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Introduction to Wireless Power Transmission

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Abstract

In this paper, we have presented the concept of wireless transmission i.e. power transmission without using any type of the electrical conductor and/or wires. We have presented an idea that is discussed here about how electrical energy can be transmitted as microwaves so that to reduce the transmission, allocation and other types of losses. Such technique is known as Microwave Power Transmission (MPT). We have also presented and correlated several aspects with the currently available Power transmission systems to the related history of wireless power transmission systems and also the related developmental changes. The basic design, merits and demerits, applications of Wireless Power Transmission are also discussed.

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Keywords

Microwave Power Transmission (MPT), Wireless Power Transmission (WPT), Wireless, Power Transmission.

Introduction

Wireless communication would be the transmission in the energy spanning a distance without the usage of wires or cables, where distance can be short or long. Wireless operations permits services, for example long-range communications, which are merely unfeasible using wires. Wireless energy transfer or wireless power transmission may be the transmittance of electric power from your power source for an electrical load without interconnecting wires. Wireless transmission is advantageous in instances where interconnecting wires are inconvenient, hazardous, or impossible. The situation of wireless power transmission is different from that of wireless telecommunications, like radio. In the latter, the proportion of one's received becomes critical on condition that it can be too low for that signal being distinguished on the ground noise. With wireless power, efficiency is the more significant parameter. A big perhaps the energy sent out by the generating plant must arrive at the receiver or receivers for making the system economical. The most common form of wireless power transmission is completed using direct induction and then resonant magnetic induction. Other methods under consideration include radio waves such as microwaves or beam of light technology. Wireless communication is mostly regarded as a branch of telecommunications. Wireless operations permits services, for example long-range communications, which can be impossible and impractical in conventional methods.

Conventional Power System

One of the major problems in existing power system is the losses occurring in the transmission and allocation of energy to the end users. Because demand drastically increases daily, the power generation increases and also the power loss can be increased. The percentage of loss of power during transmission and distribution is approximated as 26%. The primary reason for power loss during transmission and distribution may be the resistance of wires used for grid. The efficiency of power transmission may be improved to a particular level by employing high strength composite over head conductors and underground cables who use warm super conductor. But, the transmission is inefficient.

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Methods of Wireless Power Transmission

Transformer Coupling or Induction

Energy transfer between two coils through magnetic fields however in this technique, distance between two coils really should be too close. The principle of mutual induction between two coils can be used to the transfer electrical energy without using wires. The best demonstration of how mutual induction works would be the transformer, where there isn't a physical contact between primary plus the secondary coils. The transfer of energy develops due to electromagnetic coupling relating to the two coils.

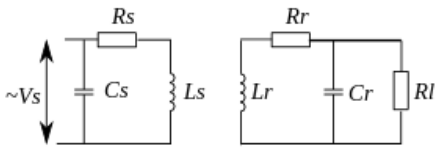

Figure 1: *Transformer Coupling or Induction*

Resonant Induction Coupling / Evanescent Wave Coupling

Researchers at MIT have discovered an alternative way of wirelessly transferring power using non-radiative electromagnetic energy resonant tunnelling. Since electromagnetic waves would tunnel, they won't propagate through the air for being absorbed or wasted, and wouldn't normally disrupt electronics or cause injuries like microwave or radio transmission. Researchers anticipate around 5 meters of range. According to them, an electro-magnetic wave in a very high angular waveguide is called as evanescent waves which carry no energy, when if a proper resonant waveguide is brought at the transmitter then the tunnel is formed towards power drawing waveguide and this can be converted in DC using rectifier circuits. A prototype model is achieved with 5 meters of ranges using this method.

Radio/Microwave Energy Transfer

It is possible to achieve a long range using this method. In this method, microwave is sent to the long distances which are received through rectenna. Rectenna extracts microwave energy back to electrical energy. The main problem with this particular strategy is how the diameter of antenna needs to be order of kilometer. Power transmission via radio waves can be produced more

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directional, allowing longer distance power beaming, with shorter wavelengths of electromagnetic radiation, typically in the microwave range. Rectenna conversion efficiencies exceeding 95% are actually realized.

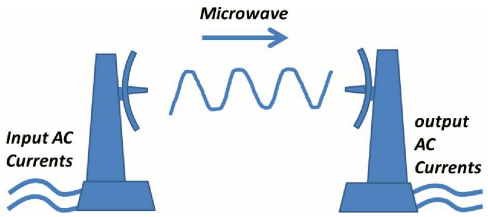

Figure 2: *Radio/Microwave Energy Transfer*

LASER Beam Transfer

In this particular method, laser is beamed for the photovoltaic cells which extract the electrical energy. This method is quite challenging to implement and manage.

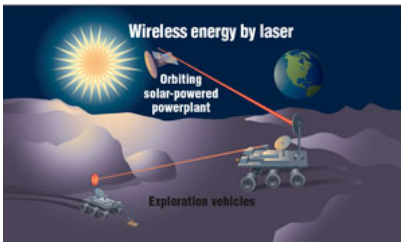

Figure 3: *Radio/Microwave Energy Transfer*

Moderate Distance Power Transmission

A competent method to transfer power between coils separated by a few meters is the fact that we're able to extend the length involving the coils with the help of resonance on the equation. An alternative way to understand resonance would be to think it is in terms of sound. An object's organic structure much like the configuration of a trumpet determines the frequency from which it naturally vibrates. This really is its resonant frequency.

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Electrostatic Induction and Electro-dynamic Induction

Generally known as `capacitive coupling` can be an electric field gradient or differential capacitance between two elevated electrodes over the conducting ground plane for wireless energy transmission involving high frequency ac potential differences transmitted between two plates or nodes.

Also referred to as `resonant inductive coupling` resolves the foremost problem in connection with non-resonant inductive coupling for wireless energy transfer; specifically, the dependence of efficiency on transmission distance. When resonant coupling should be applied the transmitter and receiver inductors are tuned for your mutual frequency as well as the drive current is modified from the sinusoidal into a non-sinusoidal transient waveform. Pulse power transfer occurs over multiple cycles. This way significant power can be transmitted spanning a distance all the way to a number of times how big the transmitter.

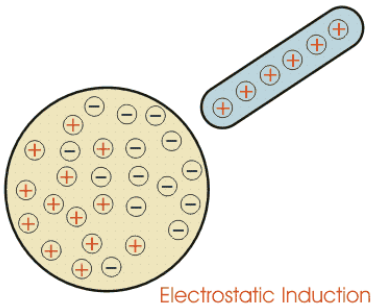

Figure 4: *Electrostatic Induction*

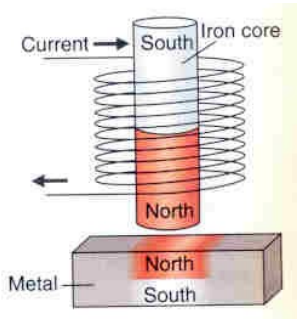

Figure 5: *Electro-dynamic Induction*

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History, Existing and Future Technologies in Wireless Power Transmission

In 1893, Tesla demonstrated the illumination of vacuum bulbs without the need for wires for power transmission in the World Columbian Exposition in Chicago. The Warden clyffe tower was designed and constructed by Tesla mainly for wireless transmission of electrical energy rather than telegraphy.

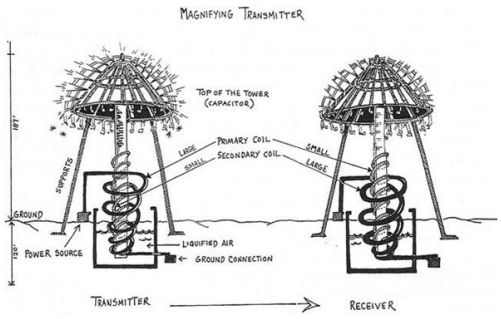

Figure 6: *Tesla Wireless Power Transmission*

The Splash Power Recharging Mat and Edison Electric's Power desk both use coils to generate a magnetic field. Electronics use corresponding built-in or plug-in receivers to recharge while purchasing the mat. These receivers contain compatible coils as well as the circuitry necessary to deliver electricity to devices' batteries. A Splash power mat uses induction to recharge multiple devices simultaneously.

Figure 7: *Splash Power Recharging Mat*

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Canada's Communications Research Centre developed a small airplane that could elope power beamed in the Earth. The unmanned plane, referred to as Stationary High Altitude Relay Platform (SHARP), was created to be a communications relay.

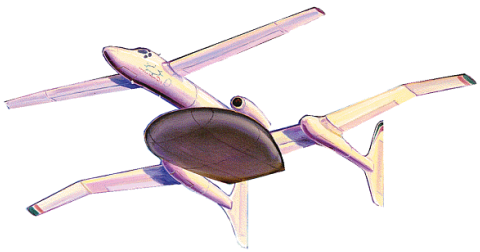

Figure 8: *Stationary High Altitude Relay Platform (SHARP)*

Microwave Transmitters - Probably the most current research and proposals use microwaves because the frequency ranges of choice for transmission. Now an efficiency of 76% may be possible using current technology for microwave power transmission. For transmission efficiency the waves have to be focused to ensure each of the energy transmitted from the source is incident about the wave collection device.

Advantages and Disadvantages

Some of the advantages are as follows:

1. Various ways of transmitting power wirelessly have been famous for centuries. The most widely known example is non-particulate radiation, for example radio waves. While such radiation is extremely good for wireless transmission of knowledge, it's not at all feasible to apply it for power transmission. Since radiation spreads in all directions, a massive tastes power would become wasted into free space.

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

3. It's more freedom of both receiver and transmitters. Even mobile transmitters and receivers might be chosen to the WPT system.

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4. The power could possibly be transmitted towards places the location where the wired transmission isn't feasible. Decrease of transmission is negligible level from the Wireless Power Transmission; therefore, the efficiency with this way is a lot higher than the wired transmission.

5. Power can be purchased with the rectenna provided that the WPT is operating. The power failure because of short and fault on cables could not exist from the transmission and power theft will be not possible in any respect.

Some of the disadvantages are as follows:

1. High capital cost for practical implementation of wireless power transmission.

2. Another potential disadvantage is the interference of the microwaves with the present wireless communication system.

3. The effect of microwave radiations at high doses received is not suitable to human health.

Applications of Wireless Power Transmission

1. Moving targets for example fuel free airplanes, fuel free electric vehicles, moving robots and fuel free rockets. Another applying WPT are wireless power source, wireless sensors and RF power adaptive rectifying circuits (PARC).

2. Mobility - user device might be moved easily in the wireless range.

3. Neat and easy Installation - since no cable running occasionally, just start-up the wireless device and you're ready to rumble.

4. Generating power by placing satellites with giant solar arrays in Geosynchronous Earth Orbit and transmitting the power as microwaves on the earth called Solar Power Satellites (SPS) will be the largest application of WPT.

Conclusion

The concepts of wireless power transmission (WPT), its history, technological developments, merits, demerits and applications are discussed in this paper. By

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this, we are able to know the greater possibilities for transmitting power with negligible losses and simple transmission from a long time. It really is envisaged that wireless energy would be really accomplished using a advantage of easy implementation and less expensive i.e., tariff of transmission and distribution overhead would dwindle and moreover it is crucial the tariff of electrical power on the consumer would even be reduced when compared with existing systems.

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