

The Electrical System

by Kate Elfers and Mun Yong Jang

Important links:

- Video overview of system: <https://www.youtube.com/watch?v=W94iksaQwUo>
- Understanding AC vs DC animation: <https://www.youtube.com/watch?v=JZjMulHoBeg>

What are the key components in the electrical system?

Switch

Battery

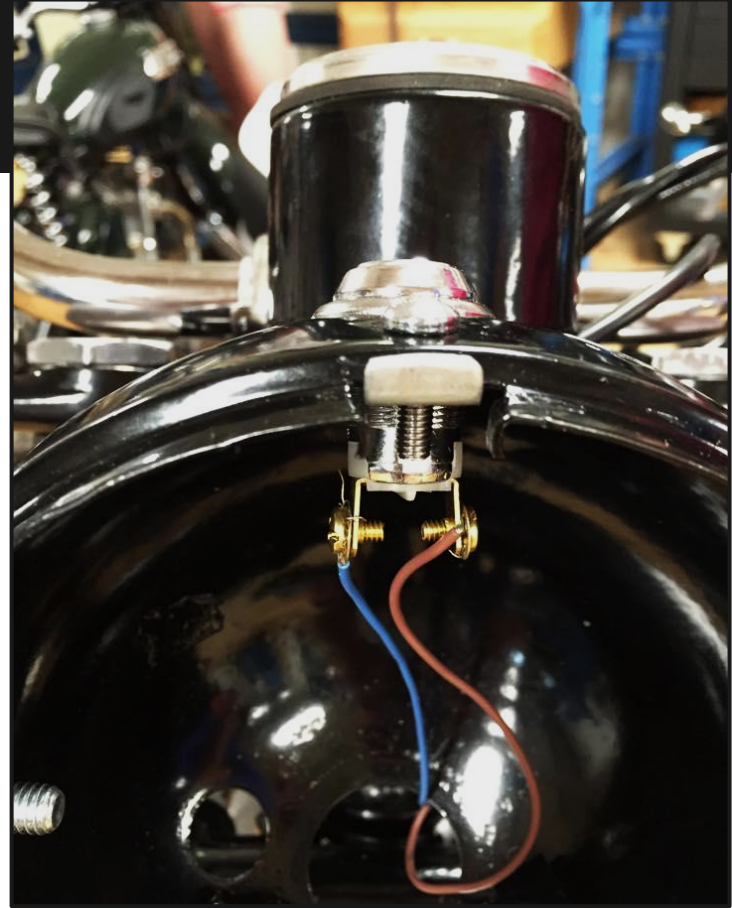
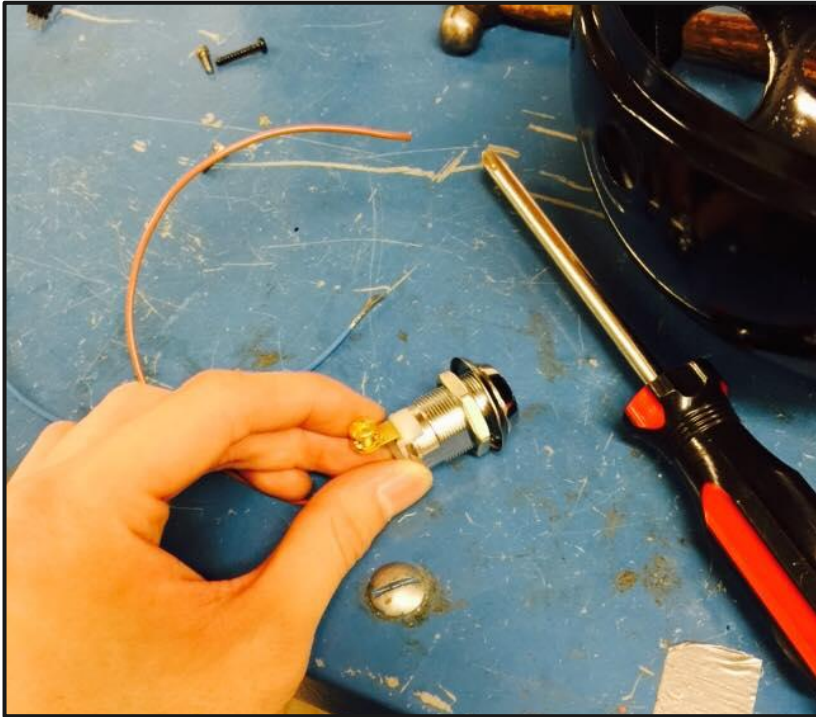
Alternator (Stator and Rotor)

Coil

Points (Contact Breaker)

Spark Plug

The Switch



The Switch

We had to wire this on/off switch into the circuit of the motorcycle. When turned on, it allows the ignition system to work.

This was very simple to do. Steps to install/work it:

1. Place the switch in the path from the battery to the coil
2. Turn the switch off: circuit is opened and the battery is disconnected from the coil
3. Turn the switch on: the circuit is closed and the battery is connected to the coil

The Battery

Powers the ignition

6 Volt

3 Cells



The Battery

Description:

It has 3 cells with 2 volts each, summing up to 6 volts. Each cell can be seen in the previous slide's picture as the yellow shapes on the top of the battery.

Testing the battery:

When we measured the volts of the battery with our voltmeter, we got a higher reading (around 9 volts) than the predicted voltage.

Possible errors: this could have been because the battery was completely new or our voltmeter could have been off.

Precautions:

While installing, we had to make sure it didn't short circuit (this would cause a fire). We also taped a rubber sheet over the top to ensure that there would not be a connection with the metal casing, which could be dangerous.

Battery vs. Energy Transfer System

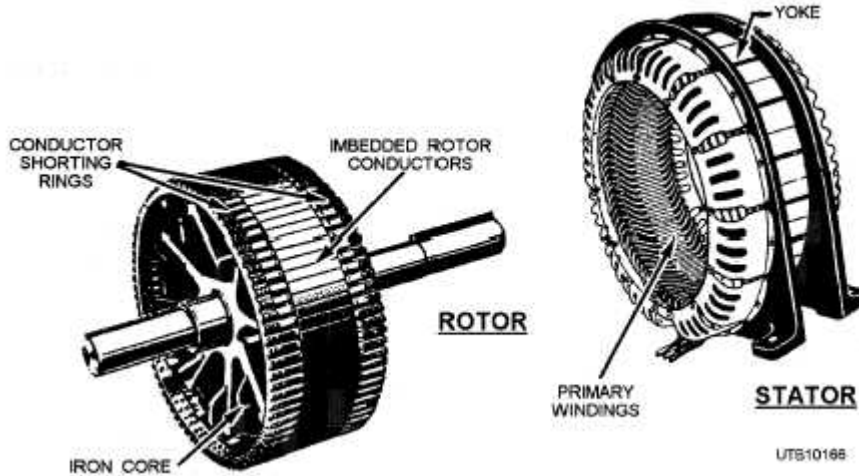
Our bike is powered by a battery– but are all?

Another set-up: energy transfer

- No battery/rectifier, instead AC is supplied directly from the alternator
- Different coil needed
- Pros: compact and reliable
- Cons: requires more maintenance due to wear on points

The Alternator

Stator and the Rotor



The Alternator

The alternator has two parts: 1) the stator 2) the rotor

The stator: a circle of 6 coiled copper wires that stays stationary-- thus the name stator.

The rotor: a six pole magnet that's connected to the crankshaft. As the crankshaft spins, the rotor spins as well.

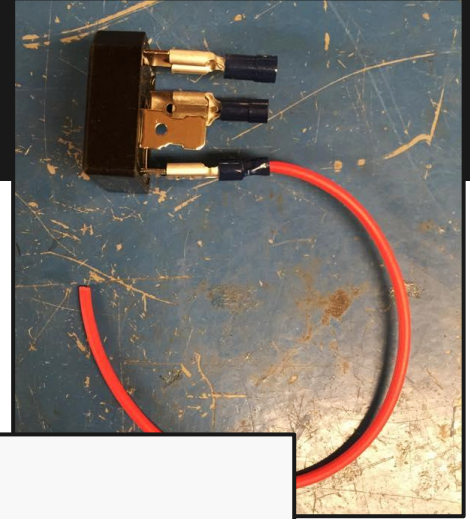
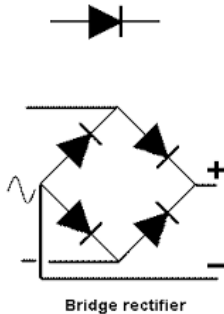
How do they work?

As the rotor spins inside the stator, the rotor creates a change in the electromagnetic field around the stator. By Faraday's law, the change in electromagnetic field creates current in the copper wires, which then results in voltage. The current that it generates is AC current, which is different from DC current in the sense that the direction of the voltage reverses.

The Rectifier

Converting AC to DC

- AC: “alternating current” changes directions
- DC: “direct current” flows in one direction, + => -
- AC has a sinusoidal wave, so the rectifier’s DC output current goes in one direction
 - This is basically achieved with 4 diodes.



The Rectifier: AC vs. DC

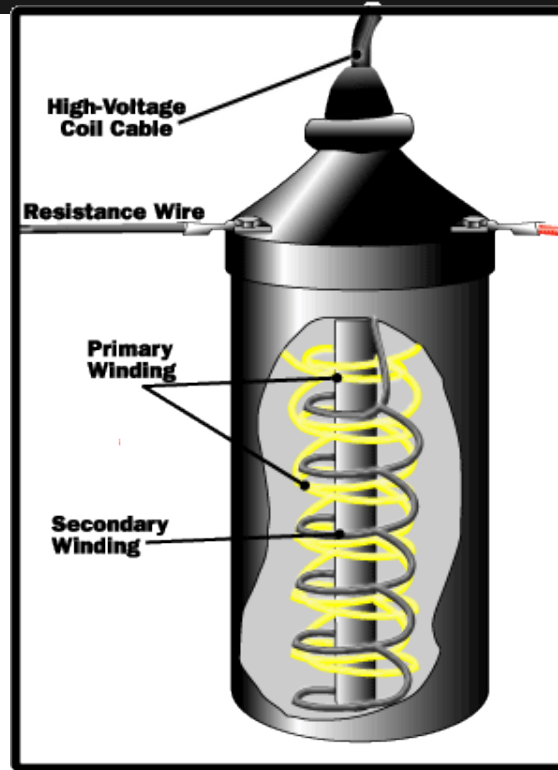
The rectifier allows us to change AC into DC. But how? It basically utilizes four diodes in order to achieve this. Regardless of the direction of the voltage that comes from the AC, the rectifier creates a steady stream of single-directional voltage.

Diodes: one way valve, helps the one direction

The Coil

Induction to generate high voltage needed for the spark plugs:

- Primary Coil
- Secondary Coil (100x more turns than primary)



The Coil

Why is it so important?

It creates the high voltage that is necessary to generate a spark in the spark plugs.

How?

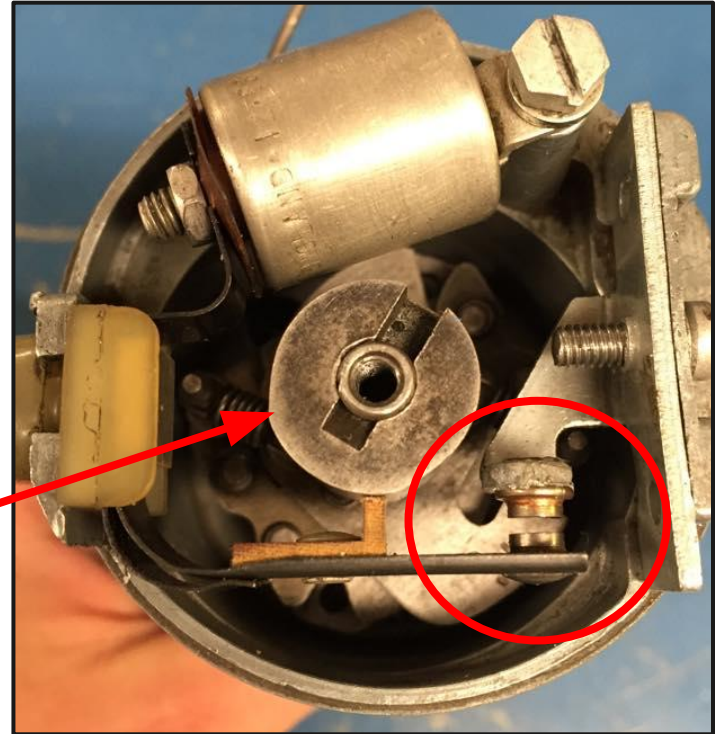
Induction! Within the coil there are two coils of copper:

- The primary winding
- The secondary winding
- The ratio between the two winding is what causes the voltage leverage. If it is 1 to 1,000, the 1 volt in the primary winding will become 1,000 volts in the secondary winding.

The Points (Contact Breaker)

Controls the timing of the
spark plug

Points cam: rotates to open/
close points



The Points

Where?

- Located in the distributor.

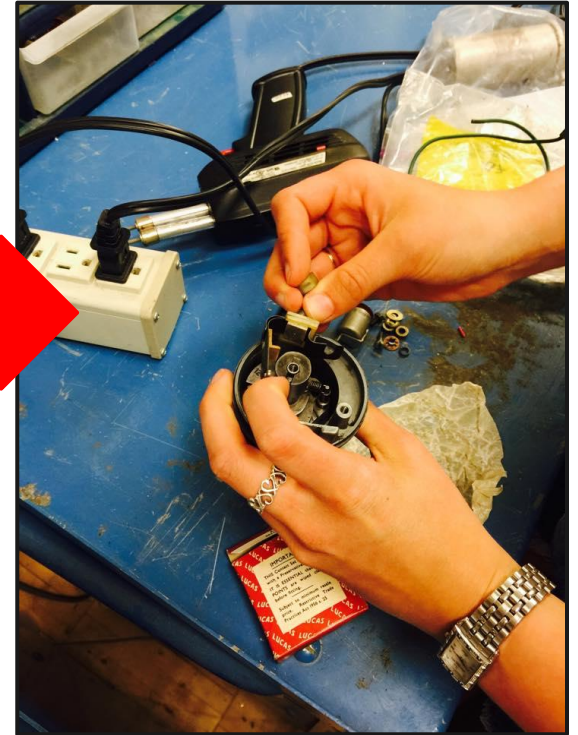
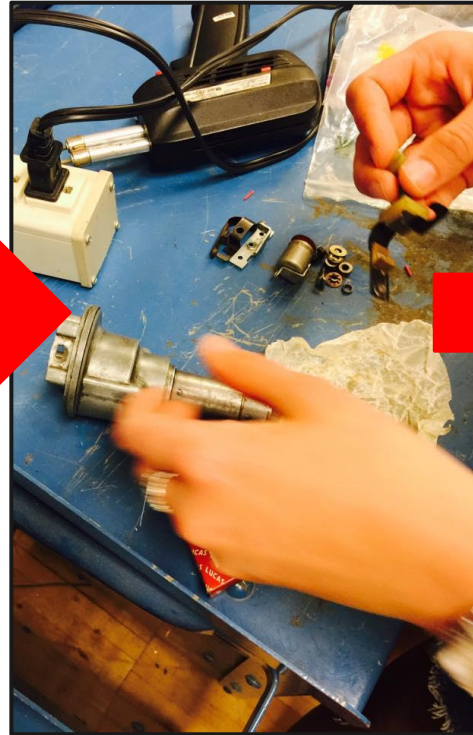
Purpose:

- These work with the coil as well as the spark plugs in order to produce the sparks. While the coil and the spark plugs work with the creation of the spark itself, these work with the timing of the high voltage that is needed to create the sparks.

How it achieves this:

- The points close and open with respect to the RPM of the motorcycle. The timing of these points also happens to depend on the centrifugal advance mechanism that we'll discuss momentarily

Assembling the Points



Assembling the Points

Some difficulties we had:

- We were using new parts of the distributor because on our original one, part of the small pillars was broken, so it would not be as stable. Therefore, we used a new shaft, however we had to spend time shaving down the shaft in order to allow it to spin without sticking in the distributor.
- We also had to adjust the shape of the metal plate that held one of the points in order to match up the points perfectly since after originally placing them into the distributor, we realized they were not perfectly laterally matched up
- We had to adjust the height of the wood lever that pushes the points off of the cam in order to make the gap between our points smaller

The Distributor & Centrifugal Advance Mechanism

Springs and Weights

- Higher RPMs
 - Lighter Weights and/or Stronger Springs
- Lower RPMs
 - Heavier Weights and/or Weaker Springs

Optimal Spark timing

- Right Before Top Dead Center
 - These weights and springs work together to produce the advance



How does it work?

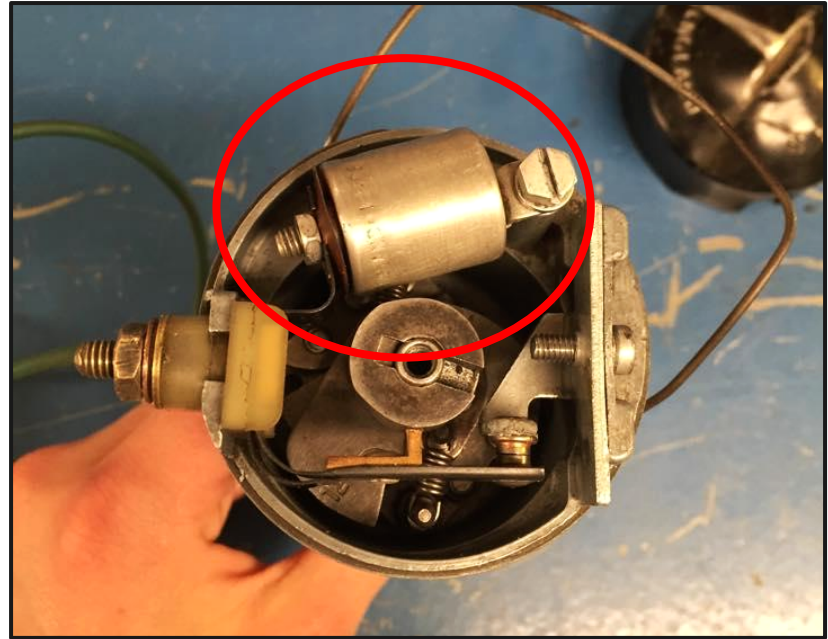
The distributor has **weights** and **springs** that allow for ignition to be advanced slightly at higher RPMs.

How does the centrifugal force come into play?

As the distributor rotates at a higher RPM, the weights get pushed out by centrifugal force, causing the springs to stretch out. This causes the ignition timing to be slightly advanced as the platform holding the cam get also rotated for the advance.

The Capacitor

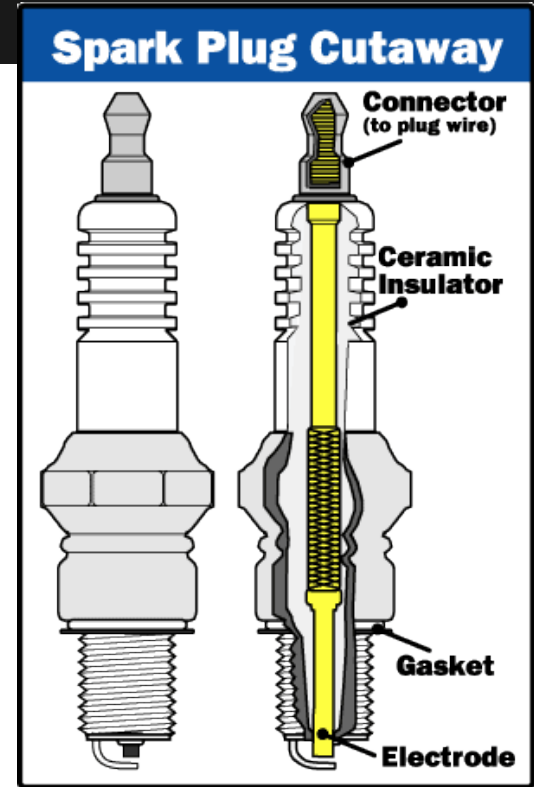
The capacitor is needed to create an LC circuit, with the coil being the inductor.



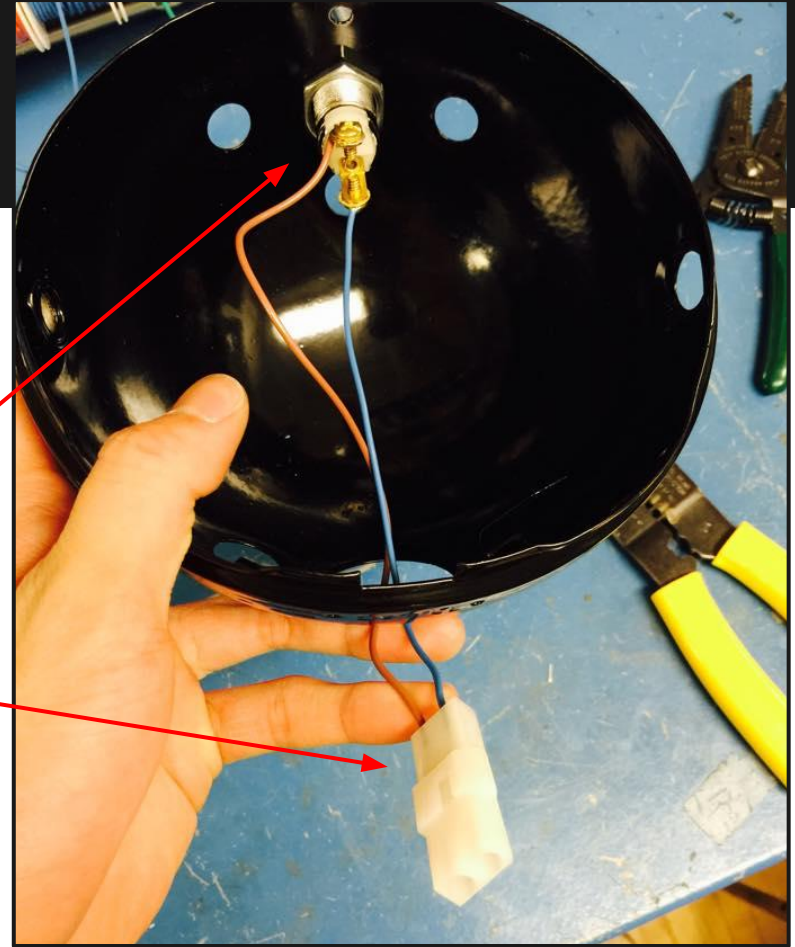
The Spark Plug

Creating the spark

- It forces electricity to cross a gap (high voltage needed)
- Insulated pathway needed to allow high voltage get to the electrode, so that the spark can only happen at the tip
- From electrode, voltage “jumps the gap” to engine block => spark!



The Headlight



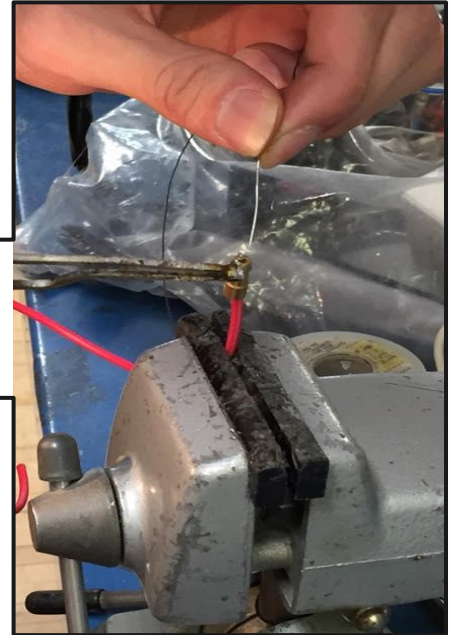
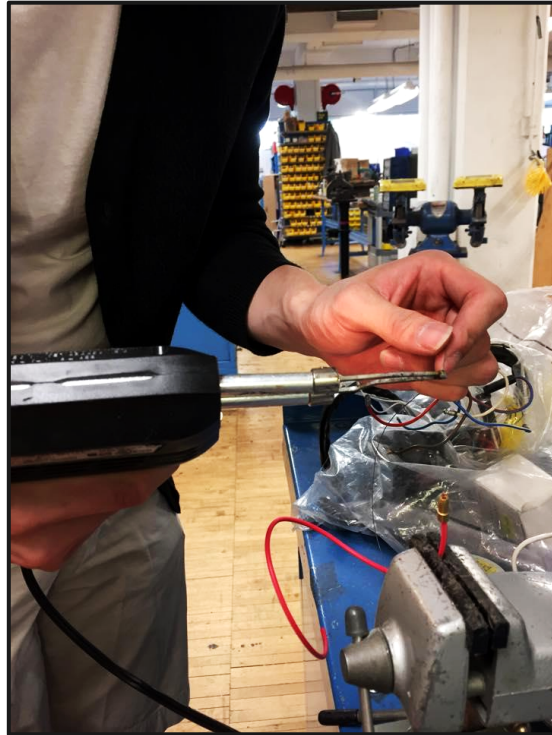
Summary of the whole system

So how do all these parts function together?

Basically, when the ignition system is turned on by the **switch**, it allows the **coil** and the **battery** to be connected. As the **distributor** turns and the **contact breakers** are connected and disconnected, this allows the higher voltage to be created within the coil that is necessary for the spark to be generated from the **spark plug**.

Some Techniques We Used

Soldering:















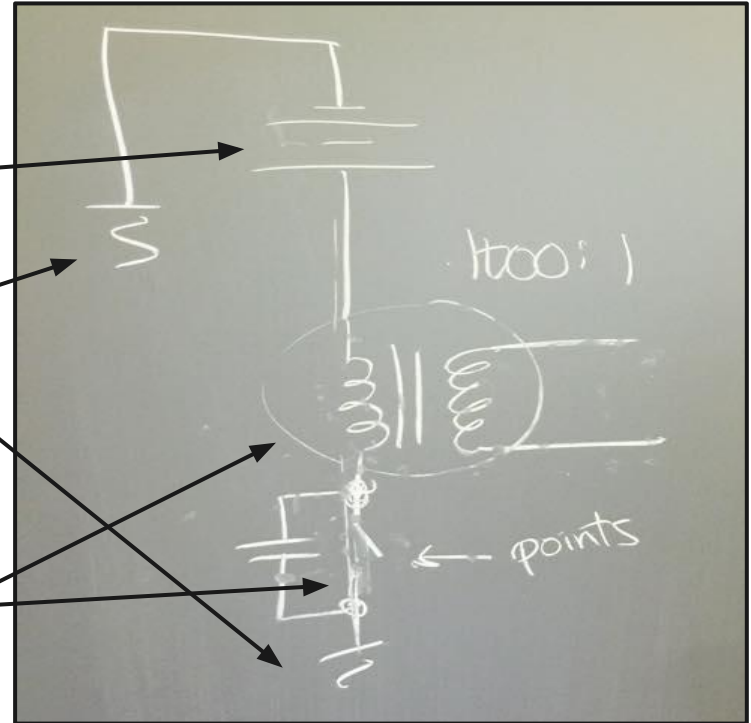
Soldering

- Purpose: attach bullet connectors to wires in order to attach wires to each other
- Where did we use it?
 - Working on the wiring harness connecting all of the parts
 - Specifically attachments in the headlight and from the battery

Some Techniques We Used

Reading Circuit Diagrams:

Component	Symbol
Battery	
Capacitor	
Diode	
Ground	
Interconnections	
Light-emitting diode (LED)	
Light dependent resistor	
Phototransistor	
Resistor	
Speaker	
Switch, SPST	
Transistor, NPN	



Some Techniques We Used

Circuits and equations:
what do all these
variables mean?

Electronics Calculations Using Ohm's Law and Joule's Law

These equations, using Ohm's Law and Joule's Law, are the most useful you'll find in electronics. They come in handy all the time for checking what's going on in your circuits.

Unknown Value	Formula
Voltage	$V = I \times R$
Current	$I = V/R$
Resistance	$R = V/I$
Power	$P = V \times I$ or $P = V^2/R$ or $P = I^2R$

where:

- V = voltage (in volts)
- I = current (in amps)
- R = resistance (in ohms)
- P = power (in watts)

Bibliography

Videos: courtesy of Youtube.com

Symbols and equations key: <http://www.dummies.com/how-to/content/electronics-for-dummies-cheat-sheet-uk-edition.html>

Photos of our motorcycle parts: Mun and Kate

Inside of coil picture: <http://auto.howstuffworks.com/ignition-system3.htm>