Introduction:

This demonstration will illustrate (qualitatively) how, by applying simple electrical theory, we can ionize the so-called noble, or inert, gases. In high school physics and chemistry, it is held that the elements on the far right column of the periodic table, such as Helium, Neon, Argon, and Xenon, are inert. That is, they have complete shells (at this grade level, a simple octet rule is used), and will thus not readily accept or donate electrons.

However, it is known that molecules containing these elements do in fact exist, though they are often man-made. By constructing a high voltage (herein after referred to as HV) power supply, and connecting the leads to a gas-filled chamber, we can demonstrate how in one way, these elements can be ionized.

Physics: (for a Physics class)

As stated above, in high school physics, students are told that because the noble gases have complete outer valence shells, they are unlikely to accept or donate electrons. However, if we impart enough energy to an atom of the gas, it will indeed ionize, losing an electron in the process.

The basic principle of a plasma globe is as follows:

A HV power supply lead is connected to an electrode, contained within a gas chamber. The chamber contains some mixture of inert gases, at a lower than normal pressure. The power supply causes various ions within the gas to begin accelerating around the vessel, with the current inducing them to circulate around the entire container. As they accelerate, they build up energy until they collide with another particle.

The collision boosts the second particle into an excited state, where it remains for a short period of time before decaying back down to the ground state. It emits the extra energy in the form of a photon, the wavelength of which is unique to each particular gas. This gives a plasma its characteristic colour. For further information, refer to the Power Point slides, available from the same site as this document.

Electronics: (for an Electronics class, or a Physics class focusing on Electromagnetics)

The HV power supply exploits two basic and related principles of electromagnetics: a current in wire induces a magnetic field. This, along with its corollary, that a changing magnetic field induces a current, are used to produce high voltages. (Barros)

The voltage produced is the ratio of the primary turns to the secondary turns. The primary is generally several hundred turns of thick wiring, whereas the secondary may be in the tens of thousands of fine wire. The induced current appears as a high voltage pulse on the secondary, which can then be exploited.

We can determine the induced magnetic field in a long wire using the Biot-Savart Law (in integral form) as follows:

$$B = \frac{\mu_0 I}{4\pi} \int \frac{d\mathbf{l} \times \mathbf{r}}{r^2} \qquad \textit{Eq. 1}$$

However, we are more properly dealing with solenoids with our two coils. In such a case, we can apply Ampére's law:

$$\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 I_{enc} \qquad \textit{Eq. 2}$$

If we apply *Eq. 2* to a solenoid of length *l*, with *N* turns, we get:

$$B = \mu_0 \frac{N}{l} I \qquad \textit{Eq. 3}$$

Project Plans:

The primary circuit is a HV power supply, which takes a line-in voltage of 12 VDC, at 6 A. The voltage is run across the primary of a car ignition coil. The switching effect is produced by a 555 IC, with its output connected to a transistor. We use variable resistors on the pins of the IC to produce our desired square wave output; these can be used to tune the circuit. After this, they can be measured and replaced with static resistors. *Fig. 1* shows the initial circuit.

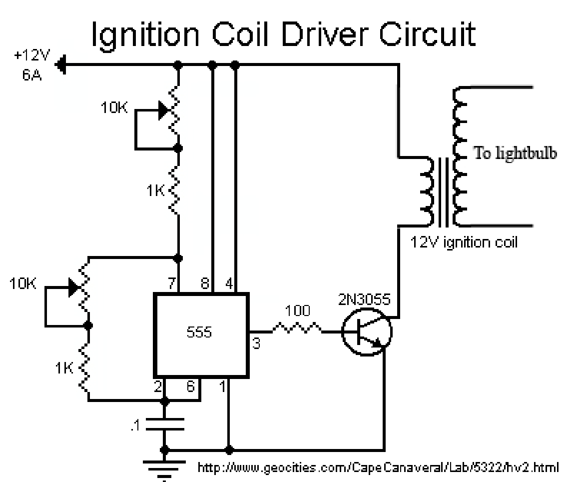

Fig. 1