IGNITION SYSTEMS – PART 1

IGNITION SYSTEM OVERVIEW

High Voltage Is Required

Spark plugs require high voltage in order to produce the spark needed to ignite the air-fuel mixture in an engine. The 12 volts that are available in a 12 volt battery are not enough to overcome the high resistance of the big “air gap” between the spark plug electrodes. It takes massive voltage to be able to jump the gap and thereby create a spark.

It is the job of the ignition system to produce the high voltage needed to produce a spark. The ignition system also controls the delivery and timing of when the spark is produced in the combustion chamber.

Todays’ ignition systems take 12 volts of battery voltage, step it up to roughly 10,000 to 45,000 volts or more, and then deliver this voltage at a precise time to the spark plug.

Spark Timing

In addition to stepping up voltage, a primary function of the ignition is to control the timing of when the coil will deliver high-voltage current to the spark plug. Ignitions are basically a switching mechanism to control spark timing.

Because combustion takes time, ignition must happen a few degrees before top dead center on the compression stroke so that combustion is completed at the optimum moment to create the most power.

As engine speed increases, and the compression stroke occurs much faster, the spark must be triggered even earlier so there is enough time for the air-fuel mix to burn.

If ignition occurs too early on the compression stroke, and complete combustion occurs before top dead center, the pressure of combustion works against the piston as it is trying to complete the compression stroke. Power will be lost, and engine knock and damage may result.

If ignition occurs too late on the compression stroke, combustion will not be complete until the piston is too far down on the power stroke. Power will be lost. Complete combustion of the air-fuel mix should occur at approximately 10 to 20 degrees after top dead center – just as the piston is beginning to go down on the power stroke. This creates the maximum force possible to drive the piston down the cylinder.

As engine speed increases, the ignition must advance spark timing further. At faster rpm, more ignition advance is needed to allow the air-fuel mix to burn completely just as the piston arrives at 10 to 20 degrees after top dead center on the power stroke.

For example, during engine tuning in a low compression engine (8.5 to 1), ignition advance will occur at roughly 20 degrees before the piston arrives at top dead center on the compression stroke, at an engine idle speed of approximately 1,050 rpm. High engine speeds will result in timing advance of about 30 to 35 degrees before top dead center (BTDC).

Early ignitions used mechanical breakers called points that operate mechanically to break the ignition circuit current and cause the spark plug to fire. Today's electronic and microcomputer ignitions use transistors to control the ignition circuit. The electronic control circuit basically becomes a big electronic switch.

Spark timing is more accurate in electronic ignitions because electronic sensors and switches are not subject to the mechanical wear and free-play that hampers mechanical points. Spark timing is more accurate at all engine speeds when free-play is eliminated.

Ignition System Components

The basic components of the ignition system are the battery, the coil, spark plug wires, spark plugs, and the ignition module. The ignition module controls the timing of the ignition spark.

The ignition module can consist of a self-contained electronic module, or it can be integrated into an Electronic Control Module (ECM) which is the onboard microcomputer used by most motorcycles today.

Ignition Coil

The ignition coil is the “main player” in the ignition system. The coil is where the 12 volts of battery current is stepped up to the range of 10,000 to 45,000 volts used in todays’ ignition systems.

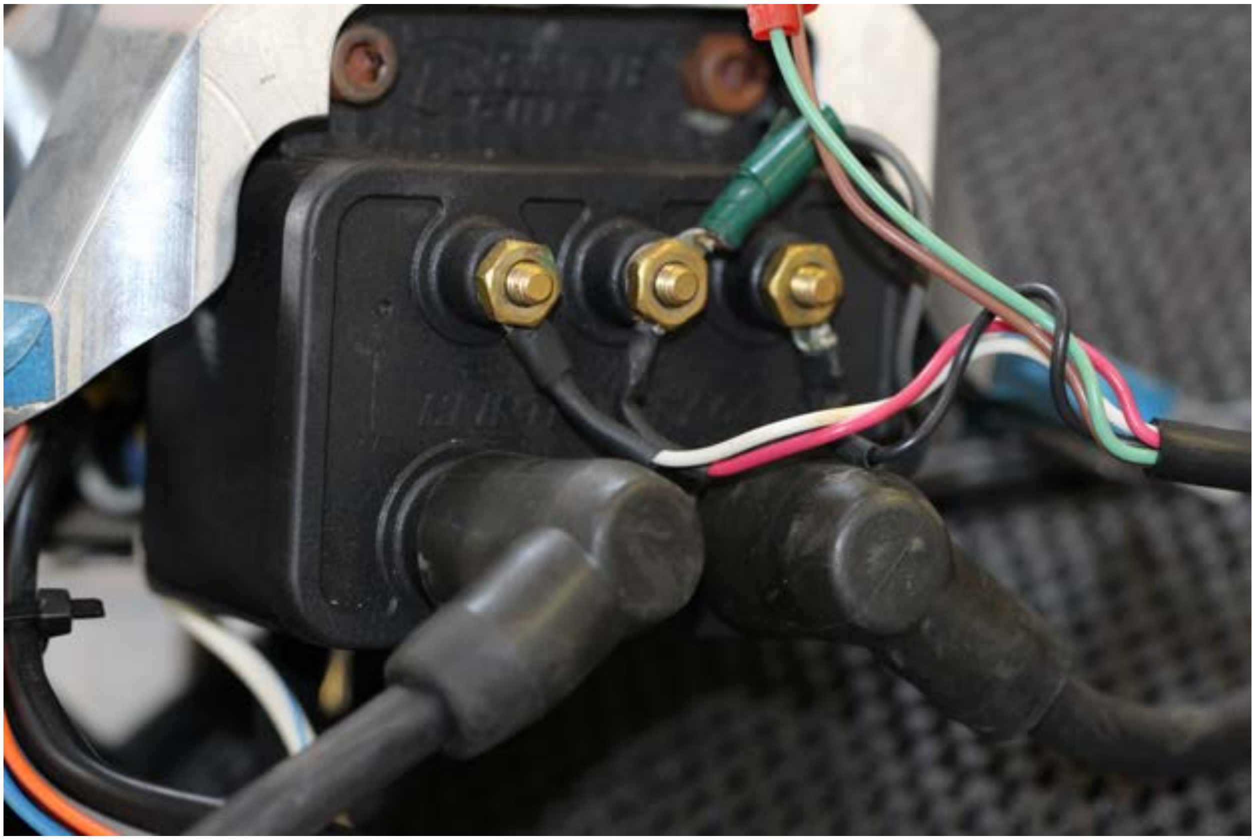
The coil is made up of two sets of copper windings. The first set of windings is made up of thicker wires called the primary windings. These windings are part of the primary ignition circuit – often referred to as simply “the primary”.

The second set of windings consists of many turns of thinner wires called secondary windings. These windings are part of the secondary ignition circuit – often referred to as simply “the secondary”. Both sets of windings surround an iron core in the heart of the coil.

IGNITION CIRCUITS

Primary Ignition Circuit

The “primary ignition circuit” involves the components that move electrical current into the primary windings of the ignition coil – hence the term “primary” ignition circuit. A magnetic field will develop in the primary windings of the coil when the windings receive current. The primary circuit will most often use DC voltage from a 12-volt battery as its electrical source.



Crane Hi-4 Ignition Coil. The left terminal with white wire fires the rear spark plug in the V-Twin Harley engine. The middle terminal receives battery current for the coil and the ignition trigger signal. The right terminal with black wire fires the front spark plug.

The components of the primary circuit are the battery and the primary windings of the coil.

One exception to using a 12-volt battery as a source of electricity is a primary circuit that generates its own current with a magneto. The initial current generated will be AC current and not DC current. In capacitive discharge ignitions, the current is later rectified to DC current.

This is the case with most motocross bikes that use a capacitive discharge ignition (CDI) with a magneto to generate current. These bikes do not use an electric starter or headlights, so a heavy battery is not needed. However, some source of electricity is still needed to generate the high voltage needed to fire the spark plug.

In the “field collapse” type of ignition, current being run through the primary windings of the coil will be cut off – current flow will be suddenly stopped. The magnetic field that had developed in the primary windings will then collapse when the current is stopped.

The collapsing magnetic field in the primary windings will then induce high voltage into the secondary coil windings. High voltage will be created in the secondary windings by a “transformer effect”.