SPARK GAP

A spark plug. The spark gap is at the bottom.

A spark gap consists of an arrangement of two conducting electrodes separated by a gap usually filled with some gas (usually air).

How it works

When a suitable voltage is supplied, a spark forms, ionizing the gas and drastically reducing its electrical resistance. An electric current then flows until the path of ionized gas is broken. This happens usually when the voltage drops, but in some cases when the heated gas rises, stretching out and then breaking the filament of ionized gas.

Usually the action of ionizing the gas is violent and disruptive, often leading to sound (ranging from a snap for a spark plug to thunder for a lightning discharge), light and heat. The visible spark is light not coming off the electron current, but the material medium fluorescing in response to collisions from the electrons exciting itselectron orbitals to high, excited states and dropping them repeatedly. It is possible for a spark in a vacuum to form—in fact, many comprise the solar wind—but without intervening matter capable of electromagnetic transitions, the spark will be invisible (see vacuum arc).

Spark gaps are essential to the functioning of a number of electronic devices, and they also occur naturally.

Spark gaps as ignition devices

A spark plug uses a spark gap to initiate combustion. The heat of the ionization trail ignites a fuel-air mixture inside an internal combustion engine, or to ignite a burner in a furnace, oven, or stove.

Spark gaps as radio transmitters

A spark radiates energy throughout the electromagnetic spectrum. Nowadays, this is usually regarded as radio frequency interference and is suppressed, but in the early days of radio communications, this was the means by which radio signals were transmitted, in the spark-gap transmitter.

Spark gaps as protective devices

Spark gaps are frequently used to prevent voltage surges from damaging equipment.

In high voltage switches

Spark gaps are used in high-voltage switches, for example, in power plants and electrical substations. Such switches are constructed with a large, remote-operated switching blade with a hinge as one contact and two leaf springs holding the other end as second contact. If the blade is opened, a spark may keep the connection between blade and spring conducting. (The spark ionizes the air, which becomes conductive, allowing an arc to form, which sustains ionization and hence conduction.) Here, a Jacob's ladder (see below) on top of the switch will pull the arc apart and so extinguish it. You might also find small Jacob's ladders mounted on top of ceramic insulators of high-voltage pylons. If a spark should ever manage to jump over the insulator and give rise to an arc, it will be extinguished.

Larger spark gaps are used to protect power lines.

In electronic equipment

- **Sensitive devices**

  Smaller spark gaps are often used to protect sensitive electrical or electronic equipment from high voltage surges. In sophisticated versions of these devices (called gas tube arresters), a small spark gap breaks down during an abnormal voltage surge, safely shunting the surge to ground and thereby protecting the equipment. These devices are commonly used for telephone lines as they enter a building; the spark gaps help protect the building and internal telephone circuits from the effects of lightning strikes.

  Small spark gaps are very common in telephone switchboards, as the long phone cables are very susceptible to induced surges from lightning strikes.

- **Less sensitive devices**

  Less sophisticated (and much less expensive) spark gaps are made using modified ceramic capacitors; in these devices, the spark gap is simply an air gapsawn between the two lead wires that connect the capacitor to the circuit. A voltage surge causes a spark which jumps from lead wire to lead wire across the gap left by the sawing process. These low-cost devices are often used to prevent damaging arcs between the elements of the electron gun(s) within acathode ray tube (CRT).

Transils and trisils are the solid-state alternatives to spark gaps for lower-power applications. Neon bulbs are also being used for such purpose.

Spark gaps as power-switching devices

Special purpose, high-energy triggerable spark gaps are also used to rapidly switch high voltages and very high currents for certain pulsed power applications, such as pulsed lasers, railguns, fusion and ultrastrong pulsed magnetic field research. These often have higher power capabilities than anythyristor, thyratron, krytron, or sprytron. One such type of switch is known as a trigatron.

Spark gaps as entertainment

An example of a Jacob's ladder with an electric arc.

A Jacob's ladder (more formally, a high voltage traveling arc) is a device for producing a continuous train of large sparks which rise upwards.

The spark gap is formed by two wires, approximately vertical but gradually diverging away from each other towards the top. When high voltage is applied to the gap, a spark forms across the bottom of the wires where they are nearest each other, rapidly changing to an electric arc. The arc behaves almost as a short circuit, drawing as much current as the electrical power supply can deliver, and the heavy load dramatically reduces the voltage across the gap. The heated, ionized air rises, carrying the current path with it. As the trail of ionization gets longer, it becomes more unstable, finally breaking. The voltage then rises and the spark re-forms at the bottom of the device. This cycle leads to an exotic-looking display of electric white, yellow or blue arcs which is often seen in movies about mad scientists.

The device was a staple in science fairs of the 1950s and 1960s, typically constructed out of a Model T spark coil and two coat hangers built into shape.

Spark gaps in nature

Lightning is a large spark leaping between a cloud and the earth or between clouds.

Source: http://engineering.wikia.com/wiki/Spark_gap