The Small Engine Ignition System

The purpose of the ignition system is to create a spark to ignite the compressed air-fuel mixture at exactly the right time. In order to do this, a very high voltage is needed to cause an electric current to jump the gap between the spark plug electrodes. The duration or intensity of this small lightning bolt is not important because the compressed air-fuel mixture is highly volatile and will be readily ignited if the conditions are correct.

The ignition system consists of the following components:

Permanent magnet (in the flywheel)
Armature-coil assembly
Spark plug
Condenser
Breaker points

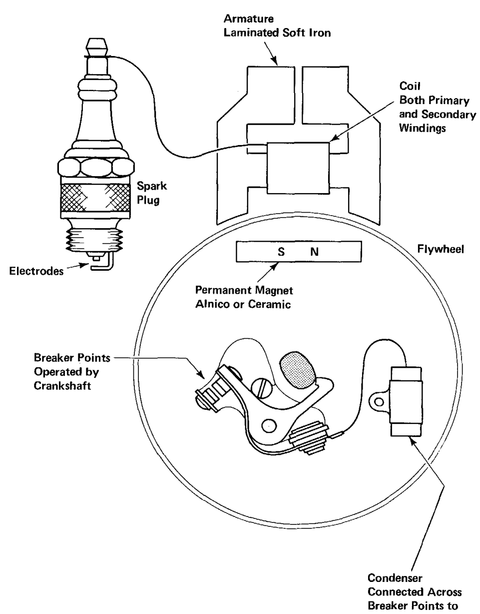
PARTS OF THE IGNITION SYSTEM

The FLYWHEEL MAGNET moves rapidly past the coil assembly causing current flow in the coil primary winding.

The ARMATURE-COIL ASSEMBLY consists of the laminated steel armature and the primary and secondary winding.

The BREAKER POINTS are operated by the crankshaft. They close just before the flywheel magnet passes the coil completing the primary winding circuit. The points open just as current flow in the primary is at maximum causing the power to be transferred magnetically (induced) in the secondary at a much higher voltage to fire the plug.

The CONDENSER is connected across (in parallel with) the points to help reduce arcing of the points which increases point life.



The following are basic rules that one must comprehend if the basic magneto is to be understood.

1. Moving a magnet past a wire causes an electrical current to flow in the wire if it is part of a complete circuit.

2. Moving a magnet past a coil made up of several turns of wire will produce a much stronger current flow because the current induced in each turn of wire will add to the total output.

3. Current flowing in a wire causes a magnetic field to surround the wire. The strength of this field depends directly on the amount of current flowing through it.

4. If the wire is wrapped to make a coil, the strength of the magnetic field of each turn of wire adds to the field next to it, producing a stronger magnet. Adding more turns of wire adds to the strength of the magnetic field.

Figure A shows a current meter (ammeter) connected to a loop of wire. Moving the magnet rapidly causes a very small current to flow in the wire, which causes the needle to deflect. Wrapping several turns of wire on a coil makes the current flow much stronger. The current flow induced in each turn of the coil adds to the current flow induced in all of the other turns on the coil to produce a strong current flow.

If a battery is connected to a complete circuit, the current flowing will cause a magnetic field to surround the wire. The more current that is flowing, the stronger the magnetic field. By passing the current through a coil made up of several turns of wire, the magnetic strength of each loop of wire adds to the others making a stronger magnetic field (Figure C).

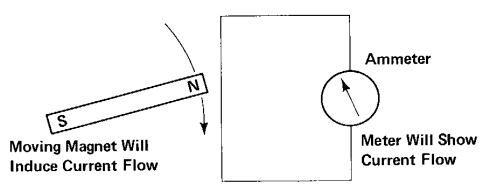


FIGURE A

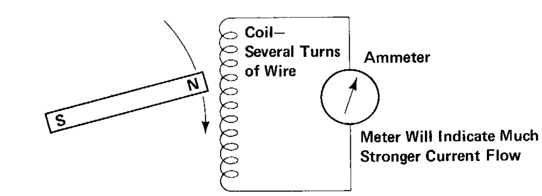


FIGURE B

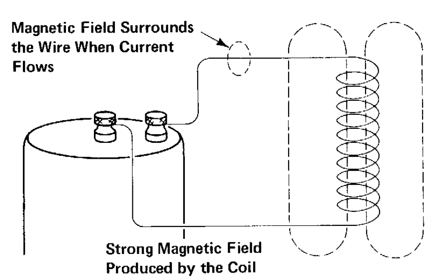


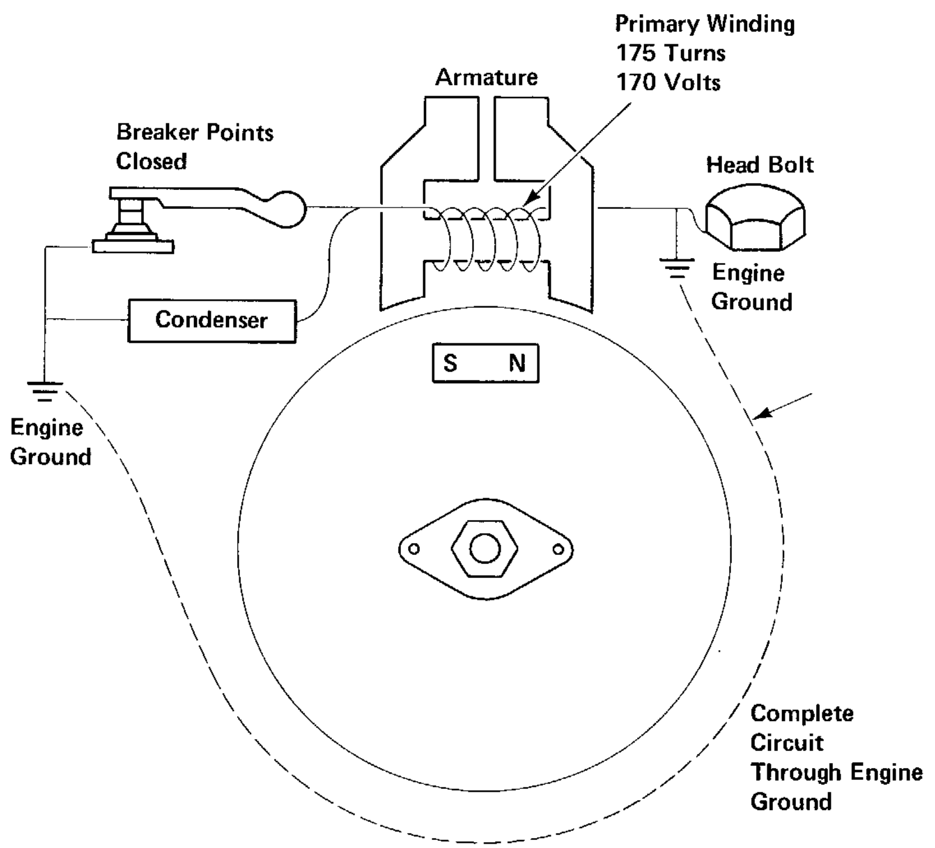
FIGURE C

IGNITION PRIMARY CIRCUIT

The primary or low-voltage circuit consists of the flywheel magnet, breaker points, condenser, and the coil primary winding. The primary winding usually consists of less than 200 turns of coated copper wire wound on the laminated armature. Note that one lead is connected to the armature on one of the mounting bolts, which connects it to the engine ground. The other lead from the primary winding goes to the breaker points. The condenser is connected across or in parallel with the breaker points. Its only purpose is to prevent arcing of the points, thus increasing point life.

Notice that when the breaker points are closed, there is a complete circuit from the engine ground through the coil primary winding, through the breaker points, to the engine ground. Since both ends of the coil primary are now connected to the engine ground, a complete circuit now exists. Current will flow through the ground as if the two ends of the primary winding were connected directly together.

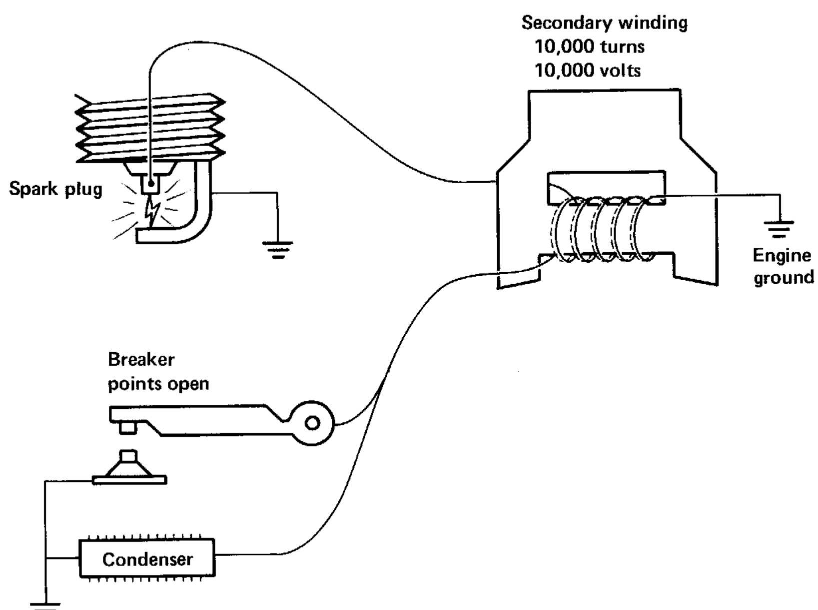
As the piston is nearing TDC on the compression stroke, the breaker points close making a complete primary circuit. The flywheel magnet passes rapidly bringing primary current to maximum. Since the current flow in the primary winding is at maximum, a strong, concentrated magnetic field will surround the primary winding. Just before the piston reaches TDC (the manufacturer determines the exact number of degrees before TDC) the breaker points open to stop all current flow in the primary circuit. This causes the magnetic field to suddenly collapse. The condenser absorbs a small amount of the current flow in order to prevent point arcing as the points open.



IGNITION SECONDARY CIRCUIT

The coil's secondary winding is wrapped around the primary winding. One end of the secondary winding is connected to the ground, usually along with the lead from the primary winding, which goes to the ground. The other secondary lead goes to the spark plug. The secondary winding consists of approximately 10,000 turns of very fine wire, usually about 60 times more turns than on the primary winding. The wire need not be large since we are concerned in the secondary with creating a very high voltage to push current across the spark plug gap. A very small amount of current is needed.

Since the secondary winding is wound around the primary winding, the magnetic field surrounding the primary winding is also surrounding and saturating the secondary winding. When the points open, the primary magnetic field collapses rapidly. The field collapses across the secondary winding. The collapsing magnetic field is a rapidly moving magnet moving past the secondary winding. This collapsing magnet tries to induce current flow in the secondary winding but because of the spark plug gap, a complete circuit does not exist. Since current cannot flow, voltage builds up. The voltage builds up until it is great enough to jump the spark plug gap, that is, if the coil can build up enough voltage! This is why the secondary winding is made up of several thousand turns of wire. A small voltage push is created in each turn of wire by the collapsing magnetic field. The voltage of all the turns is added together to create from 10,000 to 12,000 volts to jump the spark plug gap. The spark occurs at the plug when the points open, collapsing the primary magnetic field across the secondary winding which produces the voltage to push current across the spark plug gap.



FIRING SEQUENCE

1. The points close, making the primary a complete circuit.
2. The flywheel magnet passes, creating current flow in the primary winding.
3. The current flow in the primary winding produces a strong, concentrated magnetic field which surrounds both the primary and secondary windings.
4. The points open, collapsing the magnetic field across the secondary winding.
5. The collapsing magnetic field induces several thousand volts in the secondary winding to fire the spark plug.

ELECTRONIC IGNITION

The INPUT COIL is similar to the primary winding in the conventional armature. As the flywheel magnet passes the input coil, current flow is induced in the coil windings. The current will charge the capacitor.

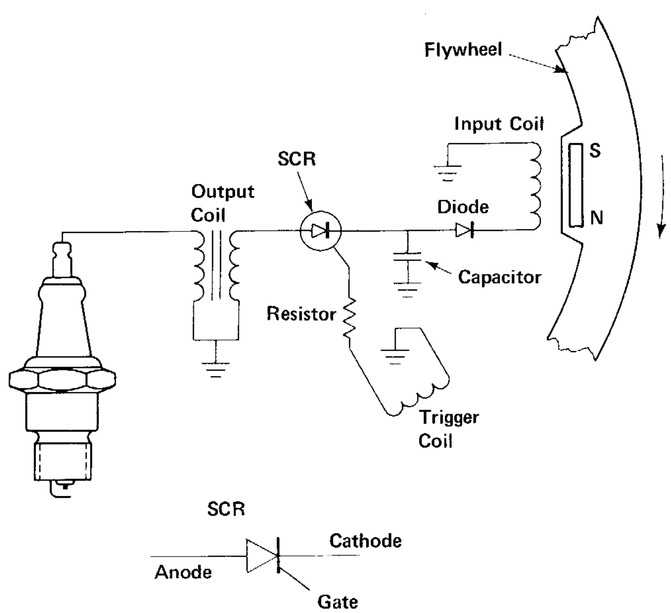
The CAPACITOR is a device that will absorb and store electrical energy for a short time. When the flywheel magnet passes the input coil, the capacitor will become charged.

A DIODE is an electrical check valve. It allows current to flow in only one direction. In this circuit it allows current to flow to the capacitor, charging the capacitor. The electrical energy is then trapped in the capacitor because the diode will not allow it to go back through the coil.

The SILICON CONTROLLED RECTIFIER (SCR) is an electronic switch. It has no moving parts but normally acts as an open switch to electrical current. A small voltage applied to the gate connection turns ON the switch (SCR).

The TRIGGER COIL provides the gate voltage to turn ON the SCR. After the magnet passes the input coil which charges the capacitor, it then passes the trigger coil which turns on the SCR allowing the capacitor to discharge through the transformer primary winding. The trigger coil is the timing device since the signal (voltage) to fire (turn on) the SCR is provided by the trigger coil.

The OUTPUT COIL is similar to a standard ignition coil in that it has a primary coil which will build up a strong magnetic field when current passes through it, and a secondary coil made up of thousands of turns of wire which will create the high voltage necessary to jump the spark plug gap. The output coil gets its current directly from the capacitor rather than indirectly from the flywheel magnet as in the non-electronic ignition system.



AN ELECTRONIC SWITCH
TURNED ON BY THE OUTPUT
OF THE TRIGGER COIL

SPARK PLUGS

The condition of the plug gives some clues to the condition and operation of the engine.

Normal. If the plug has only slightly worn electrodes and a very light coating of tan or gray deposits, it may be cleaned, re-gapped, and reinstalled.

Carbon Fouled. Fluffy, black deposits are a result of over-rich carburetion or excessive idling. If electrode wear is only slight, the plug may be cleaned and reinstalled. Be sure to correct the condition that caused the carbon fouling.

Oil Fouled. Wet, black, oily deposits indicate that oil is leaking past the rings or valve stems. Unless the engine condition allowing oil to enter the combustion chamber is corrected, a new plug will soon become fouled too. An engine overhaul may be necessary to obtain satisfactory service.

Blistered Insulator. A burnt or blistered insulator is the result of overheating. Using the wrong spark plug, low-octane fuel, incorrect timing, bad valves, and cooling system obstructions are common causes of overheating. Correct the cause of overheating and replace with a new spark plug.