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Wireless Transmission of Electrical Energy by using Inductive Coupling

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Abstract-*In this paper, we are discussing concept of transmitting power without wires. The various technologies are now evolved for wireless transmission of electricity and the need for a wireless system of energy transmission is being discussed here to find its possibility in actual practices, their advantages, disadvantages and their feasibility. Many theories, research papers, patents are available on wireless transmission of electricity but its practical use is not started yet. The paper briefly explains the possible ways to get useful and practical results out of all research carried out so far elsewhere.*

***Keywords*—Wireless Power Transmission (WPT)**

I.INTRODUCTION

Wireless power transmission (WPT) is the efficient transmission of electric power from one point to another through vacuum or an atmosphere without the use of wire or any other substance. This can be used for applications where either an instantaneous amount or a continuous delivery of energy is needed, but where conventional wires are unaffordable, inconvenient, expensive, hazardous, unwanted or impossible. The power can be transmitted using inductive coupling for short range, resonant induction for mid range and electromagnetic wave power transfer for high range. WPT is a technology that can transport power to locations, which are otherwise not possible or impractical to reach. Wireless power transfer (WPT) or wireless energy transmission is the transmission of electrical power from a power source to a consuming device without using solid wires or conductors. Wireless power system consists of a "transmitter" device connected to a source of power such as mains power lines, which converts the power to a time-varying electromagnetic field, and one or more "receiver" devices which receive the power and convert it back to dc or ac electric power which is consumed by an electrical load. One of the major drawbacks in current power distribution system is the losses during the transmission of electrical energy. As the demands of power are increasing conveniently, power generation also increases and this leads to increase power loss during transmission. Our present transmission system is only 70-74% efficient this means about 1/3 of our generated power is waste in distribution [1]. Now-a-days global scenario has been changed a lot and there is tremendous development in every field. So we have to keep pace for development of new power technology. The transmission of power without wires may be one noble alternative for electricity transmission.

2. HISTORY OF WPT

Nikola Tesla conducted the first experiments in wireless power transfer at the turn of the 20th century. From 1891 to 1898 he investigated wireless transmission of electrical energy using his radio frequency resonant transformer called the Tesla coil, which produces high voltage, high frequency alternating currents. The Tesla coil was first developed as a high-voltage radiofrequency power supply for his "System of Electric Lighting" patented in 1891. With this basic resonance transformer design concept he was able to transmit electrical energy over short distances without interconnecting wires by means of resonant magnetic inductive coupling

The transformer's primary LC circuit acted as a transmitter. The transformer's secondary LC circuit was tuned to the primary LC circuit's resonant frequency and acted as a receiver. The Tesla coil transformer itself could be configured as a wireless transmitter and used to transmit energy by capacitive inductive coupling. While demonstrating this technology during lectures before the American Institute of Electrical Engineers in 1891, the Institution of Electrical Engineers in 1892 and at the 1893 Columbian Exposition in Chicago he was able to wirelessly power lamps from across the stage and out into the room.

In 1899 Tesla moved his wireless transmission research to Colorado Springs, Colorado. At the Colorado Springs Experimental Station he assembled an enormous version of his resonance transformer called a Tesla coil magnifying transmitter, capable of producing voltages on the order of 10 megavolts. In one demonstration, using just the primary circuit energized to only one-twentieth of the oscillator's full capacity, he was able to light three incandescent l a m p s by resonant inductive coupling to an improvised secondary circuit at a distance of about one hundred feet

3. WIRELESS ENERGY TRANSMISSION TECHNOLOGY

3.1. Electromagnetic induction method

The basic concept behind electromagnetic approach of WPT is magnetic induction between two coil say transmitting and receiving coil. When transmitter coil is excited than it generates flux and when receiver coil receives this flux a potential difference is developed across its terminals. The potential difference developed in receivers is directly related to distance between transmitter and receiver coil. Fig.1 shows the basic model for WPT.

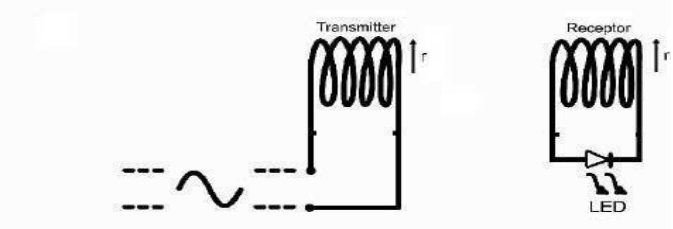

Fig-1: Basic Concept of WPT

This is the basic model and its efficiency is very poor and cannot be used for large distance transmission.

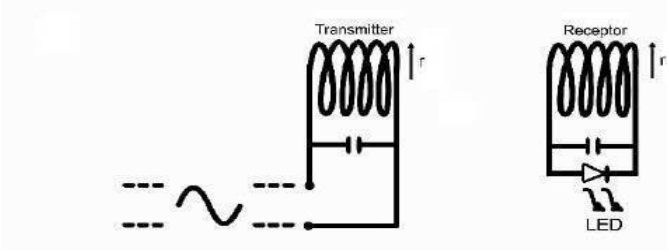

Fig-2: Modification using Coupling

We can enhance its efficiency by inductive coupling as shown in fig.2. But after this also we cannot use it for long distance transmission

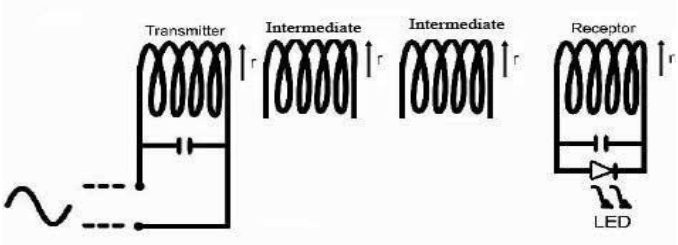

Fig-3: WPT with intermediates

For transmitting power through this method for long distance we have to introduce intermediate coils between transmitter and receiver as shown in fig.3.In general term this intermediate coils is called repeaters These repeaters increase efficiency of transmission. We can also use spiral coil for making transmitter and receivers. Efficiency is improved by using spiral based WPT.

4. BASIC DESIGN AND IMPLEMENTATION OF WIRELESS POWER SYSTEM

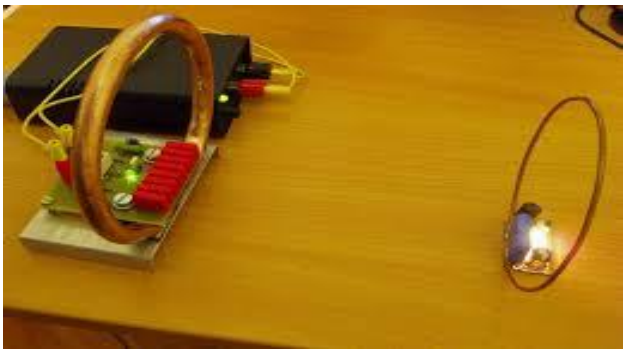

Fig-4.1: Practical Model

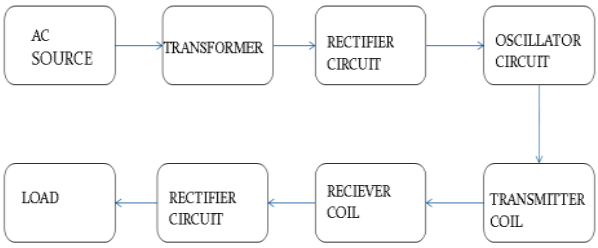

Fig-4.2: Block Diagram of WPT System

4.1 AC Power Source

In the wireless power transmission the 230V AC supply is given. And this AC supply then given to the step down transformer.

4.2 Step Down Transformer

The 230V AC supply is then gives to the transformer which is a step down transformer. As because the transformer only operates on AC supply it is necessary to give the AC supply to the system. This is the step down transformer that steps down the voltage from 230V to 24V with increasing the current.

4.3 Rectifier Circuit

The rectifier is covert the AC signals to DC signals. In this we used the bridge rectifier because the bridge rectifier works in both positive and negative half cycle. That gives full wave rectification. The rectifier is takes the 24VAC supply from transformer and convert it into 24V DC that requires for the circuit.

4.4 Oscillator Circuit

In this project the oscillator circuit is requires for generating the frequency up-to 1MHz. As well as it converts the DC supply return to AC.

4.5 Transmitting Coil

The transmitter coils are made up of copper coils, the supply is given from the oscillator is goes in this coils. Because step of down voltage the current is increases and this current is required for the produce the magnetic field. Due to current the flux are produces surrounding the coils and because of this the magnetic flux is produces between the transmitter and receiver coil.

4.6 Receiver Coil

The receiver coils are also made up of copper, the receiver receives the electric current from the transmitter. There is AC supply is takes place. Then the supply is given to the rectifier circuit that converts the AC signals to DC signals

4.7 LOAD

The 12V DC supply is comes from rectifier which having the wattage of 12 Watts. The load is used are the LED's or the DC Fan.

5. MERITS

1. Wireless Power Transmission system would completely eliminates the existing high-tension power transmission line cables, towers and sub stations between the generating station and consumers and facilitates the interconnection of electrical generation plants on a global scale.

2. The power could be transmitted to the places where the wired transmission is not possible. Loss of transmission is negligible level in the Wireless Power Transmission; therefore, the efficiency of this method is very much higher than the wired transmission.

3. Power is available at the rectenna as long as the WPT is operating. The power failure due to short circuit and fault on cables would never exist in the transmission and power theft would be not possible at all.

4. The main advantage of this technology is it does not require the wire because it wirelesses.

5. As there is no use of wires that means there is no extra wastage of wires.

6. Also due to that the losses that takes place in wired transmission such as copper loss, corona loss etc. are eliminated.

7. The weather does not affect the transmission as there is no wires are used.

6. DEMERITS

1. Capital Cost for practical implementation of WPT to be very high.

2. The other disadvantage of the concept is interference of microwave with present communication systems.

3. Common belief fears the effect of microwave radiation.

4. But the studies in this domain repeatedly proves that

5. the microwave radiation level would be never higher than the dose received while opening the microwave oven door, meaning it is slightly higher than the emissions created by cellular telephones

6. In wireless power transmission distance creates the issue in transmission. Because as increasing the distance of the transmission the strength of the magnetic field getting weak and therefore the efficiency of transmission can be reduce.

7. APPLIATIONS

- It can be used in electronics consumer such as cell phones, laptop etc.

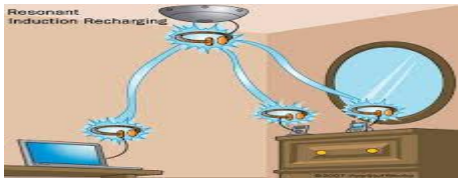

Fig-7.1: Application in Electronics Devices

- It is also used in industrial applications.
- Wireless power transmission used for in electric vehicles.

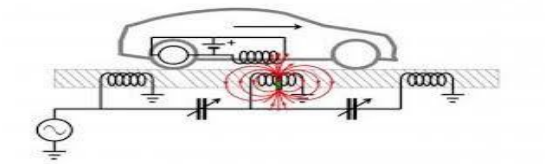

Fig-7.2: Electrical Car Charging

- Other applications such as in medical, military etc.
- This can also used for the charging of artificial hearts.

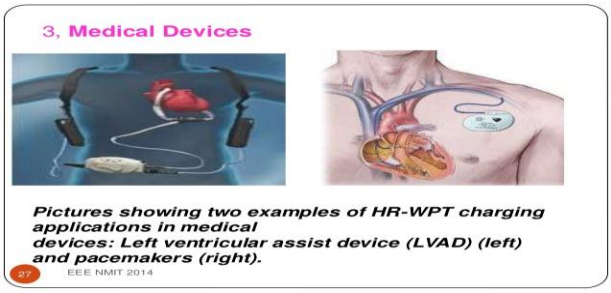

Fig-7.3:.Application in Medical

8. DISCUSSION

In our project the main goal was to design and implement a system that transmits power from one circuit to another circuit without wire. In this purpose, a transmitter circuit was implemented. At the end of the transmitter circuit an antenna was connected, which transmits the power. Another antenna was used to receive the power wirelessly from the transmitter circuit. In this project hollow copper pipes were used as antenna, because it has high Q-factor and high power handling performance. It requires a huge task to implement the whole project. During implementation a number of remarkable problems were faced and were solved as well. Though these implementation sessions require patience, it gives a great pleasure after successful solution.

9. SUGGESTIONS FOR FUTURE WORK

The circuit was just a trivial representation of a wireless power transfer concept. The time and bulk effort needed to take the project to perfection was not manageable.

To transmit the power to a greater distance, a high power radio frequency amplifier connected with an oscillator is needed. But the construction of the bulky RF power amplifier requires much time and patience. High power vacuum tube transistor amplifier with high current will make the system more efficient. A crystal oscillator circuit might be a better option for the transmitter circuit since it can produce a very high frequency A.C. current. Use of resonant inductive coupling instead of inductive coupling will increase the efficiency, power transfer and range to a new level. Further effort on this same project can yield some real solutions that can solve the problems of this project. The knowledge of this project will help those who want to design a wireless transfer system.

10. CONCLUSION

The goal of this project was to design and implement a wireless transfer for low power devices via inductive coupling. After analyzing the whole system step by step for optimization, a system was designed and implemented.

Experimental results showed that significant improvements in terms of power-transfer efficiency have been achieved. Measured results are in good agreement with the theoretical models. It was described and demonstrated that inductive coupling can be used to deliver power wirelessly from a source coil to a load coil and transfer the power wirelessly. This mechanism is a potentially robust means for transmission of power wirelessly. As it was mentioned earlier, wireless power transmission could be the next big thing

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