There are a number of possible causes for this condition: Spark plug heat range is too cold; extensive low-speed/short-distance driving; weak ignition system; rich fuel mixture; vacuum leaks; valve problems.

Fuel fouled – Firing tip may be damp with gasoline, and usually the odor of gasoline is present on the spark plug. The insulator is often tinted the color of charcoal. This indicates that gasoline is not being burned properly in this cylinder. Check for faulty or sticking choke, overly rich fuel mixture, ignition problems, or a spark plug heat range that is too cold.

Spark plugs and Connectors Failure Mode

No or reduced high voltage output

- Spark plug connectors – not properly seated on distributor cap.

Weak spark

- Coil polarity could be reversed
- Spark plugs – Fouled with fuel or carbon, insulator cracked, spark plug gap improperly set.

Meters Options

- Fluke 117 - $147.00
  - Voltage
  - Resistance
  - Amperage
  - Capacitance
- Auto Multimeter MST2800B - $25.73
  - Voltage
  - Resistance
  - Amperage
  - Capacitance
  - Dwell
  - Tachometer
  - Temperature
- Honeytek A6013L - $15.98
  - Capacitance only
- Harbor Freight - $5.99 or free
  - Voltage
  - Resistance
  - Limited amperage

Voltage Tester Options

- Deluxe test probe - $10
  - 6, 12 volt detection
- Standard test probe - $4
  - 6, 12 volt detection
- Home made light - $3
  - 6, 12 volt (bulb dependent) detection
- Not overly bright friend - $0
  - Need to tell him to touch an electrical part, but no to worry because the key is off. Good for any voltage.

Modern High Voltage Tester Options

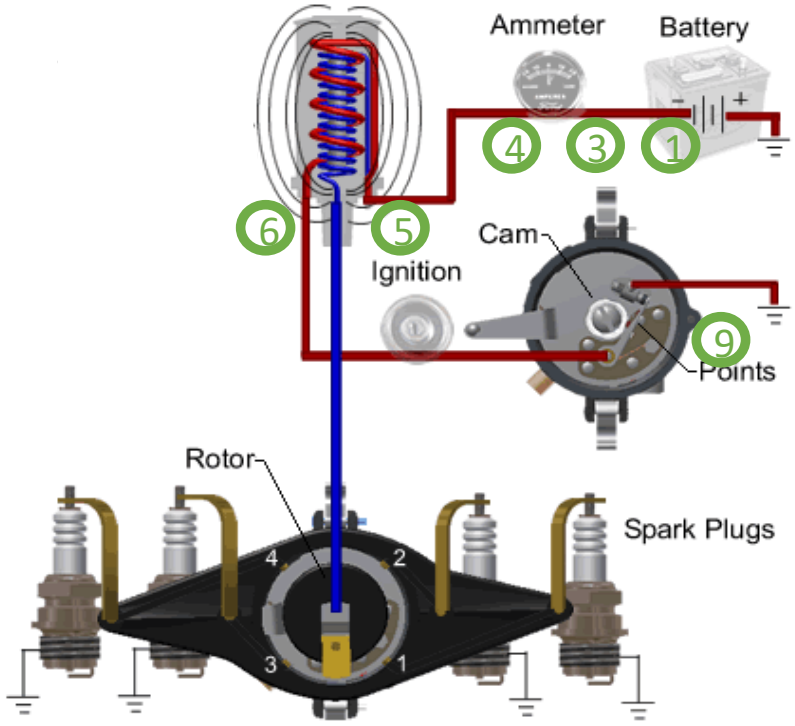
- Spark tester – measures the spark plug firing voltage - $20
- Coil polarity tester – checks polarity of primary coil circuit - $25
- Ignition spark tester - measures the spark plug firing voltage - $8
- Ignition spark tester – displays that high voltage is present - $3

Less-Modern High Voltage Tester Options

- Sears Model 244.2186 high voltage meter - measures the spark plug firing voltage - $20
- Snap-on MT2700 – checks polarity and voltage of secondary coil circuit - $35

Troubleshoot Primary Circuit

1. Voltage at the starter motor – battery good
2. Fuse condition – if installed
3. Voltage at left (driver side) terminal post – fuse good
4. Voltage at right (passenger side) terminal post – amp meter good
5. Voltage at black wire on coil – wire good
6. Voltage at red wire on coil – primary coil winding good
7. Turn on ignition switch and remove distributor cap and body.
8. Hold points open
9. Voltage at movable points arm – ignition switch, armor cable connection, lower plate wire are good



Troubleshoot Secondary Circuit

1. Points and primary circuit are normal
2. Coil should be warm to the touch
3. Coil wire – copper tips in place and firmly seated
4. Distributor cap – not cracked and no sign of carbon trail. Black tip on underside in place,
5. Distributor rotor – tip not burned or pitted. Upper spring contacting the cap.
6. Distributor body – not cracked and no sign of carbon trails.
7. Spark plug connectors – ensure solid connection with distributor body posts.
8. Spark plugs – should have all four

Credits and References

- Model A Basics - http://modelabasics.com/Ignition.htm
- Model A Ignition Primer & Restoration Guidelines – Steve Pargeter
- Snyder's web site – component pictures
- Mac's web site – component pictures
- Dykes Automotive and Gasoline Engine Encyclopedia
- Timing a Model A - Les Andrews YouTube videos
- Model A Ford Mechanics Handbook – Les Andrews
- Ford Garage web site - http://www.fordgarage.com/
- Greg Edwards – Consultation and machine work