Wireless Power Transmission of electricity for utilization of fused bulbs in rural India

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Abstract- Wireless power transfer of energy is used to transmit the electrical energy to an electrical load by giving a small amount of input current without any physical instrumental connection. The main problem which arises in wireless power transmission is the propagation loss. Over the long distances the transmission losses are very high. Tesla coil is the alternative solution to electrical energy transmission. The main advantage of using the tesla coil is that it uses the Electromagnetic field to transfer the energy. Our method provides a mobility solution for charging station for various electronic devices and novelty of our approach is to reuse the fused bulb which reduces the e-waste. We performed three experiments in which we change the Length of Secondary coil, Number of Turns in primary coil and the Diameter of the Secondary coil. The maximum electric and magnetic field observed were found to be 1400(V/m) and 99.9µT respectively. The primary focus of our research is to optimize tesla coil for the reusability of the fused or unused bulbs to reduce the e-waste in rural India.

Keywords: Wireless power transfer, Tesla coil, resonant coupling.

I. INTRODUCTION

During the last decade wireless transmission of electricity has been an essential requirement in many applications [1]. Wireless mobile charging station has become very popular during last few years. It is an economical approach in which efficiency is a substantial parameter. The proposed model provides a unique way to utilize the outdated (fused) fluorescent bulb. Cost has always been a challenge when using renewable energy resource like solar PV, biomass, biogas [2]. Near field Wireless power transfer topology can be categorize as electric induction and Magnetic induction of Wireless Power Transfer topology (WPTT) [3]. .

Our method utilizes the magnetic resonant coupling method in order to transmit the power wirelessly [4-8]. This method is based on electromagnetic field in which the waves doesn't propagates but creates an field around the transmitter [9-10]. The main advantage of such system is that the propagation loss is reduced, but the limitation to such system is that it has very low transmission distance [11-12].

II. WORKING PRINCIPLE

A. Concept of Electromagnetism

An oscillating magnetic field is induced inside the coil when an oscillating current travels across it. As a result, the voltage across the coil induces and tends to oppose the driving current [13][14]. According to Faraday's law, the EMF is the rate of change in magnetic flux:

$$\varepsilon = -N\ (d\phi_B/dt)$$

Where ,

N = number of turns of wire

ϕ_B= magnetic flux through a single loop

The Magneto-motive force (MMF) is the energy of magnetic fields. When a current flows, it creates an electromagnetic flux in thecase of a conductor material.

$$Fm = N \times I$$

When the N/I ratio reaches a saturation point, raising it no longer increases the flux(ϕ). Electrical energy will be generated in the model because of matching inductive and capacitive reactance. Resonance occurs at specific frequency for specific value of capacitance and inductance. It is used to filter and regulate the circuit. Electric field of capacitor and magnetic field of inductor will beperpendicular to each other.

B. LC circuit

Resonance is used to filter the circuit because it occurs at a particular frequency and y also depends on the exact value of inductance and capacitance [15][16]. LC circuit is designed to operate at high frequencies and for providing control of resonant frequency, the value of inductor and Capacitor can be adjusted [17]. The circuit diagram of LC circuit shown in figure 1 The inductive and capacitive reactance must be identical magnitude to reach resonance, as shown by,

$$\omega L = 1/(\omega C)$$

$$f = \frac{1}{2(LC)^{1/2}}$$

$$\omega = 2Mf$$

Where,

f = Resonance frequency in Hertz,L = Inductance in HenryC = Capacitance in farads.

When the same frequency is applied, resonant energy transfer, also known as resonant inductive coupling, based on near-field wireless transmission of energy in the form of electromagnetic radiation between two coils that reaches a highly resonant level [7].

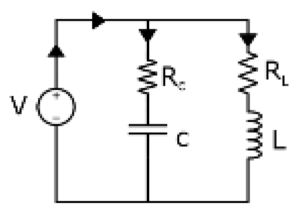


Figure.1 Schematic representation of LC circuit

Our research observed that the coupling in the Tesla coil work efficiently to provide electricity to supply a load wirelessly. Our work promises that in electrical appliances, there might be an elimination of wires in between power sources with the use of wireless power transfer.

While reviewing other research papers, most of the cases of Wireless Power Transfer (WPT) determines that the maximum transfer distance can be occupied when the alignment between the coil is coaxial [12]. But the efficiency will be reduced because of less coupling factor. Our work is different from this methodology. In our experiments, the coil alignment is in spiral so that the coupling factor will high for high power generation process and with the help of propagation of Magnetic(M-field) and Electric field(E-field) made by Toroidal propagation. This energy which generated as Electromagnetism form will be received by receiver circuit.

III. METHODOLOGY

If conducting matter is introduced in surrounding of a model, a potential difference can be produced via induced electric field that can cause charge separation. A coil of copper or another alloy material can effectively use to generate magnetic field. When the AC power is turned ON It generates an oscillating magnetic field in a conductive loop. With the help of coupling of coils, a pulsating magnetic field will be form in surrounding and that cause electric current flow through the second coil. Current will be generated by the second coil to energize the devices via Electromagnetism. Figure 2 shows the complete process of our experiment from generation to transmission.

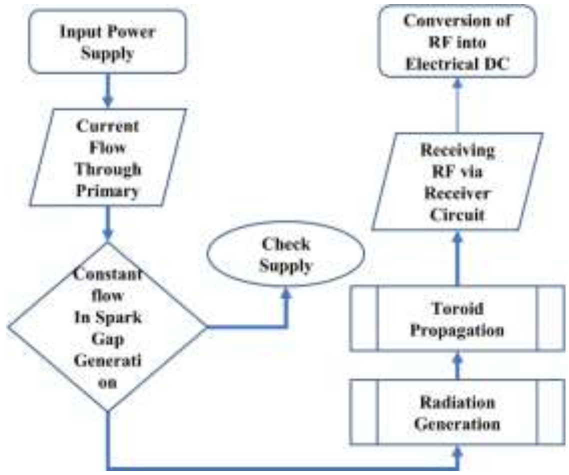


Figure.2 Methodology Diagram for the performed experiment

IV. RESULTS & DISCUSSUION

The output has based on the effect of electromagnetism and the distance between the bulb and the prototype. When the distance of a bulb from the prototype will increase, the intensity will decrease. As the frequency and the distance is indirectly proportional to each other.

Experiment:1

The first model is shown in figure 3, Bipolar N-P-N Transistor has used to protect the circuit. As it required small amount of current up to 0.5A and voltage up to 30 V. So the capacitor has no role in this circuit. If we use capacitor for the continuous flow of current that cause overheating or burning of Transistor. The coil parameters are shown in Table 1 and the desired output of frequency, Voltage and E-Field, M-field with respect to the distance has been shown in figure 4 and figure 5 the quantity of E-field and M-field radiation has shown in Table 2

Table 1. Parameter of experiment 1

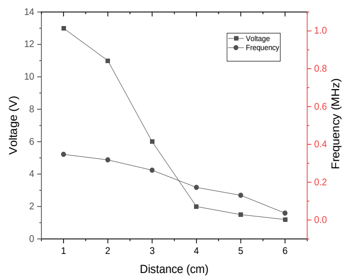
Parameter	**Value**
Primary coil Turns	5
Secondary coil Turn	~450
Length of Secondarycoil	150mm
Diameter of SecondaryCoil	20mm
Primary wire width	2.2mm
Secondary wire width	0.96mm

Figure 3. Experimental setup for Prototype 1.

Table 2. Radiation and Frequency in experiment 1

Distance (cm)	E-field radiations(V/m)	M-field radiations(uT)	Frequency(MHz)
1	350-200	5-5.50	5.217MHz

2	220-150	4-5.5	4.876MHz.
3	200-175	2.5-3.5	4.24MHz
4	100-75	2.0-3.0	3.178MHz
5	90-35	1.5-2.2	2.69MHz
6	<60	<1.0	1.59MHz



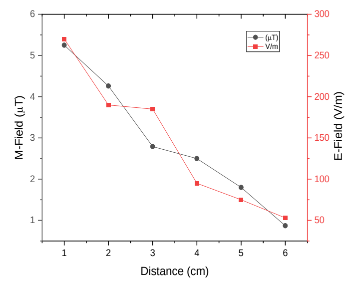


Figure 4. Graph of Frequency and voltage with respect to distance. Figure 5. Graph of E-field and M-field with respect to the distance.

Experiment 2:

Second prototype is shown in figure 6. Here the structure is approximately the same as first prototype. The difference is the size, number of turns and width of the coil. The output will be correspondingly high as compared with the previous circuit shown in Table 3 and the parameter for this experiment has shown below in Table 4. Here's Graph of frequency, Electric field and Magnetic field shown in figure 7.

Where, d is the distance perpendicular to the coil in cm and f is the frequency which can vary in kHz/MHz/GHz.

Table 3. Parameter of experiment 2

Parameter	Value
Primary coil Turns	7
Secondary coil Turn	650
Length of Secondary coil	300mm
Diameter of Secondary Coil	20mm
Primary wire width	2.9mm
Secondary wire width	0.96mm

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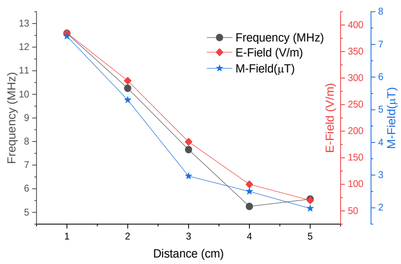

Figure 6. Experimental setup for experiment 2, Figure 7. Graph of frequency, E-field and M-field w.r.t the distance

Table 4. Radiation and frequency in experiment 2.

Distanc e (cm)	E-field radiations(v/m)	M-field radiation	Frequency(MHz)

		(µT)	
1	350-400	6-7.50	12.586MHz
2	220-300	4-5.5	10.256MHz
3	150-200	2.5-3.5	7.658MHz
4	70-120	2.0-3.0	5.249MHz
5	50-100	1.5-2.2	5.560MHz

Experiment 3:

In this experiment, different methodology has introduced in which spark gap have installed and to maintain the constant flow of current, capacitor band has used as shown in figure 8. The difference in this prototype is in the input circuit and the Toroid material to maintain its reasonable output. Now, the rechargeable batteries have been used for this prototype as it required continuous flow of current. As, the capacitor band has connected in parallel by which it maintains the spark gap so that the intensity in the bulb will be consistent. In this prototype, only three capacitors have been used. Number of capacitors can be calculated by RMS voltage divided DC Voltage of capacitor as capacitor is of Cornell-Dubliell so its capacitance and DC voltage is 0.15µf, 2000V DC. Since the methodology is different from the previous ones, The output will be high as compared to the previous circuit shown in Table 6 and the parameter for this experiment has shown in the Table 5.

Table 5. Parameter of experiment 3

Parameter	**Value**
Primary coil Turns	8
Secondary coil Turn	~800
Length of Secondary coil	150mm
Diameter of Secondary Coil	20mm
Primary wire width	3.0mm
Secondary wire width	0.96mm

Figure 8. Experimental setup for prototype 3..

Table 6, Radiations and frequency in experiment 3

Distance(cm)	E-field radiations (V/m)	M-field radiations(µT)	frequency
1	1300-1400	99.99	35MHz
2	1100-1200	77-89	31MHz
3	600-700	75-85	26MHz
4	200-250	65-70	18MHz
5	150-200	40-55	11MHz

V. CONCLUSION:

This system gives a way to have a mobile glowing bulb through an electromagnetic induction method without any direct contact with a power source. We have tested different prototypes based on change in distance and turning of coils. It leads thesystem to give higher output with high radiations. This technology can be very helpful in hilly and rural areas where there areplenty of power issues. Our proposed structures have been installed in few nearby villages for test run also. The future of this technology focuses mainly the remote areas of India as well as State such as Uttarakhand.

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