TESLA COIL FAQ

HOW DOES A TESLA COIL WORK?

A Tesla coil consists of two electrical circuits: a primary coil and secondary coil. The flat coil of thick copper wire covered by that plastic disk is the primary coil and the tall coil made of thin wire is the secondary coil. A spark gap controls when the primary coil induces an electro-magnetic field. A spark gap is a gap of air between two electrodes that fires when the electrical capacity of the primary coil exceeds the resistance of the air between the electrodes. 3/4th of the noise you hear comes from the spark gap. Essentially, the Tesla coil is two open electric circuits timed by a spark gap.

The Tesla Coil can produce extremely high voltages by using resonance. It is kind of like pushing someone on a swing. You only need to give a little push when the person is all the way back, and with each push they go higher and higher. The Tesla Coil does the same thing but uses the spark gap to time when the current of the first coil induces a current in the second coil.

The Tesla coil gets its power from a 120-volt outlet. The outlet is hooked up to two power transformers that step up the voltage to around 1500 volts. Electricity from the transformer charges the coil's capacitors. The primary coil's capacitor acts like a sponge and soaks up the charge then releases it all at once. The primary coil itself must be able to withstand the massive charge and huge surges of current, so the coil is usually made from copper, a good conductor of electricity (notice our copper stem). Eventually, the capacitor builds up so much charge that it breaks down the air resistance in the spark gap. Then, like squeezing out a soaked sponge, the current flows out of the capacitor down the primary coil and creates a magnetic field.

The massive amount of energy makes the magnetic field collapse quickly and generates an electric current in the secondary coil. The voltage zipping through the air between the two coils creates sparks in the spark gap. The energy sloshes back and forth between the two coils several hundred times per second and builds up in the secondary coil and capacitor. Eventually, the charge in the secondary capacitor gets so high that it breaks free in a spectacular burst of electric current.

The resulting high-frequency voltage can illuminate fluorescent bulbs several feet away with no electrical wire connection.

WHY IS THERE A METAL CAGE AROUND THE TESLA COIL?

https://science.howstuffworks.com/faraday-cage.htm

The enclosure you see here is called a Faraday cage, named after its inventor Michael Faraday. And like Nikola Tesla he lived in the 19th century. The Faraday cage surrounding the Tesla Coil is there to protect us from the sparks and the strong electrical fields that could interfere with electronic devices. This cage is made of unfinished metal wiring and cover the tesla coil on all sides and on top. The Tesla coil also sits on a wire mesh base that serves to ground the device safely. Generally, Faraday cages are used to shield sensitive electrical components from static electric fields that could be damaged from static electricity or other types of electrical surges.

In this instance, we are using the cage to contain the electric discharge and keep it away from us. All Faraday cages take electrostatic charges, or even certain types of electromagnetic radiation, and distribute them around the exterior of the cage safely away from the contents. In this instance it contains the electric charges from the Tesla coil within the cage's interior and distribute it around the exterior of the cage safely away from us. In short, a Faraday cage is a hollow conductor, in which the charge remains on the external surface of the cage.

Our cage is octagonal, with side that are 4 feet wide and 10 feet tall. The cage is made of steel mesh wires spaced at 1-inch intervals. The interior diameter between opposing wall is 117” or 3 inches less than 10 feet. The cage is surrounded by acrylic plastic panels that are 4 feet wide by 8 feet tall and one quarter inch thick. It serves to keep fingers from poking through the mesh and reduces the noise level. The floor and ceiling of the cage are also lined with mesh, so the Tesla Coil is completely enclosed by the Faraday cage

WHAT ARE THE PARTS OF THE TESLA COIL?

https://www.livescience.com/46745-how-tesla-coil-works.html

AC power comes in from the wall outlet at 120 volts AC, which oscillates at a frequency of 60 cycles per second. Two transformers taken from neon signs convert the 120 volts into 15,000 volts at the same frequency. The transformer charges a capacitor and when the capacitor reaches its highest charge level it fires a spark between the area known as a spark gap. The spark gap increases the frequency to 100,000 cycles per second.

The spark gap then powers the primary winding coil. It’s the flat coil made of copper tubing with about 12 turns (under the plastic disc at the base of the tall column.) The tall coil of thin copper wire in the middle is called the secondary coil. There are no wires between the primary coil and the secondary coil. When the primary coil has an electric charge, it forms a magnetic field around itself. That magnetic field causes the secondary coil to produce an electric current that steps up the voltage to several hundred thousand volts. We estimate our Tesla Coil is probably between 300,000 to 1,000,000 Volts. The charge from the secondary coil is stored at the doughnut shaped top part of the Tesla Coil called the torus. Eventually the energy stored the torus discharges in sparks to the cage that are about 4 feet long.

HOW DO THE COILS WORK?

In very simple terms, electricity is caused by the flow of electrons in a material. Some materials like conductors (metals) have a much easier time transferring electrons than others. When a metal wire has a magnetic field moved next to it, the magnetic field moves the electrons in the wire and induces an electric current. Wires can also create magnetic fields by having electric current pass through them. The Tesla coil uses this concept of electro-magnetic induction to create large voltages.

A voltage is the electric potential difference, or the push force that moves electrons down a wire. Current is rate at which electrons move down a wire. Voltage and current are closely related to each other and when one is changed the other is as well.

When the primary coil has an electric charge pass through itself, it produces a magnetic field that then induces an electric charge in the secondary coil. The amount of voltage between the two coils can change by having different sized wires and different number of turns in each of the coils. When a thick coil of wire with a few turns powers a skinny coil of wire with a lot of turns the voltage increases while the current decreases. It is kind of like putting your thumb on a garden hose. You increase the force (voltage) of the water because there is a smaller area for the water to go through, but the amount of water (current) decreases because there is less room for the water to exit the hose.

NIKOLA TESLA FAQ

WHO WAS NIKOLA TESLA?

https://www.history.com/topics/inventions/nikola-tesla-1

Serbian-American engineer and physicist Nikola Tesla (1856-1943) made dozens of breakthroughs in the production, transmission and application of electric power. He invented the first alternating current (AC) motor and developed AC generation and transmission technology. He invented and developed numerous technologies including wireless remote controls, florescent lights, radio transmission, x-ray photographs. Though he was famous and respected, he was never able to translate his copious inventions into long-term financial success—unlike his early employer, Thomas Edison.

EDISON VS. TESLA

When Nikola Tesla was a young man, he worked for Thomas Edison at his company General Electric (GE). Under Edison, Tesla worked on troubleshooting problems with electrical installations and improving the designs of motors. Tesla quit his job at GE and started his own company where he developed the idea of using alternating current (AC) to power devices instead of the direct current (DC) that Edison developed. Alternating current is safer than direct current and allowed for power plants to be miles away from homes instead of requiring power plants to be close to areas that need electricity.

Tesla found an investor named George Westinghouse who agreed to fund his work. In 1893, Tesla debuted AC electricity at the World's Columbian Exposition in Chicago by powering all the lights at the exposition. After that AC became the standard that we still use today.

Edison held many patents on DC devises and if AC became the standard, he would lose a lot of money. To prevent AC from being adopted, Edison did everything in his power to discredit Westinghouse and Tesla and even electrocuted an elephant with AC electricity to show how dangerous it was. The reality is that DC power is much less safe than AC due to the high voltages and currents required to transmit DC power.

Tesla worked with Westinghouse to build a hydro-electric dam at Niagara Falls that still powers large portions of upstate New York. Westinghouse ran into financial trouble due to a financial panic in 1890 and his company would have gone under without the aid of Tesla. Tesla voided his contract with Westinghouse that would have given him a percentage of all profits made from AC technologies he developed and sold his patents for AC technology to Westinghouse for a lump sum and set off to develop new inventions involving radio and wireless transmission.

Edison held many patents on DC devices and if AC became the standard, he would lose a lot of money. To prevent AC from being adopted, Edison did everything in his power to discredit Westinghouse and Tesla and even electrocuted an elephant with AC electricity to show how dangerous it was. Edison lost the war of the currents, despite his efforts, because the reality is that AC Power was safer and more convenient to transmit long distances.

TESLA'S FALL

After leaving Westinghouse, Tesla looked to find investors for a wireless radio transmission tower he designed. In 1901, he obtained $150,000 ($4,609,800 in today's dollars) from J. P. Morgan in return for a 51% share of any generated wireless patents and began planning the Wardenclyffe Tower facility to be built in Shoreham, New York.

At that time there was a race between Tesla and Guglielmo Marconi, an Italian inventor, to be the first person to transmit a wireless signal across the Atlantic Ocean. By July 1901, Tesla had expanded his plans to build a more powerful Radio transmitter to leap ahead of Marconi's radio-based system, which Tesla thought was a copy of his own. He approached Morgan to ask for more money to build the larger system, but Morgan refused to supply any further funds. On 17 December 1902, Marconi beat Tesla by sending the first wireless radio transmission across the Atlantic.

Investors on Wall Street were putting their money into Marconi's system, and some in the press began turning against Tesla's project, claiming it was a hoax. The project came to a halt in 1905, and in 1906, the financial problems and other events may have led to a nervous breakdown on Tesla's part. Tesla mortgaged the Wardenclyffe property to cover his debts.

In his later years he lived in hotels, moving from one to another, spending his time developing pseudoscientific theories on topics such as a motor that would run on cosmic rays, developing a way to photograph the retina to record thought, and designed a superweapon he claimed would end all war. His hotel bills were paid for by the Westinghouse company and received a small consulting fee for his past work. He died in 1943 alone in a hotel room in New York. During his life, Tesla obtained around 300 patents worldwide for his inventions.

FLEET TESLA COIL FAQ

TESLA COIL APPARATUS

AC power comes in from wall outlet at 120 volts AC, which oscillates at 60 cycles per second.

2 neon sign transformers convert this to 15,000 volts at the same frequency. (A similar transformer is used in the Jacob's ladder exhibit) This drives a spark gap oscillator generating about 15,000 Volts at about 100,000 cycles per second. The spark gap generates about three fourths of the noise that you hear, the rest of the noise is from the sparks from the top of the Tesla Coil.

This drives the primary winding of the Tesla Coil which is a flat coil made of copper tubing with about 12 turns (under the plastic disc at the base of the tall column). The oscillator frequency can be "tuned" by changing the number of turns in this winding (using a movable clip).

The Tesla Coil is a resonant air-core transformer that steps this voltage up to several hundred thousand volts. We hope to be able to estimate this more accurately at some time, but for now we would say that it is probably between 300,000- and 1,000,000-Volts AC

The tall secondary winding has about 1088 turns of enamel coated magnet wire (probably 20 gauge). This winding is 9 inches in diameter and 34 inches tall.

The torus (or donut) shaped conductor at the top stores charge and gives the secondary a resonance at about the same frequency as is driving the primary.

This resonance is very important to the operation. This is like how an opera singer can shatter a glass by singing a note at the resonant frequency of the glass.

The torus is made of aluminum and is 2 feet in diameter with an inner diameter of 1 foot and a height of 6 inches.

Energy in the secondary builds up over several cycles and is then discharged in sparks to the cage that are about 4 feet long.

FARADAY CAGE

The Faraday cage surrounding the Tesla Coil is there to protect the public, both from the sparks and the strong electrical fields that could interfere with electronic devices Inside the cage.

The cage octagonal, with sides that are 4 feet wide and 10 feet tall. The cage is made of steel mesh with wires spaced at 1-inch intervals. The interior diameter between opposing wall is 117" or 3 inches less than 10 feet.

The cage is surrounded by acrylic plastic panels that are 4 feet wide and 8 feet tall and one quarter inch thick. It serves to keep visitor's fingers from poking through the mesh and dramatically reduces the noise level.

The ceiling and floor also have mesh so that the Tesla Coil is completely enclosed by the Faraday cage.

A fan has been installed to the cage that vents excess ozone gas produced by the Tesla Coil.