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A Practical Approach for Electrical Energy, Power Transfer Wirelessly-Green Technology

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Abstract- This paper presents a practical approach for wireless power transfer by inductive coupling. As the protection of environment from pollution green cars (electric cars) are emerging out now a day increasing the requirement of electricity but lacks in electricity power sockets. So to solve this problem a new technology of wireless electricity can be used to charge these electric cars which are more reliable.

Under this research, working principle is presented about the design and implementation of wireless power transfer. The experiment results also show the validity of the theoretical analysis. During this research investigation for the need of wireless power transfer and comparison with different materials of coil used was done to demonstrate the power transfer.

The advantages, disadvantages, biological impacts and applications of WPT are also presented.

Index Terms- Inductive coupling, Nikola Tesla, Wireless Power Transmission.

I. Introduction

This idea came from the availability of limited power sockets. Thus creating wireless power transfer system which is helpful in discarding a bunch of wires. Making the system more systematic. Wireless power transfer is devices which transmit a signal which is useful for electronic devices to charge or work. It is a means by which large amounts of electrical energy may be transmitted through the atmosphere from a power source in one location to a receiver and consumer of electric power at another location. Although these devices can be one of many portable electronic products utilized today (laptops, cell phones, iPods, PDAs, lawnmowers, etc.), the primary focus initially will be on electric vehicles, and in particular vehicles for public transportation.

According to the World Resources Institute (WRI), India's electricity grid has the highest transmission and distribution losses in the world – a whopping 27%. Numbers published by various Indian government agencies put that number at 30%, 40% and greater than 40%. This is attributed to technical losses (grid's inefficiencies) and theft [1]. This problem can be solved by an alternative option for power transmission which could provide much higher efficiency; low Transmissions cost and avoid power theft. Power Transmission wirelessly is one of the hopeful technologies and may be the decent alternative for efficient power transmission.

History- Electrical Energy Power Transfer Wirelessly

Nikola Tesla he is who invented radio and shown us he is indeed the "Father of Wireless". Nikola Tesla is the one who first conceived the idea Wireless Power Transmission and demonstrated "the transmission of electrical energy without wires" that depends upon electrical conductivity as early as 1891[2]. In 1893, Tesla demonstrated the illumination of vacuum bulbs without using wires for power transmission at the World Columbian Exposition in Chicago. The Wardenclyffe tower was designed and constructed by Tesla mainly for wireless transmission of electrical power rather than telegraphy [3].

II. Components of Power Transfer Wireless System

The Primary components of Wireless Power Transmission are Inductive coils, the transmitter consisting of a frequency amplifier circuit which increases the frequency of the supply voltage from 50Hz to 10 MHz; the components used to make the transmitter circuit are mosfets, resistors, capacitors and inductors.

III. ADVANTAGES, DISADVANTAGES WPT

A. Advantages

Green

This Eliminate unnecessary cords and outdated battery solutions, while reducing energy wasted through inefficient battery chargers.

Freedom of positioning

Wired circuits have limited flexibility of positioning while wireless circuits give the flexibility of operating electronic items without wires and independently.

Eliminates power cords and adaptors

Multiple devices are supported by a single primary, eliminating the need for multiple separate power supplies or chargers.

B. Disadvantages

The Capital Cost for practical implementation of WPT seems to be very high and the other disadvantage of the concept is the high frequency which is harmful for long term use but the CEO of WiTricity Corporation says that WiTricity is safer than using a Smartphone.

HEALTH AND SAFETY

If worried about the health implications of yet another wireless signal coursing through your body, according WiTricity corporation wireless electricity is safer than using a Smartphone. These technologies have long term effects.

IV. PRACTICAL APPROACH FOR ELECTRICAL ENERGY, POWER TRANSFER WIRELESSLY

The purpose of this project is to supply power wirelessly to the load which is connected to the secondary coil. The system includes a systematic process which is explained further

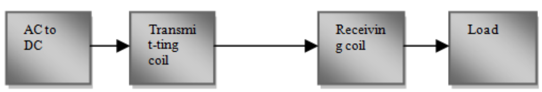

Figure 1. Functional Block Diagram of Wireless Power Transmission System

A. *POWER USAGE*

The system uses 12V, 5A D.C power

$$P = V * I$$
$$P = 12 * 4$$
$$P = 48 \text{ Watts}$$

B. *REQIREMENTS*

Wireless power transfer-

Resonant inductive coupling or electrodynamics induction is the near field wireless transmission of electrical energy between two coils that are tuned to resonate at the same frequency. [1]

If resonant coupling is used, each coil is capacitive loaded so as to form a tuned LC circuit. If the primary and secondary coils are resonant at a common frequency, it turns out that significant power may be transmitted between the coils over a range of a few times the coil diameters at reasonable efficiency. Inductive coupling uses magnetic fields that are a natural part of current's movement through wire. Any time electrical current moves through a wire, it creates a circular **magnetic field** around the wire [2]. Bending the wire into a coil amplifies the magnetic field. The more loops the coil makes, the bigger the field will be.

Efficiency-

The major problem of inductive coupling is the output efficiency as the distance increases between the primary and secondary coils the efficiency decreases. Even the power at output is not equal as input, inductive coupling suffers from various losses of power during transmission.

The efficiency of the system depends on the size of the primary and secondary coils if the size of primary and secondary is same the efficiency will be maximum this phenomenon is also known as tuning as according to resonance condition.

$$C_1 \times L_1 = C_2 \times L_2$$

According to this the product capacitance and inductance in primary and secondary must be same for maximum efficiency.

C. *Power Transfer*

The power is wirelessly transferred via resonant inductive coupling. The primary and secondary is coupled with a resonant capacitor, the primary and secondary is tuned to a frequency to let them communicate to transfer power and to receive maximum frequency.

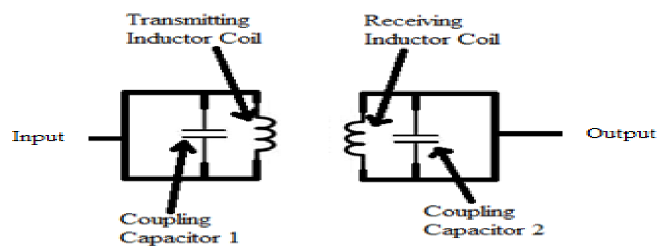

Figure 2. - Basic diagram of primary and secondary circuits

D. *DESIGN*

The transmitting and receiving coils is the main part of the system which is coupled with a capacitor as according to the condition of resonance the primary and secondary must be coupled with the equal value of capacitance and inductance.

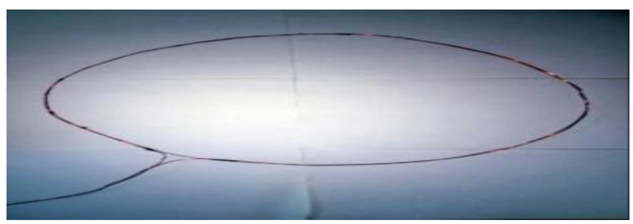

Figure 3- Size of coil

TABLE I
coil parameters

Item	Diameter	No. of turns
Transmitting coil	50cm	4
Receiving coil	50cm	2

E. *Constructions-*

1) **Transmitting and receiving 19Gauge copper super enameled wire-**

The transmitting and receiving coils are made up of 19 gauge copper super enameled wire. The diameter of coils is 50cm.

2) **Transmitting and receiving with breadboard aluminium wire-**

The transmitting and receiving coils is made up of breadboard wire the diameter is 20cm.

F. *Testing-*

1) **Setup-**

The transmitting and receiving coils is coupled with the resonant capacitors as to follow the condition of resonance. The supply is provided from a 12 volts 5A transformer which is connected to the transmitter circuit.

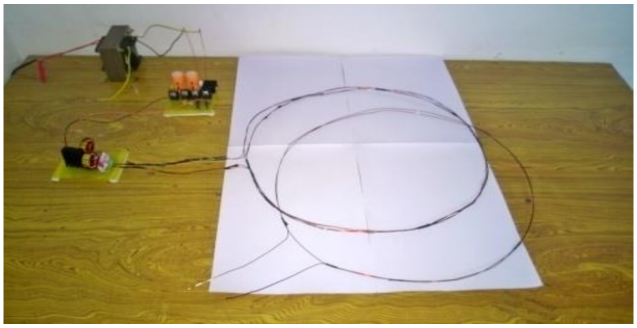

Figure 4- Setup of Wireless power transfer

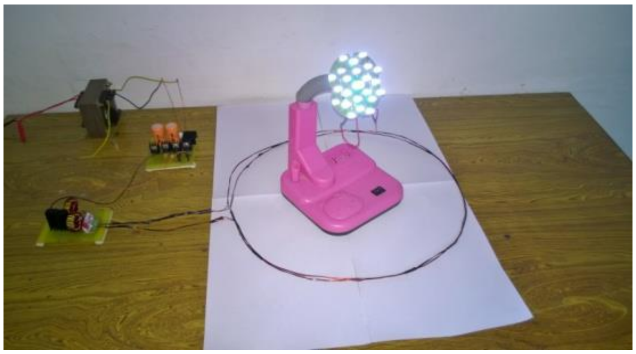

Figure.5- Operating a lamp wirelessly via resonant inductive coupling.

V. CALCULATIONS AND RESULTS

A lamp is connected to the secondary which is able to transfer 102MHz. successfully at 10watts another method of transmission is via microwaves which is ranging in kilometers.

The data below is the output voltages and efficiencies by using different coil material.

TABLE III
Output voltages and efficiencies by using different coil material

Coil Type	**I/P voltage**	**O/P voltage**	**I/P current**	**O/P current**	**I/P power**	**O/P power**
Copper enameled wire(19gauge)	12V	31V	4A	3.5A	48W	108 W
Breadboard aluminium wire	12V	25V	4A	2.42A	48W	60.5 W

Power = Voltage x Current
Input Power = 12 x 4 = 48 Watts

Copper enameled wire-
Output Power = 31 x 3.5 = 108 Watts

Breadboard aluminium wire-
Output power = 25 x 2.42 = 60.5 Watts

As the diameter of secondary is decreased as compared to primary the efficiency also decreased.

In Figure 5 the secondary coil is inside the lamp which is much smaller than the primary as a result of which efficiency is directly affected.

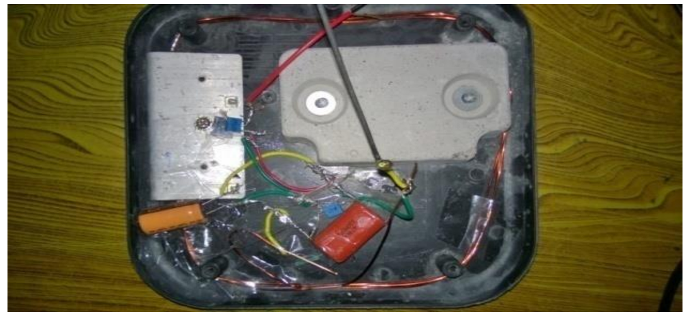

Figure 6 -secondary coil of lamp along with the resonant capacitor and rectifier circuit.

Keeping the primary of 50cm diameter

TABLE IIIII
Parameter of smaller coil

Coil Type	*Output Voltage*	*Output Current*	*power*
Smaller than primary(copper)	20V	0.53A	10Watts

According to above result the output efficiency total depends upon the size of secondary coil.

As the size of secondary is reduced with respect to primary the efficiency will decrease vigorously.

So for maximum efficiency the diameter of coil must be same.

Frequency-As there are three methods of power transfer i.e. high Voltage, high frequency and microwaves. The method used in this project is via high Frequency; the frequency received on the lamp is 102 KHz .Similarly, on the secondary whose size is same as primary the frequency is 5 MHz

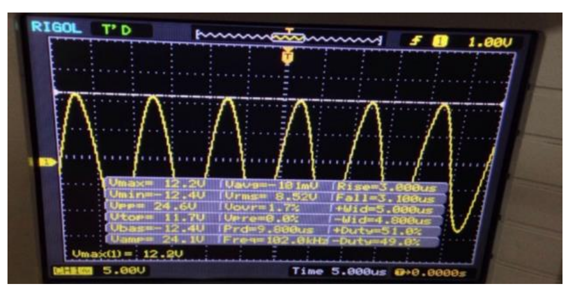

Figure 7 -Output frequency waveform with load.

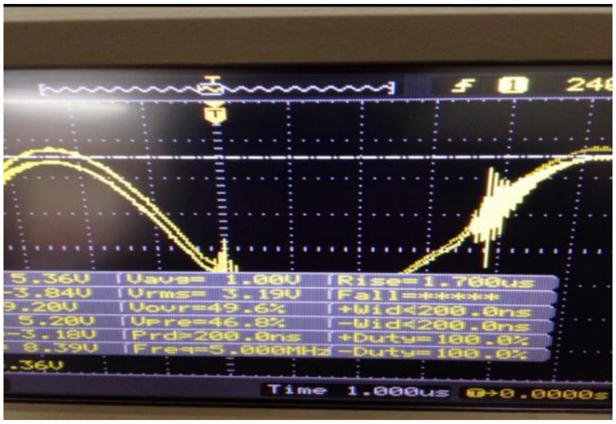

Fig.8- output frequency of same sized coils without load.

TABLE IVV
output at secondary coil

Coil	*Frequency*
Lamp Coil	102 KHz
Secondary of 50cm too	5 MHz

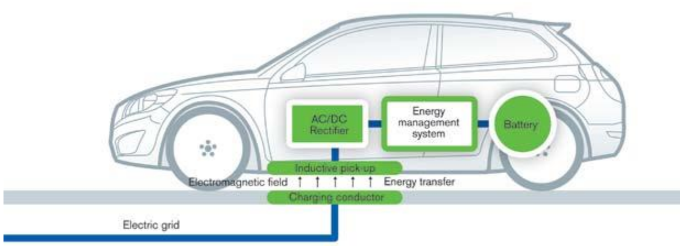

Figure 9– Wireless car charging (Block Diagram)[6]

VI. Conclusion

The result obtained by the project is less than the Q_i standard. There are more complications which is responsible to make the system more difficult to build. With such a design, power transfer for laptop-sized coils is more than sufficient to run a laptop.

As long as the laptop is in a room equipped with a source of such wireless power, it would charge automatically, without having to be plugged in. In fact, it would not even need a battery to operate inside of such a room." In the long run, this could reduce our society's dependence on batteries, which are currently heavy and expensive.

At the same time for the long range power transmission, power can be sent from source to receivers instantaneously without wires, reducing the cost [7].

Future Scope

As we know that for protection of environment from pollution green cars (electric cars) are emerging out now a day. This increases the requirement of electricity but lacks in electricity power sockets. So to solve this problem a new technology of wireless electricity can be used to charge these electric cars which are more reliable.

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