Tesla Coil

Physics II

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Throughout the annals of time, inventions usually come about from the requirement of necessity or for the betterment of mankind. The wheel, indoor plumbing, even sliced bread. Sometimes though, whether they help society or not, they can just be an awful lot of fun. Nikola Tesla himself even said "I do not think there is any thrill that can go through the human heart like that felt by the inventor as he sees some creation of the brain unfolding to success... Such emotions make a man forget food, sleep, friends, love, everything." Perhaps this was his thought after he completed his Tesla coil. A coil that, in order to work well, requires the user to construct, know, and tune it properly.

The easiest way found to create the Tesla coil was to use a kit that included most of the parts required for the construction. A wood plank is used as the base upon which to put all the other components. These components included: a spark gap, transformer, a .005 mF capacitor, and a choke coil. The spark gap was created using two tungsten rod cuts bolted to a plastic frame with approximately $\frac{1}{4}$ inch separation between them. The choke coil is 40 to 50 turns of #24 magnet wire wrapped about a 1 $\frac{15}{32}$ inch diameter tube. The transformer was placed at the front of the board near the front plate and was plugged directly into the wall through an on-off switch. The transformer was then wired to the ground and to the choke coil with #12 gauge wire and soldered off. A choke coil, which is used to block alternating current while passing direct current, is a low-resistance inductor that was connected to the .005 mF

capacitor. The capacitor was wired to one side of the spark gap and to the ground. A plexiglass plate was then placed above the bottom plate assembly to form a casing and create a second layer. A #12 gauge, eight foot long, vinyl covered wire was then coiled into six loops and placed in brackets on top of the plexiglass. One end was connected to the ground, while the other end was spliced, and then soldered into an $\frac{3}{16}$ inch diameter, seven foot copper section of tubing. This is called the primary coil. The spark gap is then connected through a tap lead to this primary coil on the second layer. The tap lead has an alligator clip on the end so that it can be adjusted to connect to any part of the copper tubing. A secondary coil, which is 450 turns of #24 magnet wire around a 3 inch diameter tube that is 12.75 inches tall, was placed in the center of the top layer assembly. This was then topped with an aluminum toroid and connected to the ground completing the construction.

There are many steps that are required for the device to work properly. The transformer receives the input voltage and steps it up to a higher voltage. This voltage is then sent to the choke coil which changes the AC current to a DC current. The capacitor, unable to be charged by the AC current, is then charged from the DC current coming from the choke coil. Whenever there is enough charge in the capacitor, the spark gap is fired sending a pulse of current down the tap lead into the primary coil. The secondary coil produces a current though inductance from the primary coil. This creates a large amount of voltage in the toroid. This voltage is dispelled

through corona discharge in the air causing the classic look of a Tesla coil.

To tune the Tesla coil there are several adjustments that can be made that will increase or decrease the final discharge from the toroid. The spark gap can be separated by a greater distance, causing the spark to jump a greater distance. This forces the spark to be stronger when it does jump, producing a larger voltage through the rest of the device. The tap lead can also be moved to different places on the copper tube. This changes the resistance in the primary coil because the current would have to travel through a longer distance. This in turn will change the inductance through the secondary coil. Any change in inductance will cause a change in the frequency of the coil itself. Once the two coils are tuned to have the greatest amount of inductance, there will be maximum discharge from the toroid itself.

Whether it was in the construction, the research into how it worked, or in the tuning of the machine itself, a lot was learned in the process. Perhaps the Tesla coil was a breakthrough in electrical research, but if not, it was still a ton of fun to play with. As Tesla says, "Like a flash of lightning and in an instant the truth was revealed.… A thousand secrets of nature which I might have stumbled upon accidentally I would have given for that one which I had wrestled from her against all odds and at the peril of my existence." Sounds a bit like a Tesla coil.

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