DOCUMENT
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DOCUMENT TITLE

AIRCRAFT GENERAL KNOWLEDGE

CHAPTER 4 – IGNITION SYSTEM

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IGNITION SYSTEM

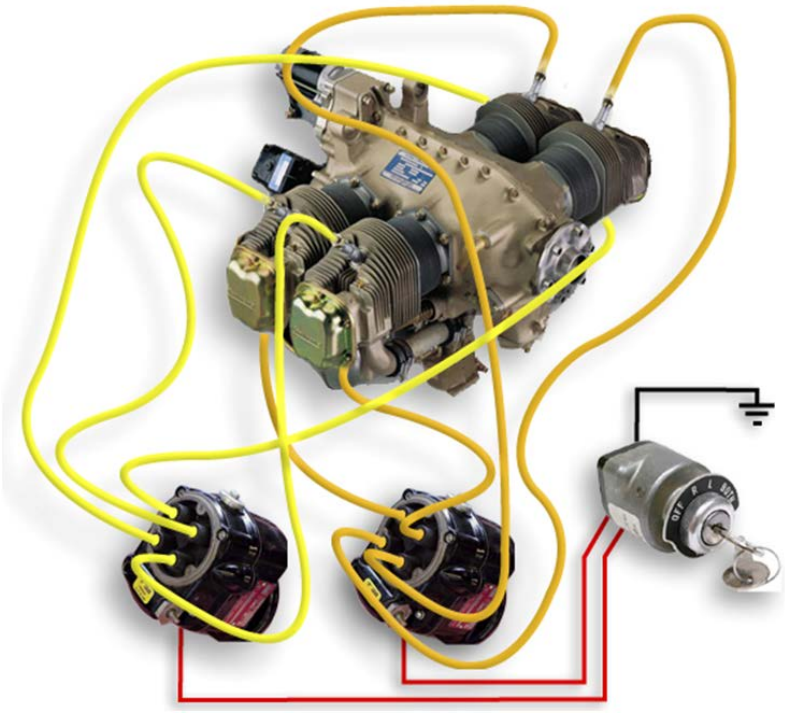
4.1. Introduction

The purpose of the ignition system is to provide a high tension spark, which will ignite the fuel air mixture within the cylinders. The ignition system must also be capable of maintaining the correct sparking sequence.

4.2. Magneto Ignition Systems

Magnetos are self contained, engine driven electrical generators, utilising a permanent magnet to generate sufficient high voltage to create a spark at the spark plugs.

A typical light aircraft incorporates a dual ignition system with two individual magnetos, separate high tension leads, and two spark plugs per cylinder. Each magneto operates independently to fire one of the two spark plugs in each cylinder, this improves combustion efficiency and provides a safety margin should one system fail. If one magneto fails the engine will continue to operate on the other, however, some power loss can be expected; the same is true if one of the spark plugs fail.



The purpose of the dual ignition system is to provide redundancy and more efficient combustion.

4.3. High tension magneto system

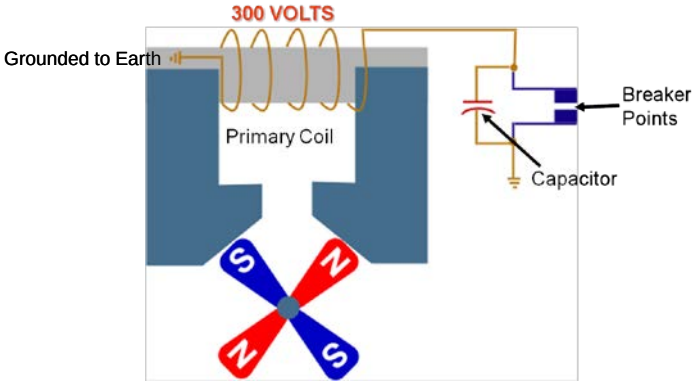
Most aircraft make use of the high tension magneto system

The high tension magneto system makes use of two distinct circuits:

- The primary winding electrical circuit
- The secondary winding electrical circuit.

4.1.1. Primary Circuit

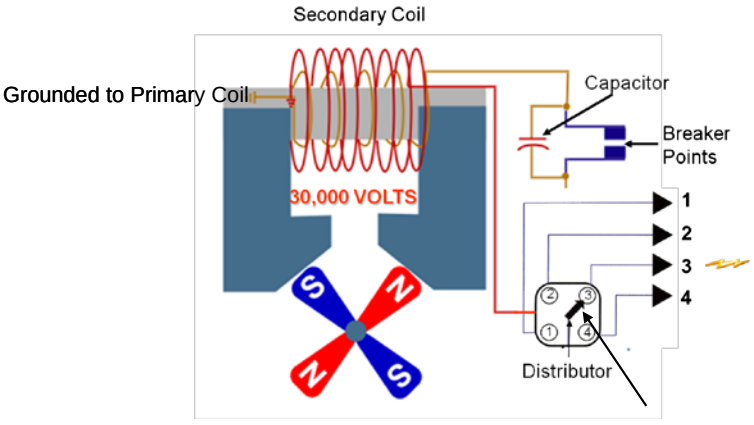
Approximately 300 volts is generated as the permanent magnet revolves inside the primary circuit winding of the magneto. Connected to this circuit are the cockpit magneto switch, capacitor (sometimes referred to as condenser), and contact breaker points.



4.1.2. Secondary Circuit

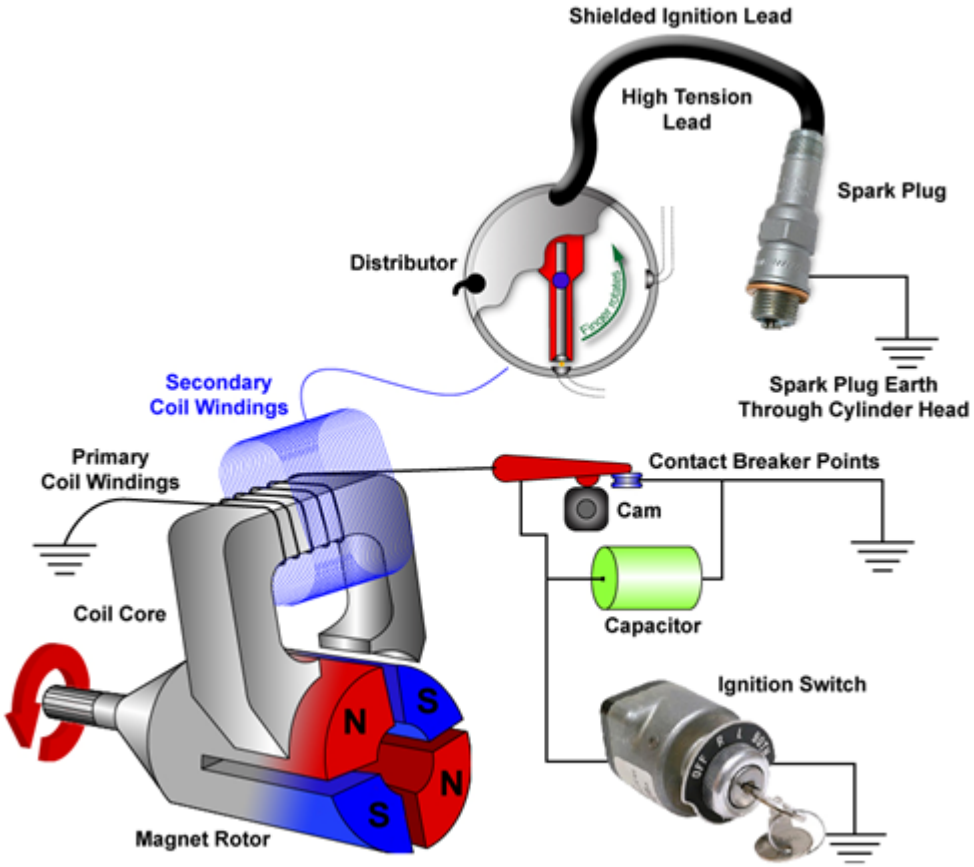
Surrounding the primary winding is a secondary circuit winding which produces approximately 30,000 volts for the spark plugs. This circuit is connected to a distributor mechanism which, via an ignition harness, directs the high tension voltage to spark plugs in the correct firing sequence.

The interaction of primary and secondary winding circuits, work on the same principle as a step up transformer.



As the rotor passes the correct terminal ,voltage is directed to the spark plug

4.4. Magneto operation



As the engine drives the magneto, primary voltage flows to earth via the contact breaker points, when the magneto switch is open.

Note: If this switch is closed, the magneto will not be able to produce a spark as the primary circuit will be permanently earthed; which is how the ignition system is turned off.

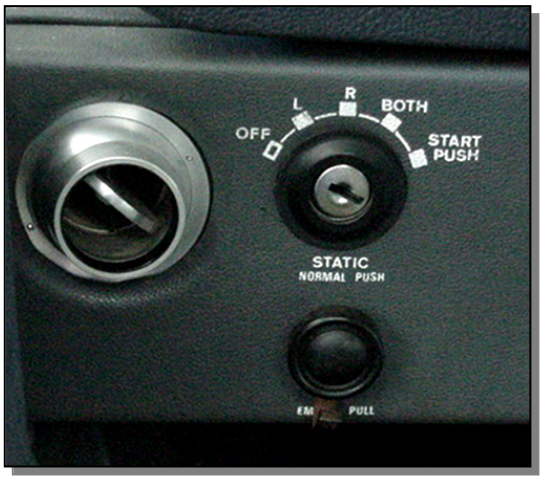
The contact breakers are placed to regularly interrupt the primary circuit, via a rotating cam, within the magneto as each piston reaches its firing point. The current now flows to a capacitor which abruptly stops the flow. As a result of the primary circuit stoppage, the surrounding secondary winding circuit is subjected to a large induced voltage. The resultant high voltage current flows, via a distributor and harness, and creates a spark at the spark plug.

The function of the capacitor is to not only interrupt the primary winding circuit, but achieve it with great speed; *the rate of collapse is significant in the magnitude of the resultant secondary voltage.* Another purpose of the capacitor is to reduce erosion at the contact breaker points, without it, current would continue to flow as the contacts opened resulting in pitting and burning of the surfaces. *A failed capacitor will reduce magneto performance, and possibly stop it altogether.*

Magneto control is via a cockpit mounted switch.

The switch has five positions:

- Off
- L – Left
- R – Right
- Both
- Start.



The Off selection earths both of the magnetos primary circuits and they cease to function. With Left or Right selected, only that associated magneto will function, normal operation is with Both selected. Both magnetos are operational in the Start position as well as any associated starting aids.

Note: Should an earth wire to a magneto become disconnected, the magneto will be live no matter which position the switch is in.

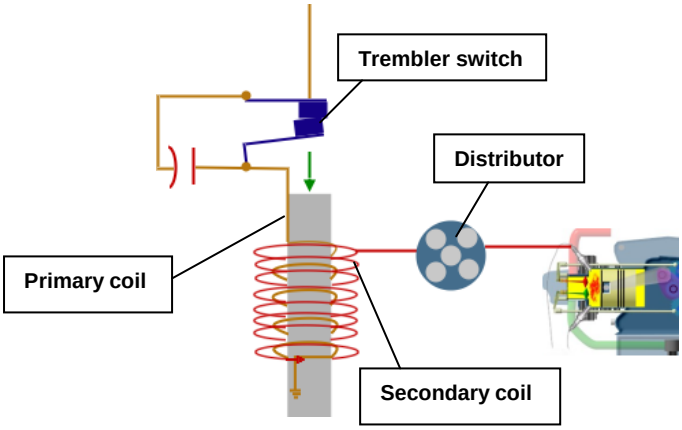
4.5. Starting Aids

When the aircraft is being started, the engine is only turned at about 120 rpm; at this speed the magnetos are not turning fast enough to generate a high energy spark to initiate ignition. A variety of devices may be incorporated in the ignition system to overcome this, they include the:

- Booster coil
- Induction vibrator
- Impulse coupling.

4.1.3. High Tension (HT) Booster Coil

The HT booster coil consists of a completely separate induction coil, having its winding energized from the aircraft battery (or ground starter).



When the starter is selected, the battery energizes the primary coil, and an internal mechanism produces a high voltage current which is then fed to a separate brush onto the distributor rotor. As the rotor and brush rotate a stream of sparks is provided to the spark plugs.

4.1.4. Induction Vibrator

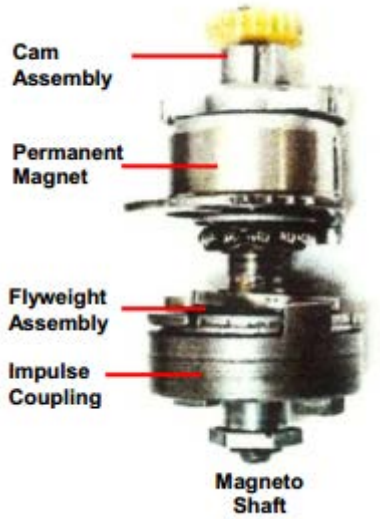
The induction vibrator is probably the system most in use in today's aircraft and is energized only when the engine is being started.

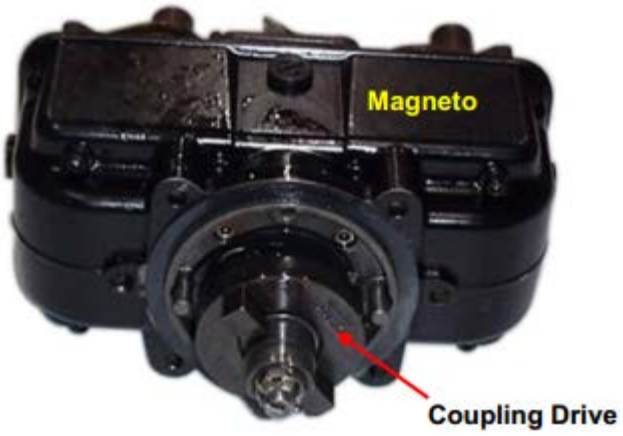
In this system, an **uninterrupted battery current** is sent through the primary windings of the magneto. The magneto then induces a high voltage in the secondary coils, which is led to the spark plugs.

Note that all the above items rely on the aircraft battery to be functional.

4.1.5. Impulse Coupling

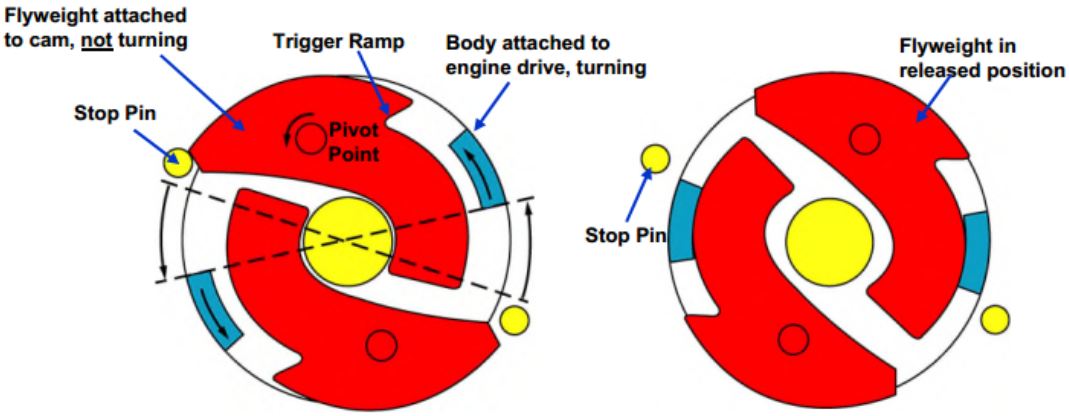
The impulse coupling is a mechanical device which uses a spring to temporarily increase the rotational speed of the magneto; this produces a fat retarded spark – **fat** meaning high voltage, and **retarded**, because of the slow rotational speed of the engine there is no need for spark advance.





Whilst the engine is rotating slowly, under the influence of the starter motor, the action of cams and spring momentarily delay the rotation of the permanent magnet. When the spring tension is overcome the mechanism releases the magnet, which rotates rapidly, and produces an intense spark.

This process is repeated until the engine fires and gains enough speed to deactivate the coupling.



4.6. Magneto functional checks

A pre take off check, to ensure both magnetos are functioning correctly, is carried out by briefly running on one magneto at a time. When either the Left or Right magneto is selected independently, a small decrease in rpm is to be expected, due to a change in the combustion process with only one spark plug operational in each cylinder. Engine manufacturers will specify the allowable drop but typical figures are a maximum of 125 rpm, and no more then 50 rpm variation between each magneto.

If these figures are exceeded, or there is no observed drop, the aircraft must be returned for maintenance.

The probable causes of any malfunction during these checks are likely to be:

- Broken or shorted earth wires in the magneto
- Improperly timed magnetos
- Fouled spark plugs.

It should be noted that no rpm drop is abnormal and could likely indicate **a live magneto**, in this instance *no attempt should be made to move the propeller once it has stopped, as it could fire even though the magneto switches are off.*

Prior to engine shut down, whilst at idle speed, both magnetos are momentarily turned off and on again. There should be a momentary stopping of the engine; this indicates both of the magneto primary circuits are earthed and the magnetos will be safe when turned off.

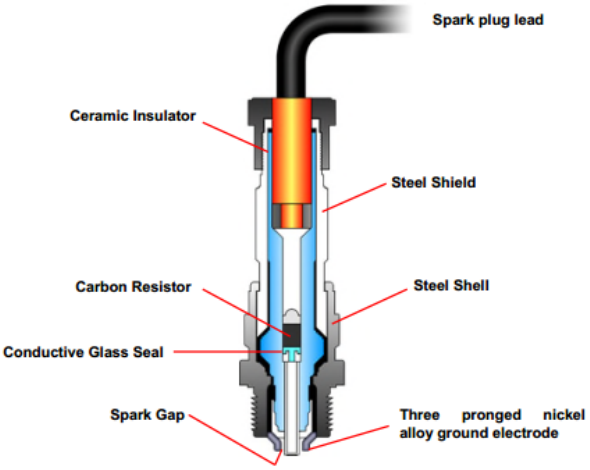
Remember the magneto generates its own power, and is capable of producing a spark when the propeller is moved if the magnetos are faulty or switched on.

4.7. The Spark Plug

The spark plug provides the air gap required for the ignition of the fuel / air mixture in the cylinder.

Two spark plugs are installed in each cylinder to ensure efficient burning and maximum power. Having two spark plugs also aids with system integrity, if one fails there is still a spark from the other.

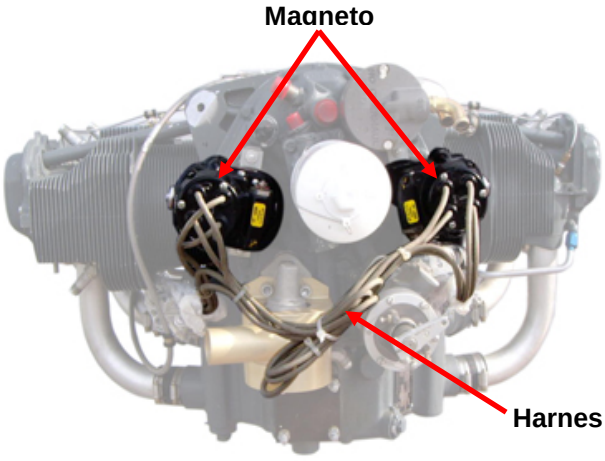
The central electrode conducts the high voltage power from the ignition wire to the combustion chamber.



The outer casing is used to mount the plug in the cylinder, and provides the base for the side electrode. Between the electrodes is the air gap, which is set in accordance with the engine requirements (approximately 0.5mm). As the high voltage impulse from the central electrode “jumps the gap” toward the side electrode, a spark is produced.

4.8. The Ignition Harness

The current produced by the magneto is carried to the spark plugs by means of heavily insulated high tension wires. These wires, grouped together, are known as the ignition harness.



The ignition harness protects the high tension wires from damage by engine heat, vibrations and weather. By covering the harness with metal braiding (which reduces magnetic fields created by the harness), avionic interference is reduced. This is known as shielding or screening.