WIRELESS POWER TRANSMISSION

Puneet[1]

[1]*Department of Electrical Engineering, GNDEC Ludhiana*

Abstract

In a Complex network of power transmission & distribution a wireless technology has to be developed for simplicity and reliability. The various factors like costs and losses can be reduced by developing wireless transmission technology. Thus our concentration is to eliminate the wires to large extent. This research paper will focus on technical areas for wireless power transmission and its applications.

Keywords- *Microwave, Radio wave, Rectenna, Solar Power Satellite, Wireless*

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1. INTRODUCTION

As the name suggests, wireless power transmission means a transfer of power without the help of wires. This is necessity of the present time. In a power transmission a various factors come like a line losses due to capacitance, inductance and resistances in a line, a surge in line due to lightning, insulation failure, theft and various others. Thus we can't use the large extent of power that utilities generate. Thus these losses have to be eliminated. A various techniques are developed to decrease these losses but we can't eliminate them completely. As per figures by World Resource Institute (WRI), in India has a higher transmission and distribution losses in the whole world. These losses include technical losses and theft. Thus these prove the inefficiency of system. Thus it is uneconomical to continue same process of transmission. Various efforts are done for wireless power transmission from the past. NikolaTesla, a father of wireless technology successfully tested and lighted an incandescent lamp by means of a resonant circuit grounded on one end.

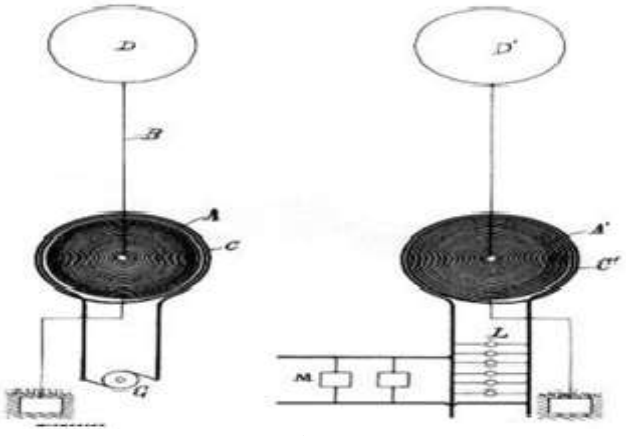

Fig.1

The lamp is lighted by the current induced in the three turns of wire wound around the lower end of the coil. In past the various efforts are done to introduce worldwide wireless power transmission but the lack of technology and funding make these efforts unsuccessful.

2. VARIOUS WIRELESS POWER TRANSMISSION RANGES & TECHNIQUES

Power can be transmitted wirelessly up to different ranges with different techniques-:

2.1 Short Range

When the power to be transmitted up to few centimeters then we can say power is transmitted wirelessly in a short range or in a small distance.

- Techniques for Short distance wireless transmission

2.1.1 Inductive Coupling

A very simple example of wireless power transfers is transformer. The primary and secondary winding of transformer are electrically isolated from each other. The secondary emf is induced in transformer wirelessly by magnetic coupling between coils as explained by Faraday's Law of emf induction

2.1.2 Capacitive Coupling

This is also a method of wireless power transfer within the electric network. The electric field in a network produces displacement current between the nodes of the circuits.

2.2 Moderate Range

A wireless power transfer up to few meters (1to5m) comes under moderate range.

- Technique used for Moderate distance wireless transmission

2.2.1 Resonant Inductive Coupling

This methods is also known as electrodynamic induction. This type of wireless power transfer contains a resonant circuit i.e. LC circuit which can be tuned. The power is transferred between two magnetically coupled coils. The coils must be a part of resonant circuits. The frequency of both coils is tuned such that both coils must resonate at same frequency. The power is transferred over a range of 5m.

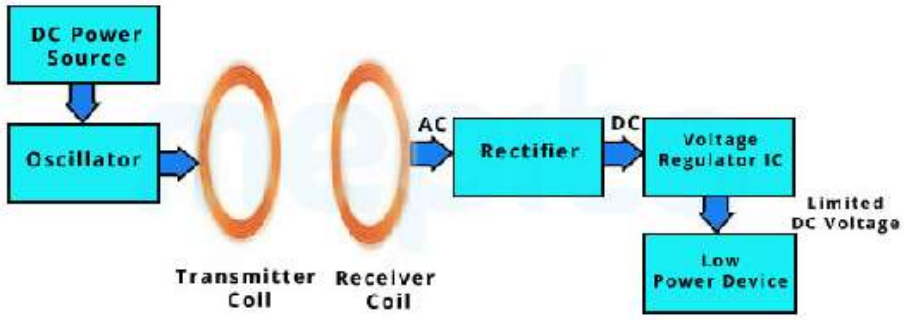

Fig. 2

The fig. 2 shows a basic layout of power transfer for a resonant circuit between two coils wirelessly

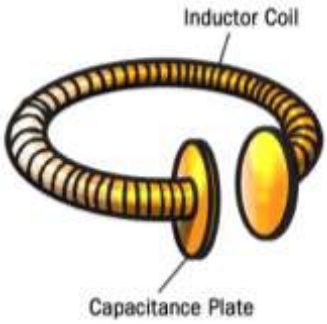

Fig. 3

This figure 3 shows an inductor and capacitive plate. Thus it is a LC or resonant circuit. The Capacitive plates charged and share power with resonant circuit which is tuned at same resonant frequency as the source resonant circuit.

According to the theory, one coil can recharge any device that is in range, as long as the coils have the same resonant frequency.

Fig. 4 represents a wireless recharging of devices

2.3 Long Range

This is the most important point of wireless power transfer. The long range power transfer is the very important need of today to reduce all the complexity, losses in the network. Many experiments are done in this line, since there is not much development is done on long range power transmission however the research over development of long range transmission techniques is going on.

- Most recent techniques used over long range power transmission is by power beaming. This done by transmitting power by radio wave making their wavelength limits smaller, particularly in microwave band of electromagnetic spectrum

2.3.1 Microwave Power Transmission

William C. Brown an American electrical engineer has the large contribution to the development of modern wireless power transmission technique. In the early 1960's Brown invented a rectenna (rectifier circuit+antenna) which directly converts microwave to DC current. He demonstrated his invention by powering a helicopter from the distance through microwave in 1964.

The Microwave power transmission consist three main components -:

2.3.1.1 Microwave Generator

The microwave transmitting devices are classified as Microwave Vacuum Tubes (magnetron, klystron, Travelling Wave Tube(TWT), and Microwave Power Module (MPM)) and Semiconductor Microwave transmitters (GaAs MESFET, GaNpHEMT, SiC MESFET, AlGaN/GaN HFET, and InGaAS). Magnetron is widely used for experimentation of WPT.

2.3.1.2 Transmitting Antenna

The slotted wave guide antenna, microstrip patch antenna, and parabolic dish antenna are the most popular type of transmitting antenna. The slotted waveguide antenna is ideal for power transmission because of its high aperture efficiency (> 95%) and high power handling capability.

2.3.1.3 Receiving Antenna

This is the most important part of whole system.. This is the main discovery of William C. Brown. This receiving antenna is called Rectenna. This is so called because it consists of rectifying circuit with a low pass filter between the antenna and rectifying Diode which convert microwave received directly into DC current.

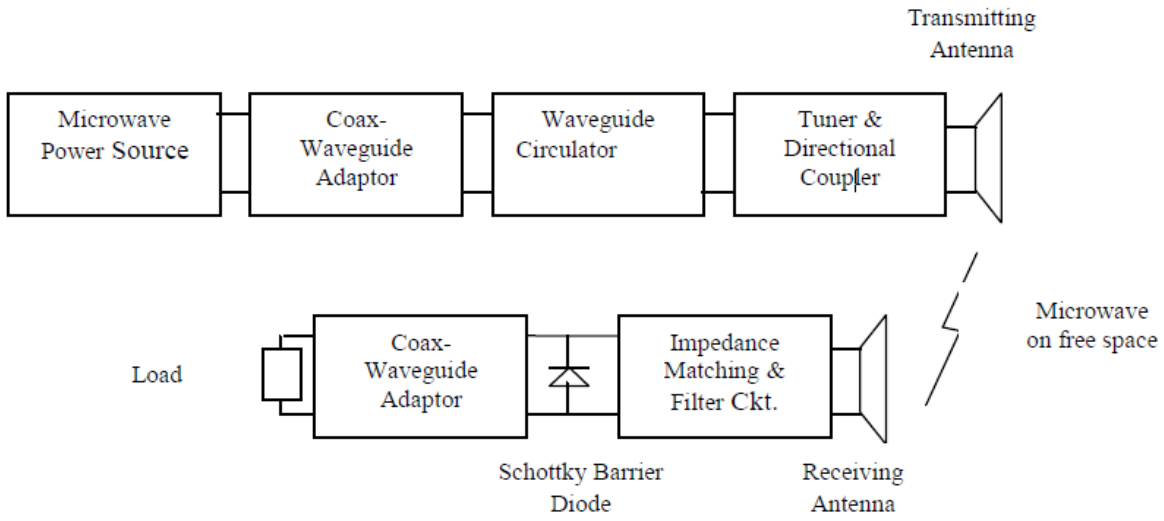

Fig. 5: Functional Block Diagram of Wireless Microwave Power Transmission System

Advantages- Wireless Microwave Power Transmission system is able to eliminate the existing high-tension power transmission line cables, towers and sub stations between the generating station and consumers completely and facilitates the interconnection of electrical generation plants on a global scale. We can locate a transmitter and receiver by our choice. We can choose mobile transmitter and receiver also. The other advantage is reduction of line losses, reduction of cost of transmission line and its maintenance cost, reduction of theft.

Disadvantages- There are some limitation and disadvantages also of wireless microwave transmission like interference of microwave with existing communication signals.

2.3.2 Laser Transmission

Laser is a source of light with a difference from others that it emits light coherently. Power can be transmitted wirelessly by converting the power to laser radio frequency and is allowed to focus on a tight spot. Laser beam is allowed to spot at a photovoltaic cell. This mechanism is generally known as "power beaming" because the power is beamed at a receiver that can convert it to electrical energy.

Advantages- There is lot of advantages in this system It allows narrow beam cross-section area for transmission over large distances; Compact size; No interference to existing radio communication.

Disadvantages- There are various disadvantages too. Laser radiation is hazardous. Conversion between electricity and light is inefficient. Photovoltaic cells achieve only 40%–50% efficiency. Atmospheric absorption, and absorption and scattering by clouds, fog, rain, etc. It requires a direct line of sight with the target. This method has been used in military and aerospace applications.

3. SOLAR POWER SATEELITE CONCEPT

This is the very relevant and simple way of transmitting power wirelessly for long distance i.e. to space to earth similarly like our cell phones receive signals from the satellite in the space. Actually solar power satellite transmission of power is the part of microwave wireless power transmission or we can say this is the application of microwave power transmission.

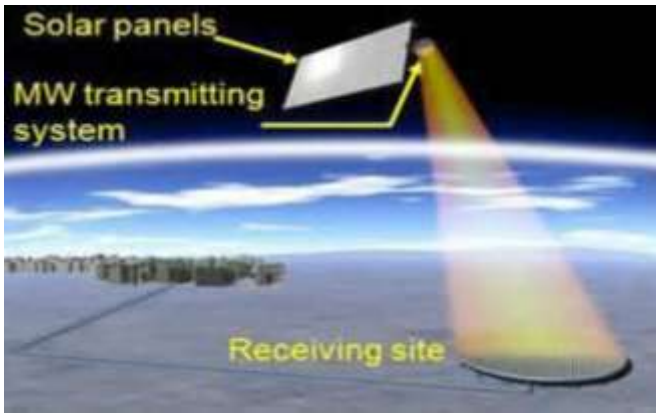

Fig 6 shows a wireless microwave transmission by solar power satellite concept.

Here the solar cells are installed in a huge number in the space. Since the solar energy is 24hrs available in the space. These cells are working continuously. The electrical energy is converted into radio frequency wave with a wavelength in a microwave range limits. There is transmitting antenna installed with these solar cells in the space. The transmitting antenna will send the microwave signal wave to the earth that will be received by the receiving antenna which are installed at earth in large areas. These antennas are called rectenna because rectifier circuit is installed along with receiving antenna. Thus direct conversion of microwave to electricity will take place at receiving end. Thus we will get continuous supply. The descriptive figure is shown below in fig 7.

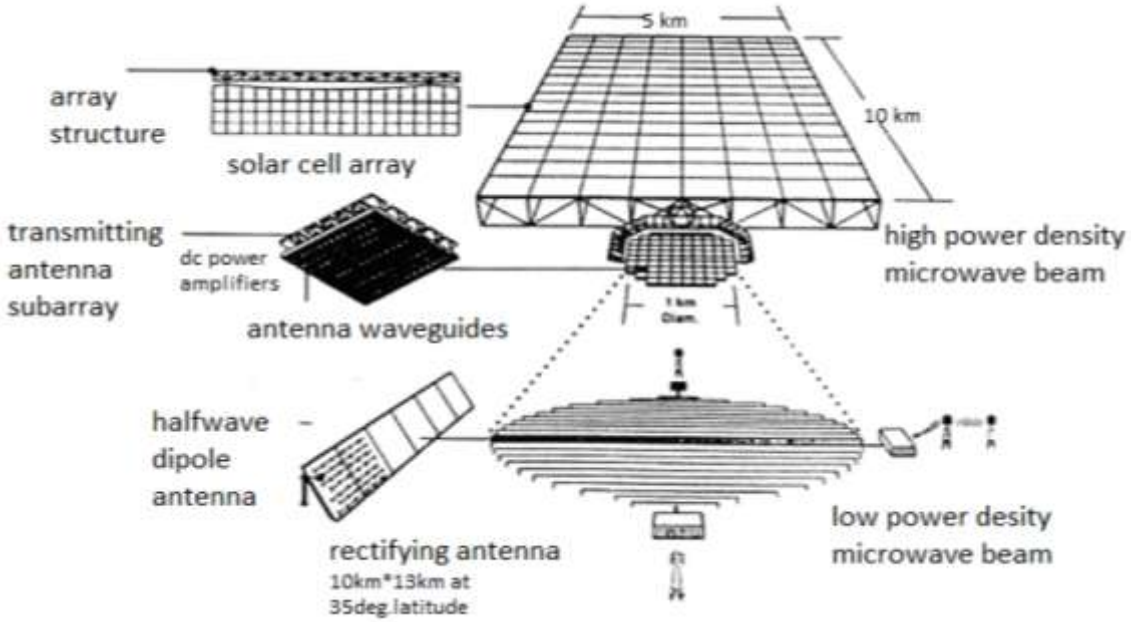

Fig.7 shows a description of solar power satellite transmission

4. BENEFITS AND APPLICATIONS OF WIRELESS POWER TRANSMISSION

4.1 Benefits

(a) Complete Elimination of High Tension wires and losses.
(b) Costs will be reduced.
(c) The chance of system failure will decrease thus reliability will increase.
(d) Possibility of shock and sparkling in wires will eliminated thus the wireless power system is safer.
(e) Wireless power transfer utilize grid system will eliminate disposable batteries thus system is environment friendly.

4.2 Applications

(a) Wireless power and charging of devices in residential, domestic and industrial areas.
(b) Wireless charging and power to moving or mobile targets such as electric vehicles, fuel less plains, bikes, cars etc.
(c) LED lightning wirelessly eliminating need of batteries, cords, wires.
(d) Military Applications.
(e) Power can be supplied to remote areas easily by solar power satellite.
(f) Medical Applications.

5. BIOLOGICAL IMPACTS

If we tell about the microwave power transmission technique then according to some beliefs microwave radiations are hazardous to human and birds. But studies regularly proved that the level of microwave radiations would never be higher than those while opening the door of Microwave oven. This means that the microwave radiation level is slightly higher than radiations emitted by cellular phones.

6. CONCLUSION

The wireless power transmission is a new technology and is developing by various scientists, engineer from past three centuries. This technology will play a very important role in the future to make a power in the reach of every person at any location. We will not need cables, pipes, and copper wires to receive power. We can make power available like signals at cell phones at any location. Various important factors like cost, losses, theft, safety, continuity of power supply can be made controllable.

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