Module 3: Battery, Charging, Electrical Systems

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Basic Electrical

- What Questions/Concerns do you have?
- What do you want from this module?

Powertrain Electrical Components

- Battery
  - Powers the Starter Motor
- Starter Motor
  - Turns the engine
- Alternator
  - Recharges the battery after Starting
  - Powers the Ignition system and electrical accessories
- Ignition System
  - Ignites the air/fuel mixture at the proper time

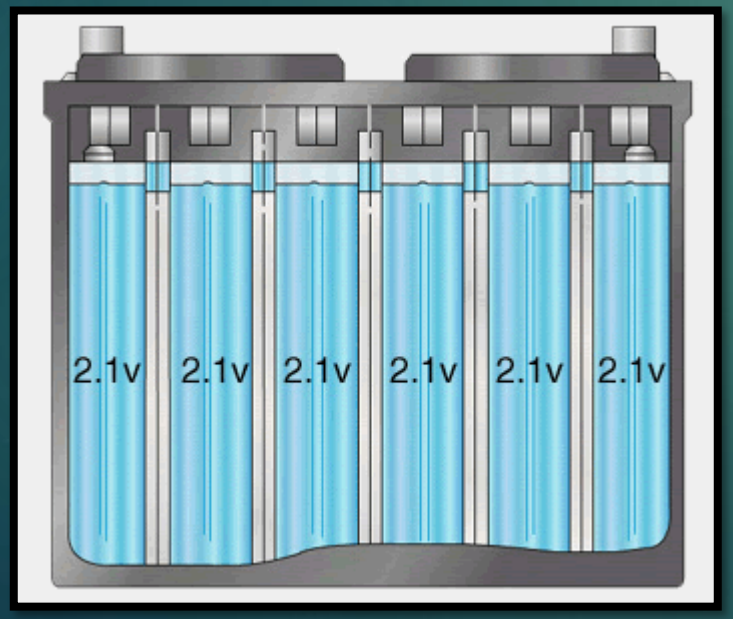
Batteries

- 2 dis-similar metals in an electrolyte
  - Lead (Negative Plates)
  - Lead Dioxide (Positive Plates)
  - Sulfuric Acid/deionized water

- Why do car batteries use sulfuric acid?
  - Low Freeze Point
  - High Resistance to boiling

Batteries

- Source of power
- 6 cells
- Each cell is 2.1volt each
- 12.6 volts total (Fully Charged)
- Not all batteries are equal



BATTERY DISCHARGE CYCLE

- Positive and Negative Plates become Lead Sulfate
  - Plates become sulfated if left discharged for a long period of time
- The specific gravity of the Electrolyte decreases.
- Water level increases

BATTERY RECHARGE CYCLE (CHARGING)

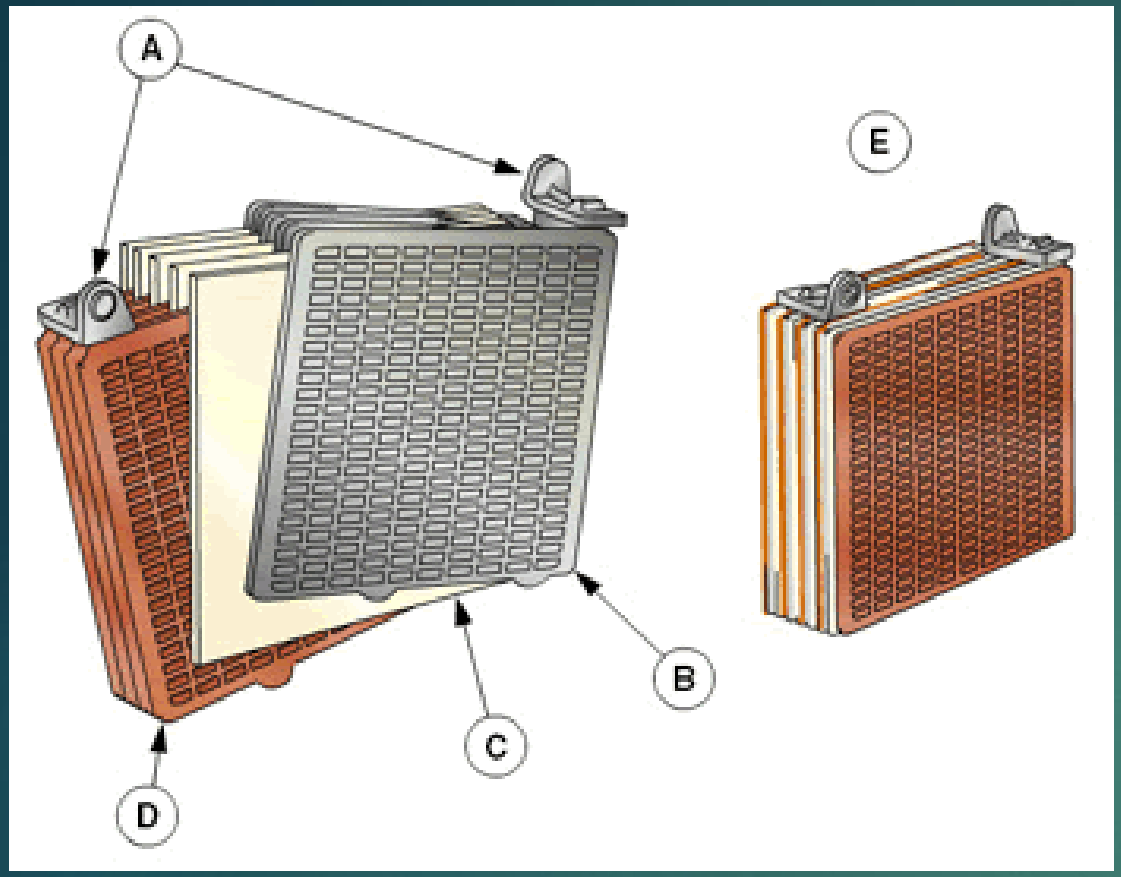
- Positive plates become PbO_2
- Negative Plates become Pb
- The specific gravity of the Electrolyte increases
- Acid level increases

Types of Batteries

- Flooded lead acid
- Enhanced flooded lead acid battery
- AGM
- Gel battery

Types of Batteries

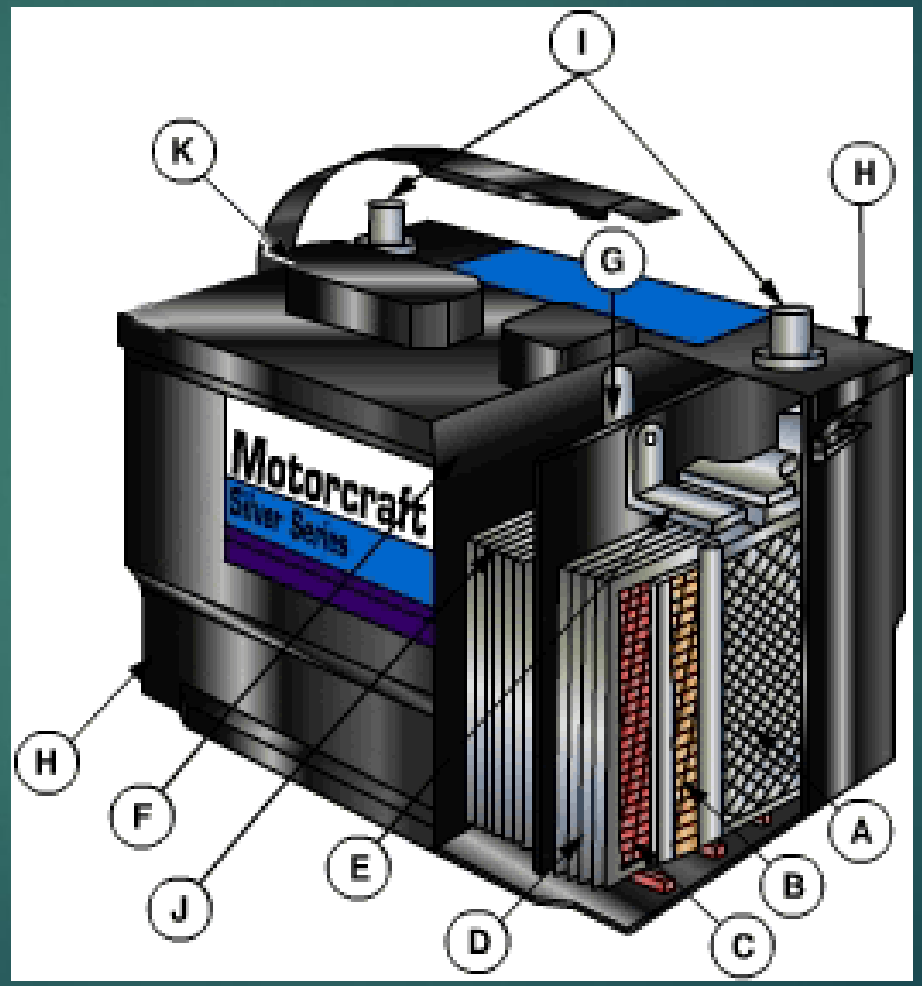
- Flooded lead acid
  - Traditional car battery
  - Has a wet acid solution bath



A. Plate Straps
B. Negative Plates
C. Separators
D. Positive Plates
E. Cell

Lead Acid Batteries

a) Grid
b) Plates
c) Separators
d) Plate groups
e) Assembled elements
f) Battery cell
g) Thru-partition cell connectors
h) Container and cover
i) Terminals
j) Electrolyte
k) Vent caps



Types of battery

- Enhanced flooded lead acid battery (EFB)
  - Used in some start/stop applications
  - Alternative to a higher cost AGM
  - Designed to have best of flooded

    and AGM battery

Valve Regulated Lead Acid Batteries

Sealed Battery

- Absorbed Glass Mat (AGM)
  - Acid is totally absorbed into the separator
  - Cell is compressed 20%
  - Reduced damage by vibration
  - May be OEM
- Gelled Electrolyte
  - Silica added
  - Electrolyte becomes similar to gelatin

Deep Cycle Batteries

- Deep cycling means to almost fully discharge
  - Golf carts
  - Marine trolling motors
- Specially designed (thicker) plates to resist heat warpage

Battery ratings

- Most automotive batteries have a CCA rating
- CCA = COLD CRANKING AMPS **0° F**
- Usually good to compare one from the next
- The larger the number the better quality
- ALL Vehicles have a minimum CCA required to start by each model
  - Not same battery to crank a small 4 cylinder as a large 8 cylinder
- NOT to get confused with CA (cranking amps—another rating)

Reserve Capacity (RC)

- Minutes the battery can produce 25 amps
- Maintain 10.5volts
- 80 ° F

How does temperature affect Battery Life?

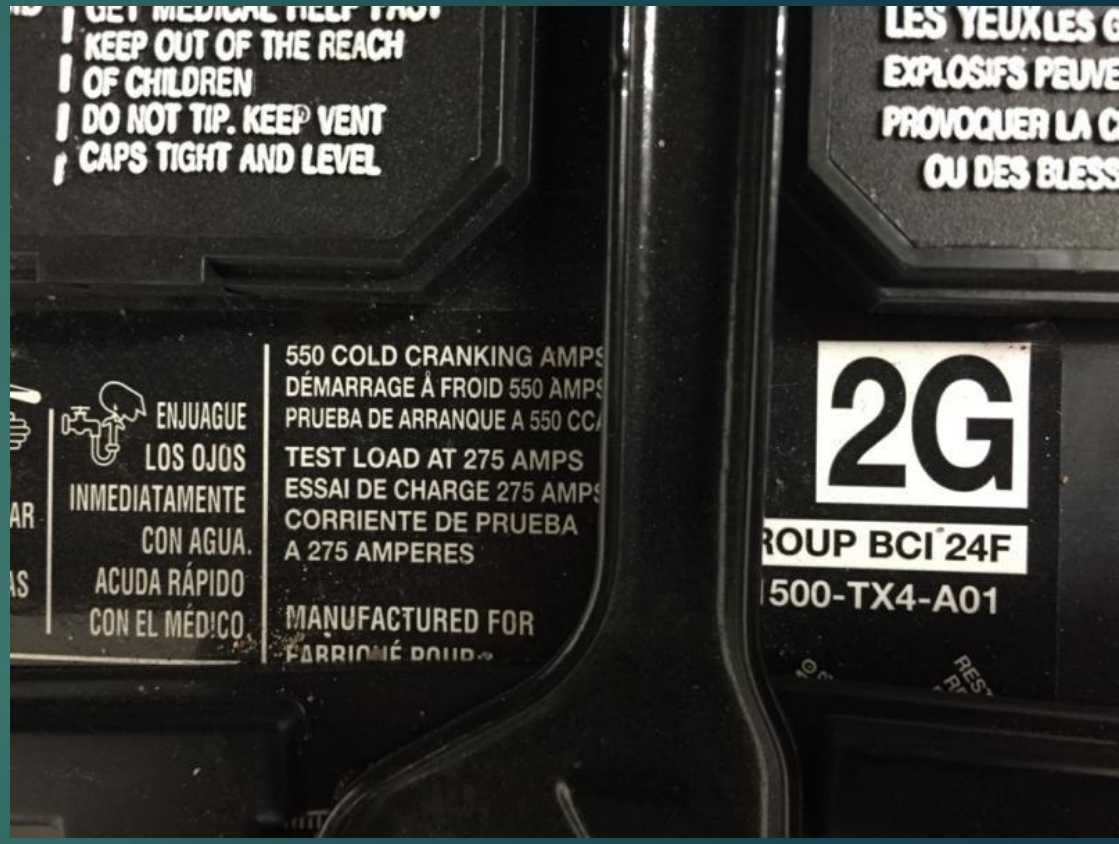
- Lower Temperature
- Decrease in battery **Performance**
  - 10% for every 10 degree drop in temperature

- Higher Temperature
- Decrease in Battery **Life**
  - Every 15° F increase in temperature will reduce the battery life by 50 %

77° F Perfect

Battery “Group”

- Part Number
- Designated by the Battery Council International (BCI) to standardize
- Associated with Length, Width, Height dimension to fit the vehicle
- Terminal location
  - side post
  - top post
  - positive on left or right



Normal Charging Voltage
13.5 volts to 15.5 volts

Some vehicles charge at
12.5 volts

- Overcharging:
  - Warp Plates
  - Boil out water
  - Crack case
- Undercharging:
  - Battery can sulfate
  - Not have enough power
  - Never fully charged

State of Charge

Specific Gravity	State of Charge	Voltage
1.265	Fully Charged	12.6
1.225	50%	12.4
1.155	25%	12.0
<1.120	Discharged	11.9 or lower

- Difference: 0.7 Volts

Safety Considerations

- Eye protection
- Acid
  - Rinse spills
  - Neutralize
- Prevent accidental arcing
  - Disconnect negative terminal
  - Don't use battery as tool tray
- Never smoke or have near open flame

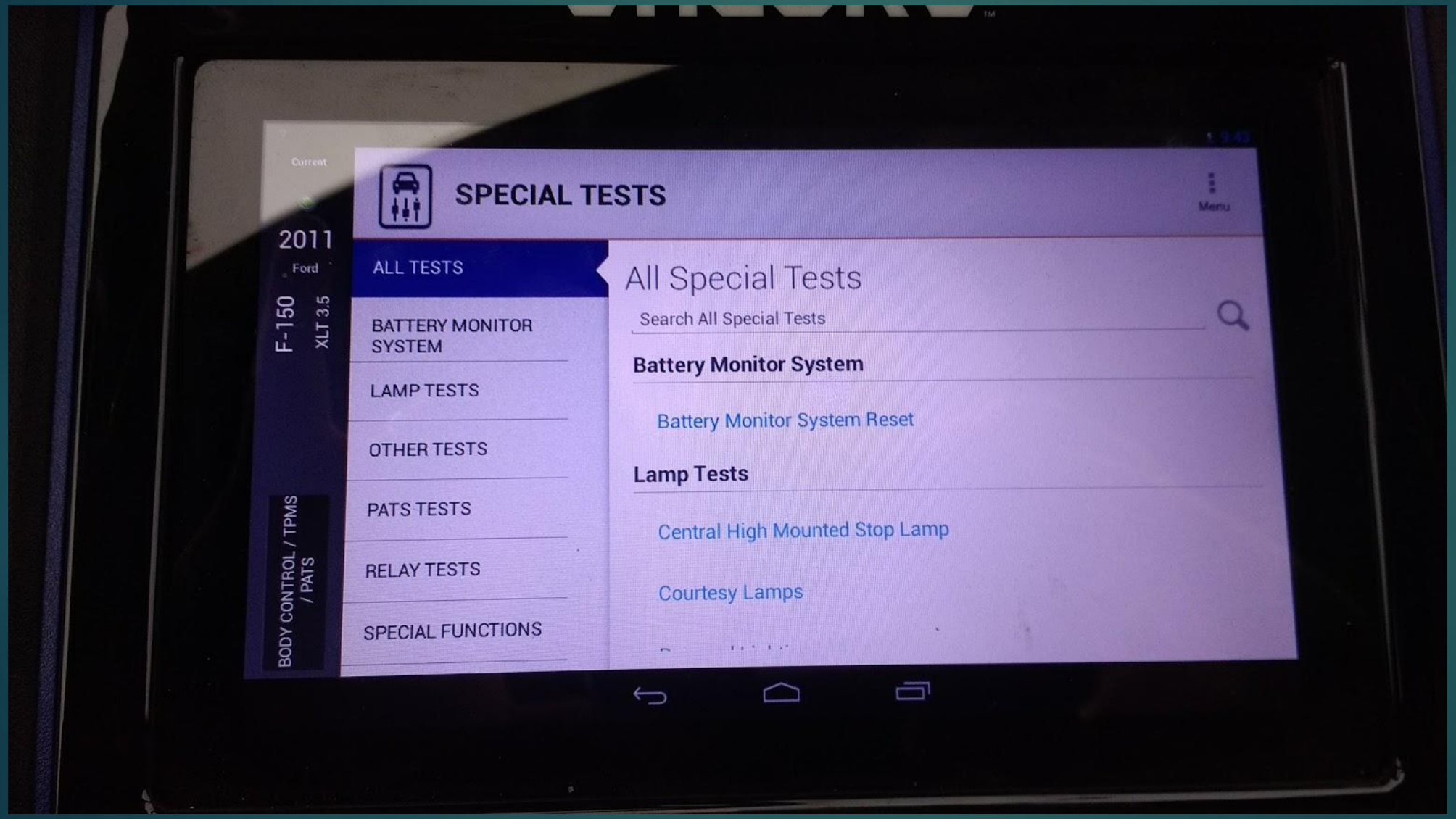
BATTERY TESTING

- Load testing
  - Simulates an actual starting event
  - Pass/fail test
  - Can only test when fully charged
- Conductance testing
  - All electronic calculation
  - Safer to use
  - Can test a partial dead battery
  - Most common in shops today
  - Estimates battery ability by:
    - STATE OF HEALTH
    - STATE OF CHARGE
    - HELP DETECT EARLY BATTERY FAILURES

How long does a battery last?

- The question of the day
  - Just like oil changes and oil quality???
  - Doesn't ever battery have a warranty in months??
  - What kind of charging conditions (smart charge, computer controlled)
  - What kind of operating conditions (temp)
  - Is it used regularly
  - What extra work load demands have been added
    - Radios
    - Lights
    - Inverters
    - Power supplies
    - Etc….

Temperature	Battery Life
77°F (25°C)	5 Years
92°F (33°C)	2½ Years
107°F (42°C)	~1 Year


Current
SPECIAL TESTS
Menu
2011
Ford
F-150
XLT 3.5
BODY CONTROL / TPMS / PATS
ALL TESTS
BATTERY MONITOR SYSTEM
LAMP TESTS
OTHER TESTS
PATS TESTS
RELAY TESTS
SPECIAL FUNCTIONS
All Special Tests
Search All Special Tests
Battery Monitor System
Battery Monitor System Reset
Lamp Tests
Central High Mounted Stop Lamp
Courtesy Lamps

Replace battery without losing ADAPTIVE MEMORY

- Adaptive memory
  - radio station, memory seat, clock/time,
  - shift patterns, ignition timing, fuel adaptive
  - Computer strategy and programming

- Install another battery in parallel
  - Use diagnostic link
  - Power outlet

Battery charging

- Slow charge when possible (5 amps)
- May take 8 hours or more
- Never charge a frozen battery
- (electrolyte in discharged
- batteries will freeze)

Battery faults


PartsMaster
A DANGER/POISON
SHIELD EYES
EXPLOSIVE
GASES CAN CAUSE
BLINDNESS OR INJURY
PROTEJA LOS OJOS
LOS GASES EXPLOSIVOS
PUEDEN CAUSAR DAÑOS
O CEGUERA
KEEP OUT OF THE REACH OF CHILDREN
DO NOT TIP DO NOT OPEN BATTERY
CALIFORNIA PROPOSITION 65 WARNING
NO VOLTAR NO ABRIR LA
WARRANTY VOID IF THIS LABEL
IS REMOVED. LIMITED WARRANTY
valid only if dated when sold
RETURN
RECYCLE
LEAD


CATALOG NO. N° DE CATALOGUE
2370
REPLACEMENT MODEL
MODÈLE DE RECHANGE
47PS
CCA (SAE)
525
20HR CAPACITY
CAPACITÉ 20HR
60Ah
LOAD TEST
ESSAI DE CHARGE
260
ACDelco
100-82773
13502370
Pb
Detroit, MI U.S.A. 48243


1-888-EVSTART
12-VOLT Battery
NGER / POISON
SULFURIC ACID
CAN CAUSE
BLINDNESS OR
SEVERE BURNS
NO
SPARKS
FLAMES
SMOKING
11/13
KEEP OUT OF THE REACH OF CHILDREN
DO NOT TIP. KEEP VENT CAPS TIGHT AND LEVEL
FLUSH EYES IMMEDIATELY
WITH WATER. GET
MEDICAL HELP FAST
RECYCLE


6/17
PLUS
EverStart
12-VOLT
Battery
34-3
600
750


12-VOLT
Battery
1-888-EVSTART
Cranking Amps
750
GROUP, INC.
Walmart stores, Inc.
Copper recycling

Starting system

- Electrical motor for cranking engine
- High torque
- High amps load
- Turns flywheel with gear drive
- Used to crank engine over until fast enough that engine can run (300 rpm)

Has internal parts that wear out over time !

Starter Current Draw

- Four-cylinder engines

  70 to 120 amperes
- Six-cylinder engines

  100 to 200 amperes
- Eight-cylinder engines

  185 to 250 amperes

Excessive Starter Current

- Starter motor
  - shorted windings
  - binding armature (worn bushings)
- Seized engine
- Improper starter clearance
  - Excessive Clearance: Whine During cranking
  - Insufficient Clearance: Whine After cranking

Stop Start Technology

- Engine shuts off at stops
- Sometimes may not be obvious
  - Maybe important to know if working on car with a disabled start/stop function
- Auto start stop icon on dash cluster
- Aux. battery in trunk
- Battery switch module on battery
- Rpo codes (GM LK9)
- Disable button (not on GM)
- NOT by starter visual inspection

Stop Start

- Conventional starter designed to withstand 35,000 starts for durability testing.
- Start/Stop starter motor designed to withstand 350,000 to 400,000 starts.
- The number of starts is logged and a "replace starter motor warning indicator" alerts the driver when close to the end of life expectancy

--this has to be reset with a scan tool when starter is replaced.

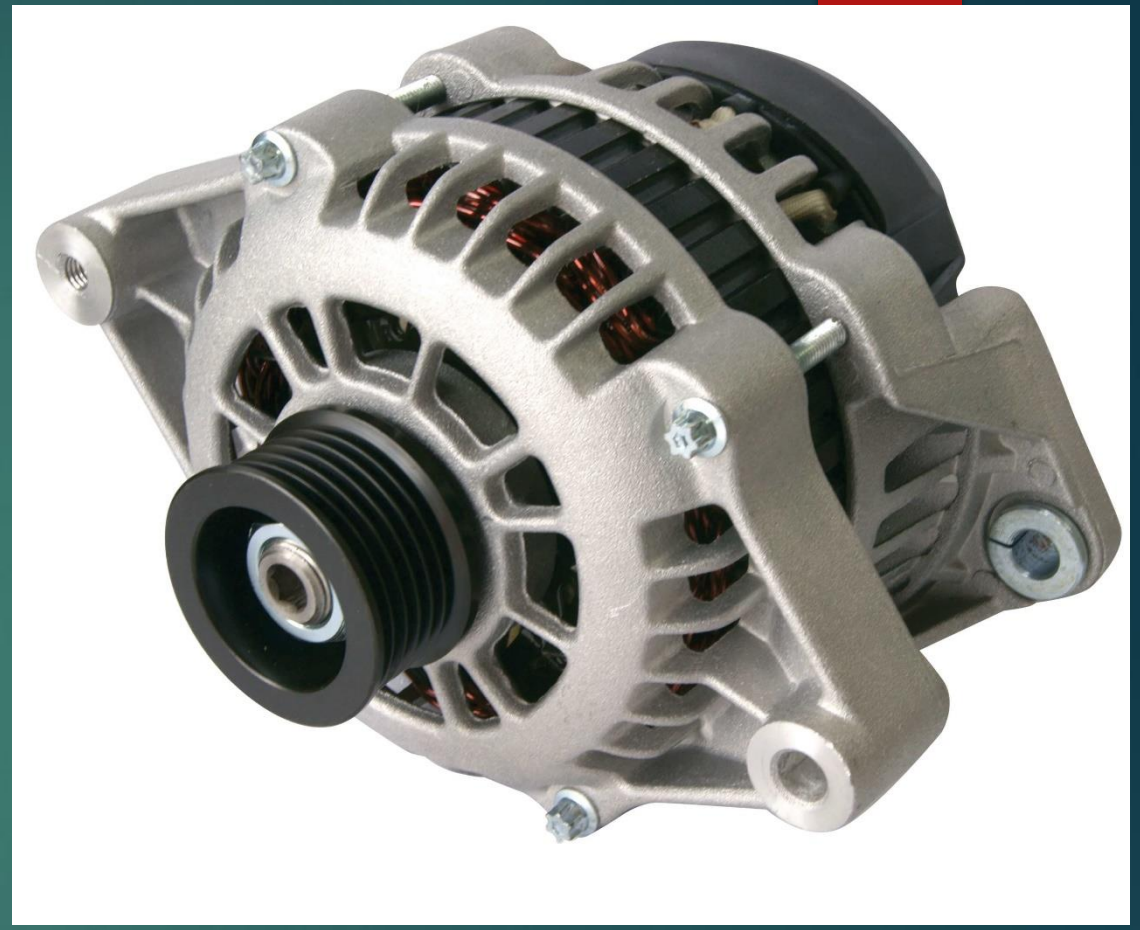
AUX BATTERY

- Small AGM battery located in trunk similar in size to motorcycle but much different in function

- Uses this battery for accessories when engine is shut down & then isolate main battery to keep from discharging ……..since it will be needed for engine restart

CHARGING SYSTEM

- Alternator
- Belt driven from engine
- Recharges battery after start
- Powers all accessories after start up
- Some have de-coupler pulley (NOISE)
- Symptoms of failure
  - Battery light on
  - Dead battery
  - Noise internally
- Has internal parts that wear out over time !

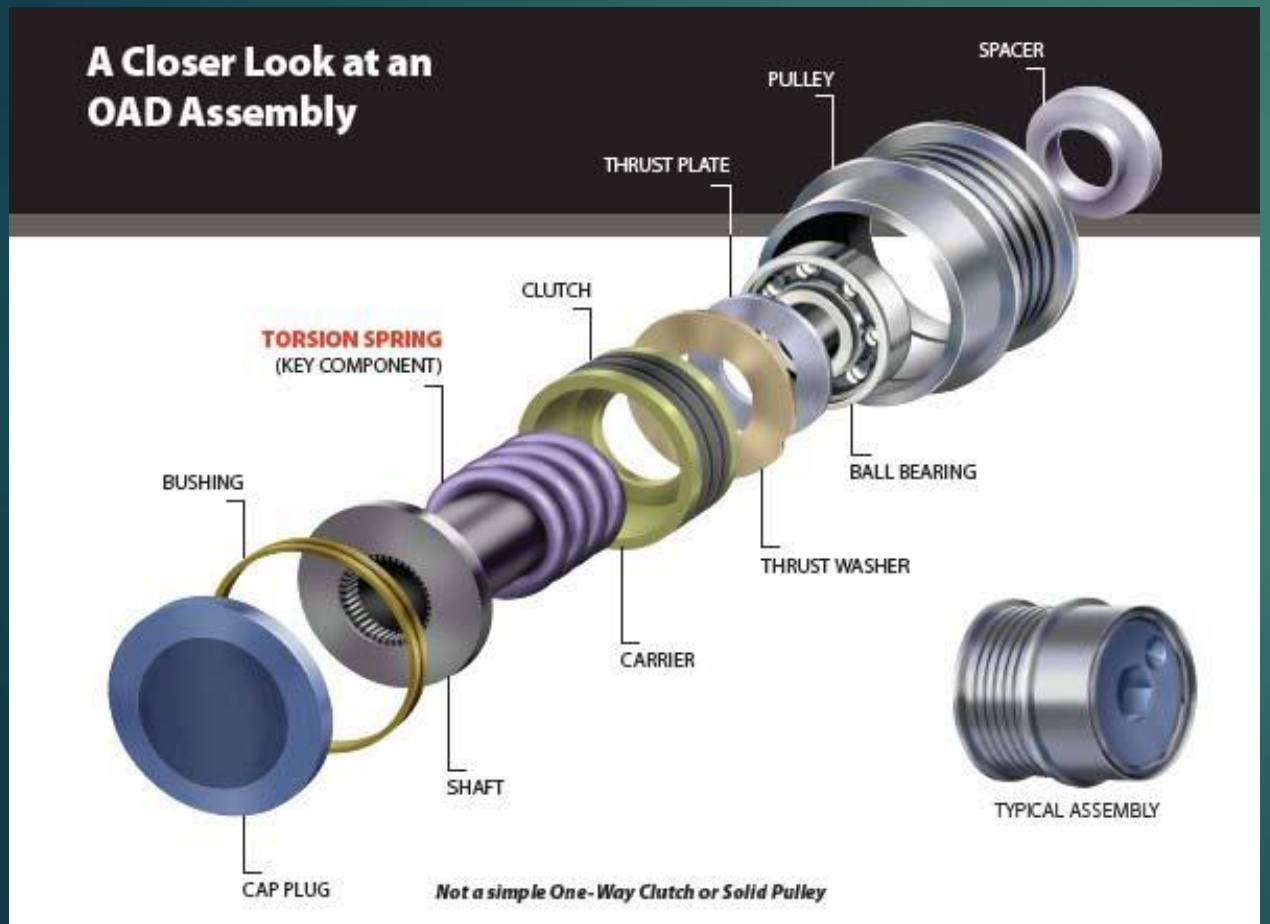


Charging System Faults

- Undercharging leads to low battery voltage
- Overcharging leads to battery and/or component damage
- Both problems can be caused by the regulator

Alternator De-coupler Pulley

- OAP (Overrunning Alternator Pulley)
- OAD (Alternator Decoupler Pulley)



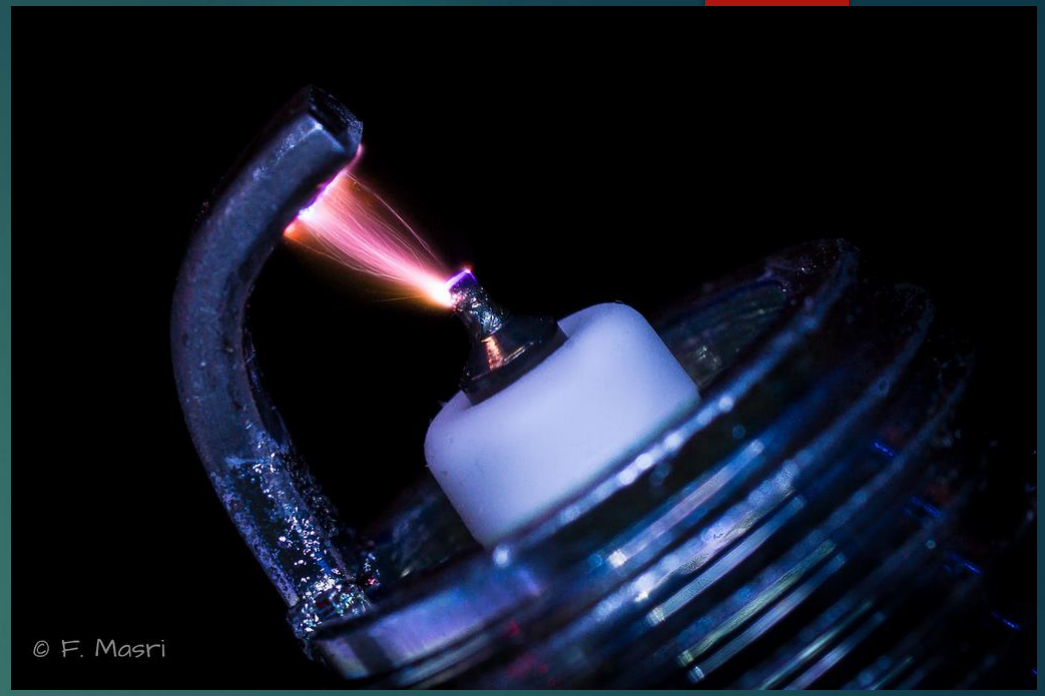
Alternator De-coupler Pulley

Signs of a failing OAP (Overrunning Alternator Pulley) or OAD (Alternator Decoupler Pulley)

- Unusual Belt Noises (Serpentine belt)
- Unusual Vehicle Vibrations
- Undercharging
- Pulley Spins in both directions

Ignition system

- Ignites the air/fuel mixture for combustion
- Must be timed to ignite on compression stroke of engine
- High voltage to jump spark plug gap
- Ramps up voltage with use of a transformer called ignition coil
- Uses several engine sensors to determine proper timing



Parts

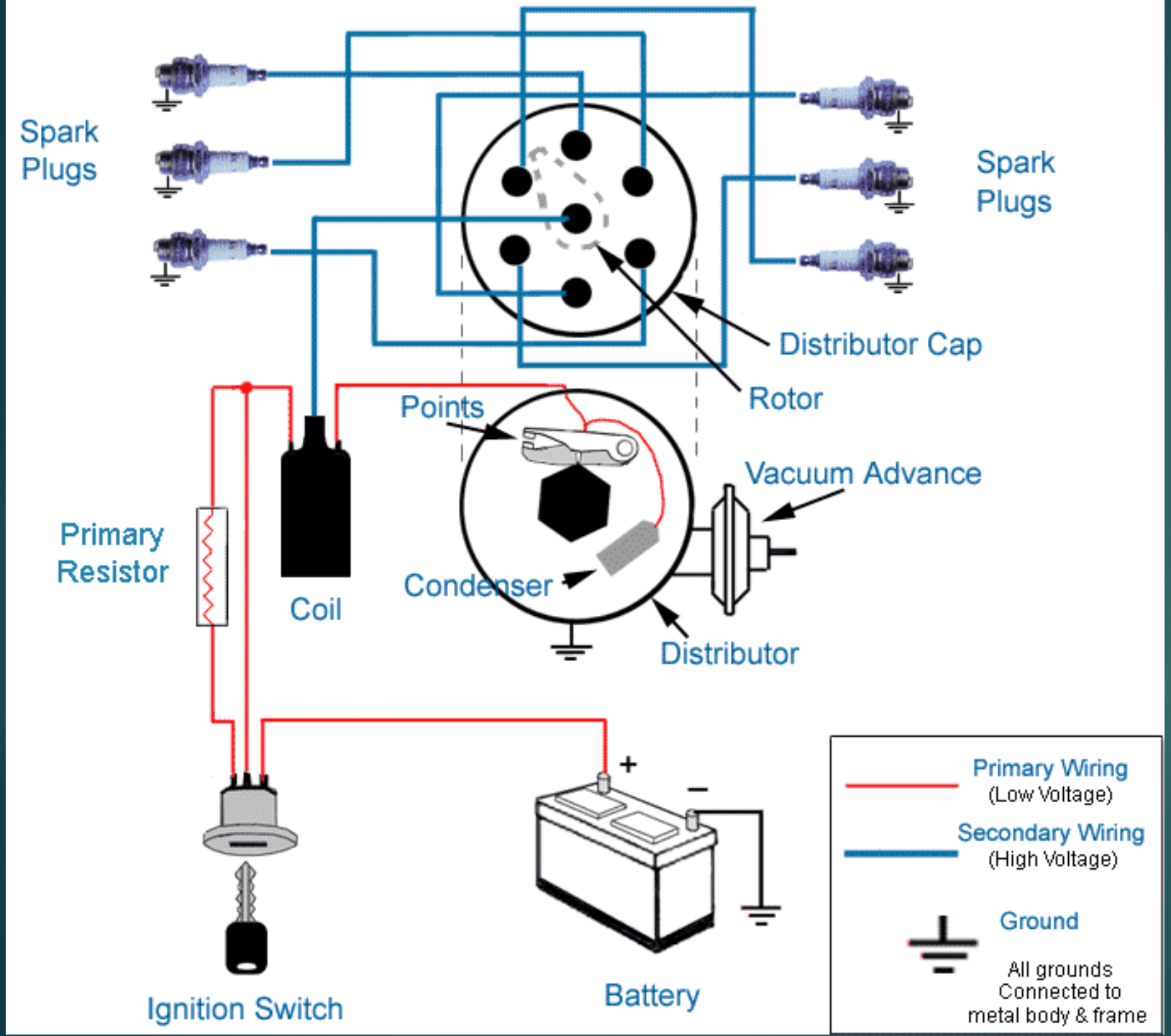
- Battery
- Ignition Coil
- Spark Plugs, Distributor, Ignition Cables
- Trigger
  - Points
  - Ignition Control Module
    - Pulse Generator
    - Hall-Effect
    - Photo Optic

Ignition coils

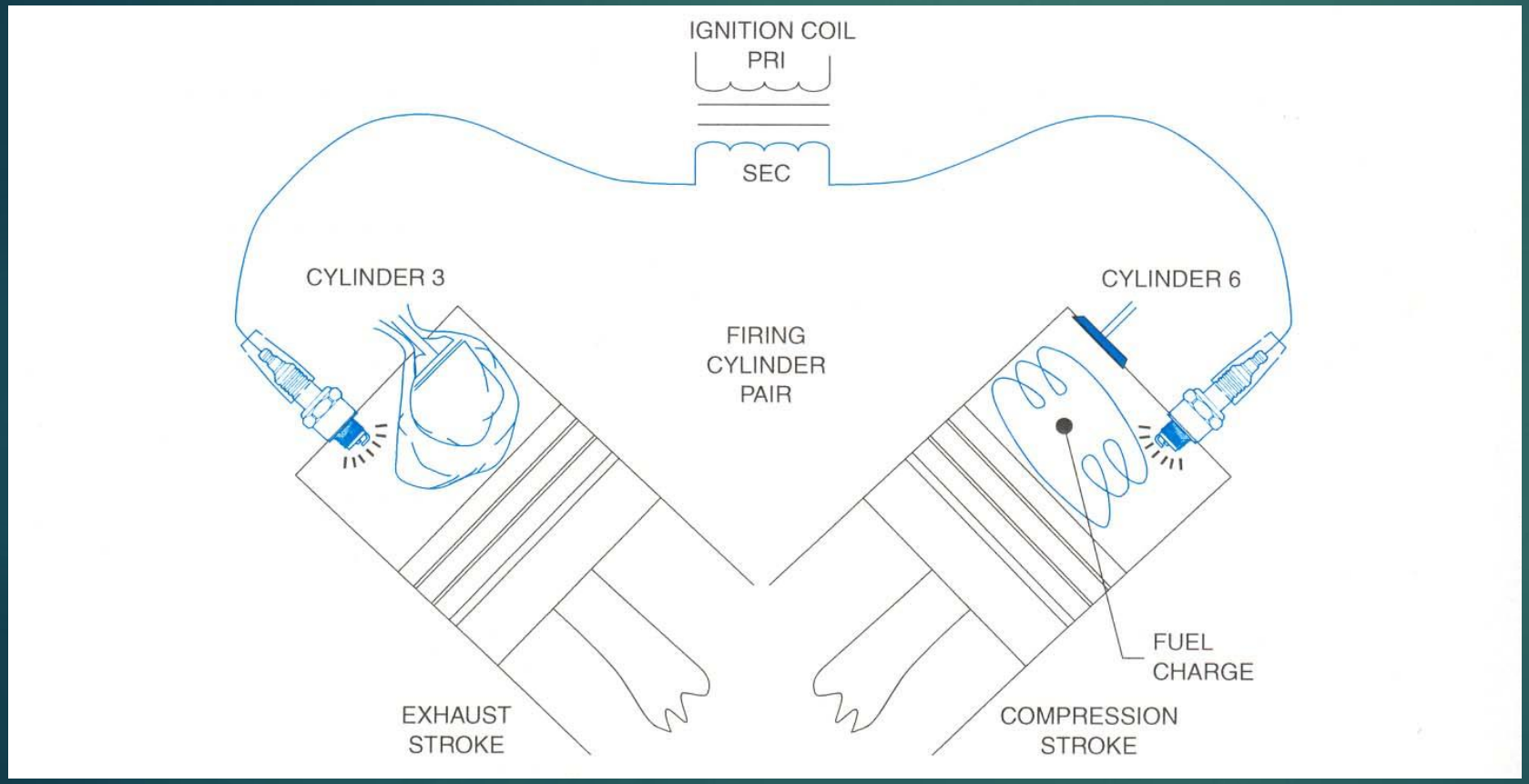
many different shapes and sizes

Firing Order

- Determined by crankshaft and camshaft design.
- Often cast into the intake manifold for easy reference.


Spark Plugs
Spark Plugs
Distributor Cap
Rotor
Points
Vacuum Advance
Primary Resistor
Coil
Condenser
Distributor
+
–
Ignition Switch
Battery
Primary Wiring
(Low Voltage)
Secondary Wiring
(High Voltage)
Ground
All grounds
Connected to
metal body & frame

Waste Spark


IGNITION COIL
PRI
SEC
CYLINDER 3
CYLINDER 6
FIRING
CYLINDER
PAIR
FUEL
CHARGE
EXHAUST
STROKE
COMPRESSION
STROKE

Ignition System Maintenance

- Spark plugs will wear over time
- Spark plug wires
- Ignition cap and rotor wear out with time

- Ignition coils - can be damaged if maintenance is not performed

- Misfire can cause an engine performance issues & Check Engine lights

Types of Spark Plugs

- Copper
  - 20-30k Miles
- Sliver
- Platinum (Double)
  - Single 60k Miles
  - Double 100K Miles
- Iridium
  - 100k-120K Miles

OEM may Specify 30K -120K Miles
Regardless of Spark Plug Type

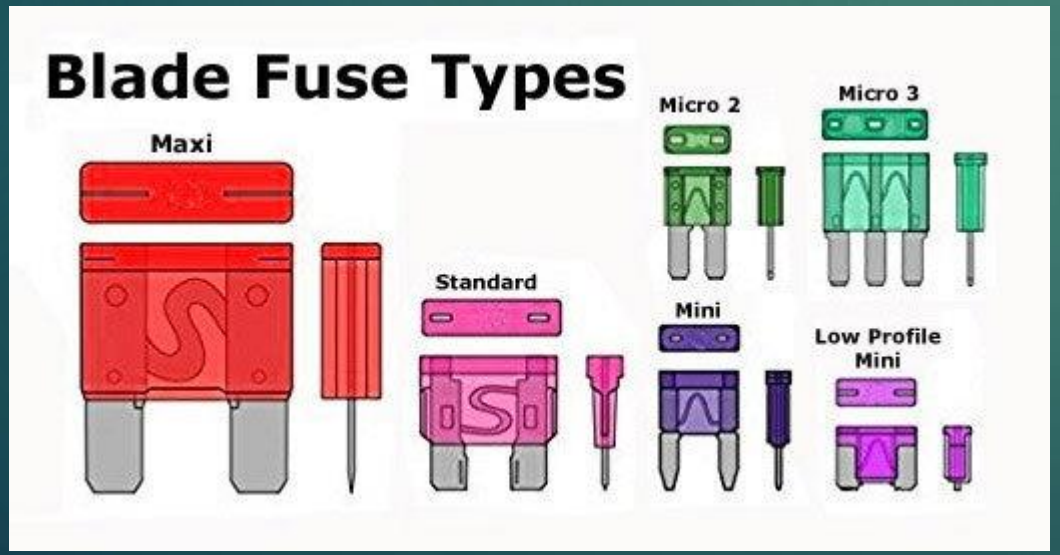

BKR7E

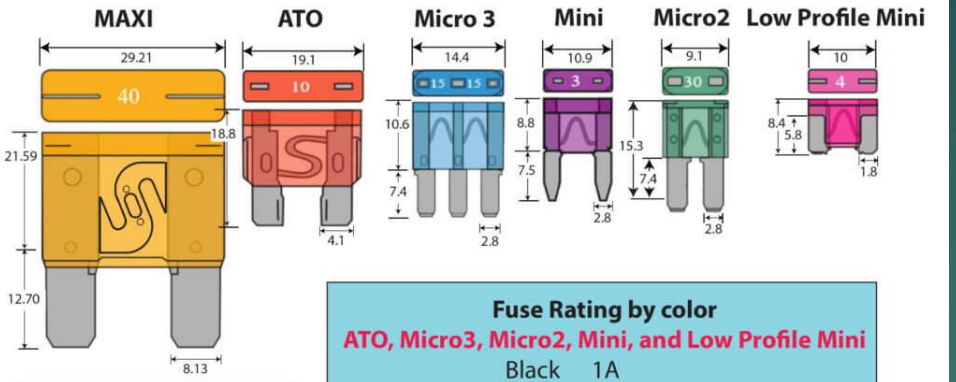
Knock Sensor

- Detects abnormal combustion
  - Ping, spark knock, or detonation.
- Abnormal combustion causes piston slap and vibration
- Knock sensor detects the vibration
- The voltage signal from the knock sensor (KS) is sent to the PCM
- PCM retards the timing under knocking conditions

Automotive Fuses

- Protect circuit from damage caused by excessive current flow from shorts or malfunctions.
- Rated at their maximum current flow.
- The Circuit Current must be lower than the Fuse rating.



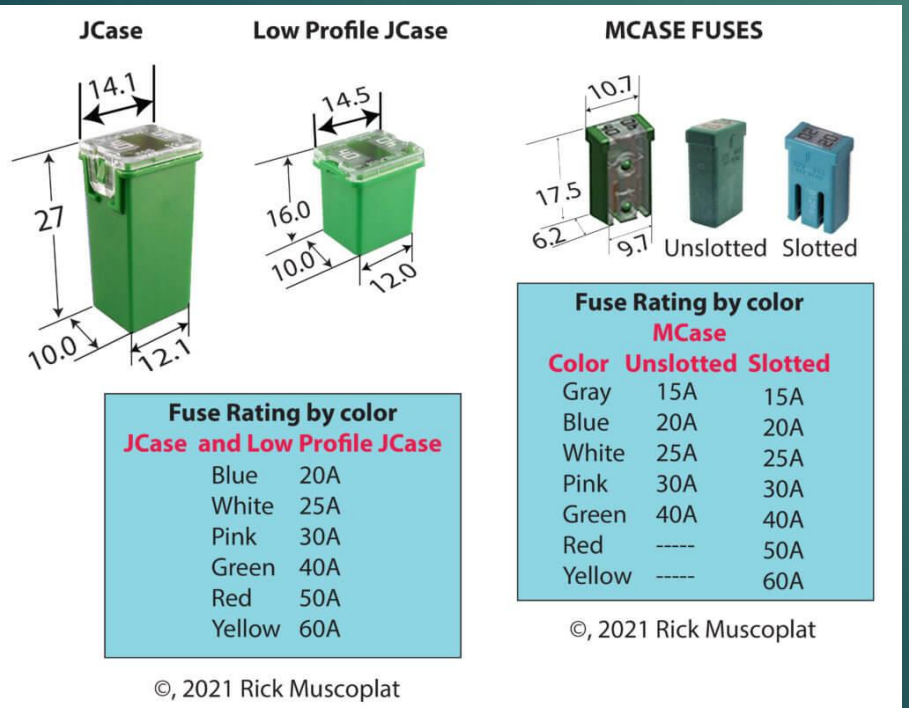


Fuse Rating by color
MAXI Fuse

Tan	70A
Red	50A
Blue	60A
Yellow	20A
Clear	80A
Green	30A
Orange	40A

Fuse Rating by color
ATO, Micro3, Micro2, Mini, and Low Profile Mini

Black	1A
Gray	2A
Violet	3A
Pink	4A
Tan	5A
Red	10A
Blue	15A
Yellow	20A
Clear	25A
Green	30A



Fuse Rating by color
JCase and Low Profile JCase

Blue	20A
White	25A
Pink	30A
Green	40A
Red	50A
Yellow	60A

Fuse Rating by color
MCase

Color	Unslotted	Slotted
Gray	15A	15A
Blue	20A	20A
White	25A	25A
Pink	30A	30A
Green	40A	40A
Red	-----	50A
Yellow	-----	60A

Questions?