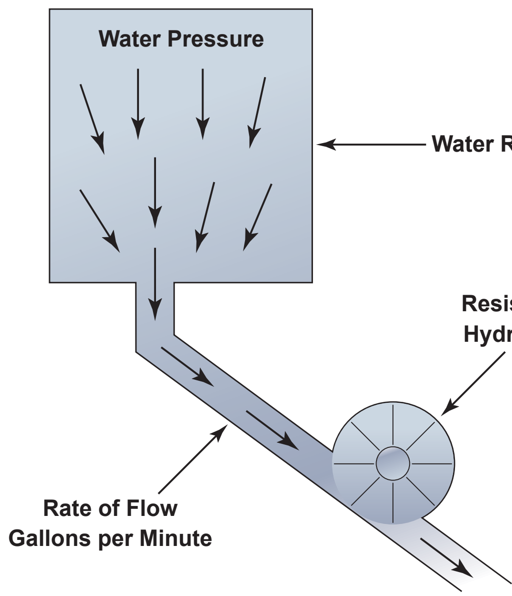
ELECTRICAL THEORY – PART 1

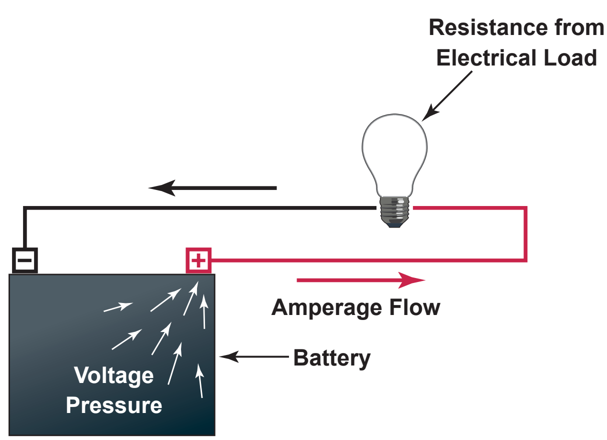
Current Flow

In order for current to flow, there must be a surplus of electrons located at the starting point of the current flow. In other words, atoms that have an overall negative charge must be located at a starting point.

How Electrons Flow
"Water Pipe Illustration"



How Electrons Flow
"Electrical Circuit Illustration"



Water flow in a hydroelectric plant - such as the one at Niagara Falls - is very similar to the way electrons flow through an electrical circuit. ***Water pressure*** *is similar to* ***electrical voltage pressure****.* ***Water flow*** *is similar to* ***electron flow*** *measured as amperage.* ***Resistance*** *at the hydroelectric motor is similar to the resistance that electrons encounter when running through an* ***electrical load.***

Secondly, there must then be a shortage of electrons located at the end point of the current flow. In other words, atoms that have an overall positive charge must be located at the end point. Think of the positive charged atoms as the bait to attract the negatively charged atoms.

Remember, atoms with a negative charge (having surplus electrons) will be attracted to atoms with a positive charge (having a shortage of electrons).

So how is this surplus and shortage of electrons created so we can get the atoms to travel and energize loads? The surplus and shortage is created inside the battery. The battery is the beginning and end of electrical flow.

All electrical current flow through a motorcycle begins and ends in the battery. The battery is the supply source for all electrical current flow.

Battery plates located inside the battery are used as starting points and ending points for current flow. Battery plates that have an overall negative charge will be the starting point of current flow. Battery plates that have an overall positive charge will be the ending point of current flow.

Different types of battery plates will receive either a negative or positive charge as follows:

1) Battery plates located on the **negative** side of the battery will receive a **surplus of electrons** – these plates will receive **negatively charged atoms.** The negative side of the battery consists of the negative plates inside the battery, and the negative terminal on top of the battery.

2) Battery plates located on the **positive** side of the battery will receive a **shortage of electrons** – these plates will receive **positively charged atoms**. The positive side of the battery consists of the positively charged

plates inside the battery, and the positive charged terminal on top of the battery.

A very simple picture of current flow can be best illustrated using a battery, an electrical wire, called a conductor, and a light bulb.

Electrons begin their journey from the negative battery terminal, through the electrical wire, and through the light bulb filament which “lights up”. After passing through the light bulb filament, the electrons return through the electrical wire, and back to the positive battery terminal to complete the circuit. The current flows from negative to positive in this example.

The surplus of electrons on the negative side of the battery will be attracted to the shortage of electrons at the positive side of the battery. The “free electrons” that are all “piled up” on the negative side of the battery are anxious to travel to the positive side of the battery where there is “more room”.

The chemical reactions inside a battery that cause the buildup of electrons at the positive terminal will be discussed in detail in the chapter on batteries.

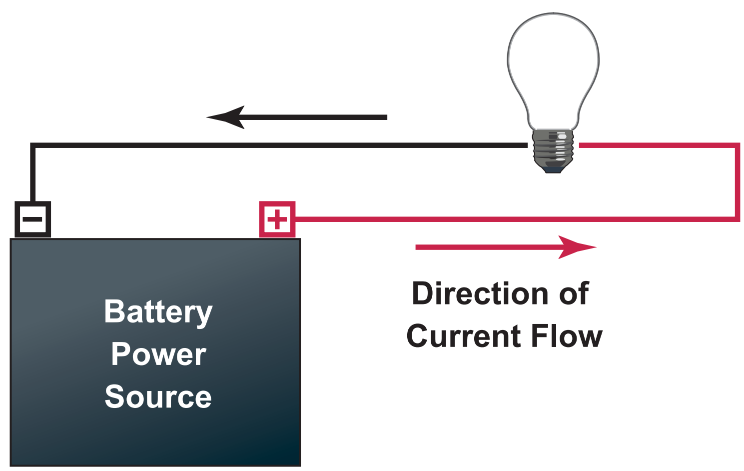
Theories of Electrical Current Flow

There are two fundamental theories of electricity, the Conventional Theory and the Electron Theory.

The “Conventional Theory” claims that current (free electrons) flow from a substance with a positive charge, through a conductor, to a substance with a negative charge. The conventional theory of current flow is used in motorcycle mechanics, automotive mechanics, and in the power sports industry.

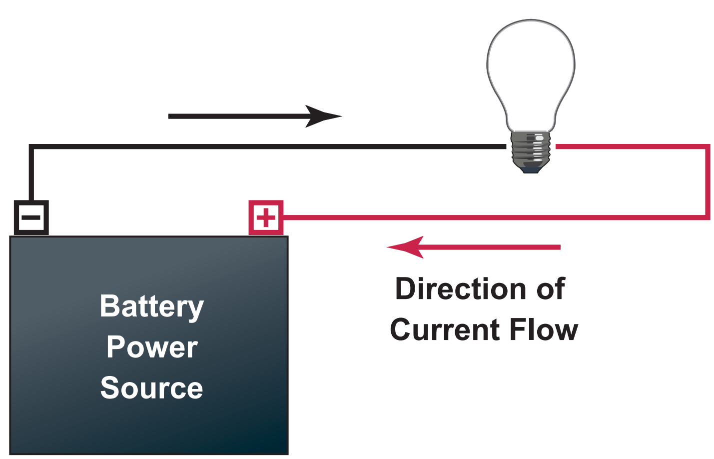
However, another theory of electrical flow - the “Electron Theory” - is the foundation of electronics. The electron theory simply states that current flows from a substance with a negative charge (more electrons) to a substance with a positive charge (fewer electrons) at the atomic level. It states that the reason electricity flows is that there is an excess of electrons in one area that will automatically flow to an area with fewer electrons.

Conventional Theory of Electron Flow



The "conventional theory" of current flow claims that current flows from positive to negatively charged substances.

Electron Theory of Electron Flow



The “electron theory” of current flow claims that current flows from negative to positively charged substances.

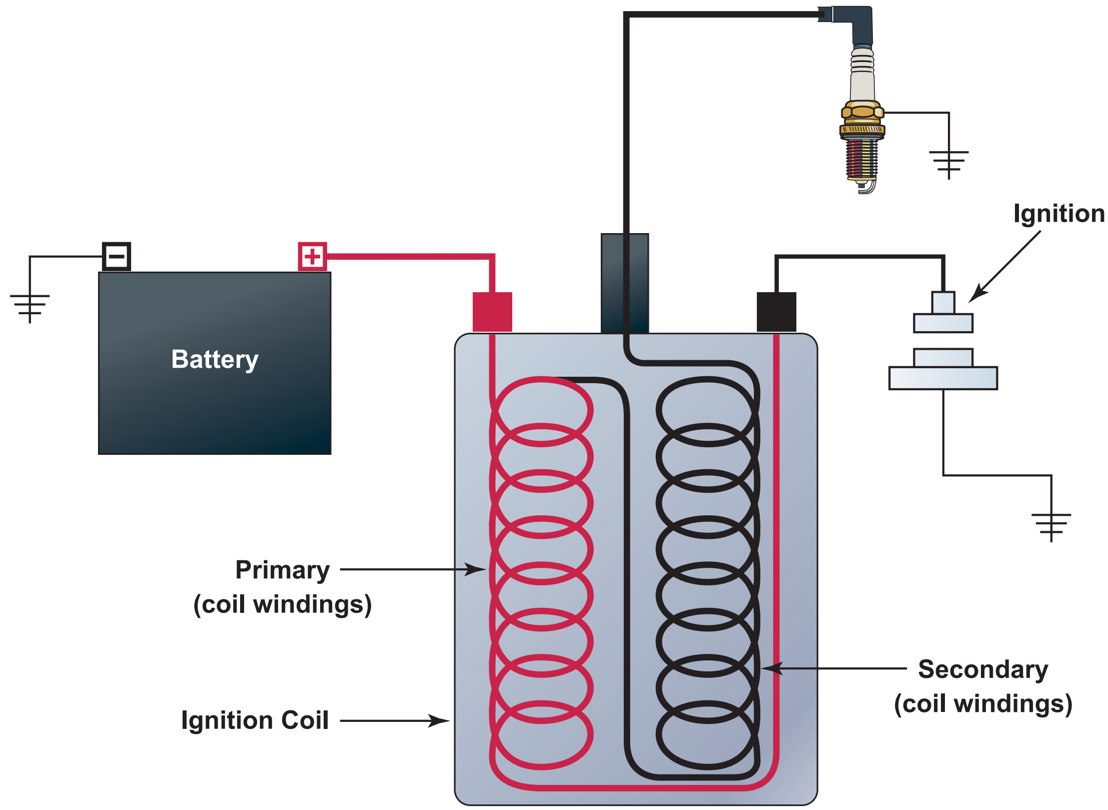
The electron theory is the most widely accepted theory of electrical flow. Both theories are used, and it does not make any meaningful difference as to which theory is referred to in practice. In other words, it does not really matter which direction the current flows. Electricity is simply the flow of electrons.

MUTUAL INDUCTION

Ignition System: Coil (Primary and Secondary)

The coil of an ignition system produces massive voltage of roughly 10,000 to 45,000 volts – the voltage needed to fire the spark plugs. This amount of voltage is produced by harnessing the electrical phenomenon of mutual induction. The mutual induction reaction is used in a “field collapse” type of ignition system.

Basic Ignition System



A motorcycle coil uses the principle of mutual induction to generate the 15,000 volts and more that is used to fire the spark plug. Coarse primary windings surround many turns of finer secondary windings. (The windings are separated here for illustration purposes.) Both windings surround a common iron core. When the ground return path is switched off by the ignition module, current is stepped up to many thousands of volts and travels through the spark plug gap where the current finds ground again.

There are two coil windings in the typical coil. These windings represent two ignition circuits called the primary ignition circuit and the secondary ignition circuit.

The primary circuit coil windings consist of roughly 200 turns of coarse copper wire. The secondary circuit coil windings consist of about 20,000 turns of fine copper wire. The thicker primary windings surround the fine secondary windings inside the coil.

The” field collapse” ignition process begins when low voltage from a battery or magneto flows through the primary windings of the coil – the primary circuit. This current flowing through the wire creates a magnetic field.

When it is time to fire the spark plug, an electronic switch (an ignition module) or mechanical points turns off the current to the primary windings. This causes the magnetic field in the primary windings to collapse. This collapsing of the magnetic field causes a voltage spike of about 300 volts.

The voltage spike in the primary windings is then “induced” into the 20,000 turns of fine copper wire in the secondary coil circuit. These fine secondary windings “step up” the 300 volts to the roughly 10,000 to 45,000 volts needed to fire the spark plugs. **In this process, the primary coil windings induce voltage into the secondary coil windings. This is the phenomenon called “mutual induction”.**

Mutual induction is the electrical process used in a transformer. The ignition coil is basically a small transformer.

The two sets of coil windings are linked together with a magnetic “flux” field. The change in the primary circuit - which involves turning off the current to the primary circuit – causes the inducing of voltage into the secondary coil windings.

Because the two sets of coil windings are close together, most of the magnetic flux generated in the primary coil windings will interact with the secondary coil windings. This would not be the case if the primary and secondary coil windings were located further apart. If such were the case, the induced current would be much weaker.