PHYSICS PROJECT RESEARCH REPORT

PROJECT TITLE:

MINI TESLA COIL

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**ABSTRACT**

The tesla coil is basically resonant transformer which is used to produce potentials in the range of tens to hundreds, or even thousands of kilovolts. Many alterations were done to the original design to increase the efficiency and usage of the device. We explain the range of experiments design to investigate the tesla coil action, ending with design of upper toroid at the secondary side. This paper explain simple design of tesla coil.

**INTRODUCTION**

Nikola tesla(1856-1943) was one of the most great inventor in world history he invented the tesla coil, which is basically resonant air core transformer in 1891 he also did the work in the field of power and communication there invention have greatly changed the human life. Tesla coils or resonant transformer of high frequency and high potential have been used in many commercial application the tesla coil more than hundred years ago. Nikola tesla plans to transmit the electrical energy without wires. He thought that by building a big enough tesla coil, with enough high voltage, he could ionized the whole earth atmosphere, allowing it to conduct electricity.

The original circuit consisted of a high voltage AC supply, a spark gap, a capacitor, a primary coil linked to a secondary coil. The specialty of the secondary coil was that one end of the coil was open to air. The working of the coil is simple, when the high voltage supply is given to the circuit, the capacitor starts to charge. As the capacitor charges to its peak value no more current can flow thus the spark gap which is in parallel with it will start to ionize the air present in between. Due to the immense flow of current the air in between the spark gap will ionize and even though there wouldn’t be any physical connection, the air would conduct and the spark gap will fire up. Current will be transferred through air to the other end of the circuit. Once this happens the capacitor will discharge too.

This current will flow to the primary coil and a magnetic field will be produced which will be linked with secondary coil. Now when the electrons start to flow in the secondary coil towards the top they are breaking their equilibrium state. Thus they tend to fall down backwards, this causes a more positively charged region near the top load. So it pulls the electrons with more force now, due to which more number of electrons are attracted towards the top of the secondary coil each time. Once the top load gets saturated it too ionizes the air and releases a spark in the air. As the earth is the ground for the top load, we see a long spark being released by the top load. This process takes places continuously within milliseconds repeatedly causing a continuous discharge of sparks in the surroundings.

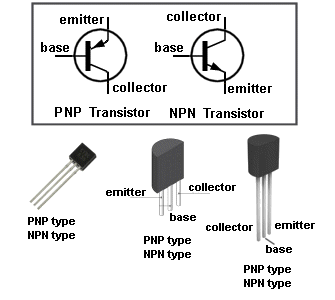
The output of the coil varies on a lot of factors. The value of capacitance, the length of the spark gap, inductance of the coil, number of turns, top load etc.

**DESIGN PROCEDURE**

The following are the specifications of the components used to build the tesla coil.

**1. TRANSISTORS:**

A transistor is a switch which three terminals. A base, emitter and collector. The collector is like a reservoir of current and the emitter is the destination. The opening and closing of the reservoir door is the base terminal. Whenever there will be voltage on the base terminal the doors will open and the charge will flow from the collector to the emitter, which is equivalent of a switch in an on state. As soon as the voltage drop equals to zero the doors will close and thus the switch will go to off state.



A transistor is used to replace the spark in a conventional tesla coil. Thus the choice of transistor has to be done very carefully. Depending upon its operation as a switch, response time etc. TP31C or 2n2222 are the two good choices. In the experiment 2n2222 is used.

**2. COILS**

The coils are basically two inductors which are magnetically linked to each other. Thus insulated copper wires are used for both the primary and the secondary windings. The number of turns, the thickness of the wire, the inductance influence the output of the circuit. Thus it is very important to pay attention and do rough calculations before making the coils. A key point is that both the windings should be in the opposite direction for the circuit to work. In the DC tesla coil they do not matter as much as they do in the conventional tesla coil as the procedure of tuning the coils is not required here.

**WORKING**

The operation of the device is quite simple to understand. The circuit is switched on by switching on the regulated power supply. The voltage is gradually increased from 0 to 60V approximately. Thus the current starts to flow from the positive end of the battery. Now as we

See the base-collector junction is reversed bias (Both the terminals are connected to the positive end) thus the junction would become reverse bias and the transistor would remain switched off.

The secondary coil has a huge amount of turns as compared to the primary coil. Now when the coil comes in contact to the primary coil the electrons start to flow upwards in the secondary coil. But due to state of equilibrium the electrons would want to remain in the same state. Reason for that is because the other end of the coil is open to air which means that the resistance is very high. Now due to the electrons not wanting to make an upward movement a positive charge starts to develop in the top half of the secondary coil. There is an electron

Deficiency and thus as more amount of linkage happens between the two coils more and more positive charge is developed. Due to this phenomenon the top half of the coil tries harder to pull the electrons present in the coil. This causes sudden high flow of electrons from the bottom of the coil to the top half. As we see the secondary is connected to the base of the transistor, the electrons are pulled from there too.

As the electrons are also sucked in from the base terminal of the transistor, this causes the flow of current into the base terminal to stop. Due to this the transistor is turned off and there is no flow from the collector to the emitter of the transistor. The field of the primary coil collapses and thus the circuit is turned off. This process takes places several times in a second. Thus a continuous stream of sparks are observed. Sometimes we observe that there is no visible spark at the end of the secondary coil. This may be case when the circuit is either not functioning properly or the coils are not tuned. Minor adjustments can be done to rectify the mistakes such as changing the resistance values or the length of the coils.

Now the testing of the device can be easily done by two methods. Number one is to visually see the sparks created by the secondary coil by brining any metal object near the open end. This will cause a small streak of lighting to the metal. The second would be brining any light bulb near the secondary coil. The field created by the secondary interacts with the gas present inside the light bulb, which ionizes the gas present inside them. This causes the electrons to excite and when they return to their normal state they emit light.

There can be a few reasons for the circuit to not work to full efficiency or not work at all. One of the issue can be the windings. One should make sure that the windings are in opposite directions and there should be proper insulation all through the windings. The turns made should not overlap each other as that will cause disruption in the field that is being created and thus will weaken it. The circuit should be connected properly and care should be taken to not have any loose ends as the output of the circuit is very high and may cause severe damage if care is not taken. Special instruments should be used to carefully check the voltage and current outputs as the normal meters won’t be able to detect the output.

**OBJECTIVE**

* We always saw the electrical energy in different forms. i.e. light fan. Through the tesla coil we can see electricity visually.
* The tesla coil electricity can transmit without wires.

**ADAVANTAGES**

• Charging is slow immediately after the spark gap fires.

• Provide excellent load sharing if 3 phase rectifier is use at high power.

• Allows power through put to be control by altering the rotary speed.

**APPLICATIONS**

• Spark gap radio transmitters.

• Induction and dielectric heating (vacuum tube & Spark gap radio transmitters

• Induction and dielectric heating (vacuum tube & spark gap types)

• Induction coils (differ only in the transformer core material being used).

• Medical X-ray devices (typically driven by an induction coil).

• Quack medical devices (violet-ray).

• Ozone generators

. • Particle accelerators.

• Electrical stage shows & entertainment.

• Generation of extremely high voltage with relatively high power levels

**EXPERIMENTATION**

A set of experiments were carried out to determine the output of the device. Different kind of tests were done to find the maximum range, Voltage and current outputs, spark lengths etc. Different sets of values were taken and different scenarios were set up to test the system.

The first experiment was to check the output range of the device with the variation of input voltage. For this experiment, the variable voltage source is kept at a constant voltage and then the

Light is brought near the secondary coil. As the light is brought near it starts to glow. As the distance increases the amount of brightness decreases. Thus the distance is proportional to the output of the coil. Then after a certain distance the light will stop laminating. This point was noted and is the maximum range for that specific voltage input. This experiment is repeated with different set of input voltages. The results show us a direct relation between the areas of the field is directly proportional to the input voltage being fed to the circuit.

There is no harm in holding the light in your hand as it will not cause any damage. The illumination is caused due to the excitation of the gas inside the filament and there no actual electricity flowing through the light. Thus there is wireless transmission of power. A piece of metal object should be taken near to the secondary coil. This would cause a sudden

Path for the electrons from the top load and a discharge would appear. Now to take the readings, gradually start increasing the voltage. As the voltage is increased an increase in the length of the sparks increases. To measure the length of the sparks, slowly move the metal object away from the open end of the coil. The spark would extended to its maximum limit and won’t appear

After the critical length, any measuring scale can be used to detect the length of the spark. Number of turns in the coils, input voltage both of these factors are massively responsible for the length of spark discharge.

**RESULTS**

1. The maximum spark that was fired was of length 2cm from the open end of the secondary coil

2. The maximum range of the output was 20cm from the open end of the secondary coil.

3. The maximum DC output recorded from the receiver circuit at 12V was 7.2V.

4. When multiple receivers were used the output was divided among the two depending upon the distance between them and the coil.

**CONCLUSIONS**

The goal of the this project was extend our knowledge of electrical electronics engineering and shed some light on the technical and artistic nature of Tesla coils, while attempting to create a unique and tesla coil. The coil that was created was capable of producing spark and spark was limited only by the lack of properly functioning of equipment. While there are a number of improvements that could be made the project served its initial purpose in creating a coil capable of acting as a power source and illuminating the finer points of creating such a coil. While designing the tesla coil we learned many things from our high voltage concepts and it also Helpful in brush up of our knowledge in practical application. We tried to design the unique

Tesla coil combining both electronics and electrical. By this project we minimized the distance between the electronics and electrical components as practical aspects.

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