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Wireless Power Transmission System for Electric Train using Microwave

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Abstract

In this paper, we have presented the idea of cable-less power transmission for Electric Train. It is also stated that power can also be transmitted by wireless power transmission without using any kind of electrical conductors or wires. We have presented the idea of Power Transmission using Microwave, employs propagating electromagnetic waves in the microwave frequency range as the carrier of wireless power. Applying this technology to the Electric Train will bring positive effects to current railway systems. The methodology of a WPT system for Electric Train and a WPT circuit are first analyzed and the advantages and the efficiency of the train system are also discussed. Many research papers and concepts on cable-less power transmission are available but this technology is not yet materialized for commercial use.

Introduction

Wireless Power is literally transmission of electrical energy without wires. Often compare the wireless transmission of electrical energy from the transmission of information, for example, radio, cell phones, or Wi-Fi Internet access. The main difference is that a radio or microwave transmissions - is a technology for recovery and transport information, rather than the energy that was originally issued for starting. Wireless electricity is a relatively new field of technology, but dynamic. We developed methods to deliver energy effectively and safely to a distance without interruption. The concept of wireless power transmission (WPT) goes back to the days of Heinrich Hertz and Nikola Tesla, who discovered that energy could be transported by electromagnetic waves in free space. Tesla as the use of wireless energy transmission employs low-frequency transmission, supported by natural electromagnetic resonance of the earth. His concept is important in order to later study of electromagnetic wave propagation.

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A related area is energy harvesting, where stray electromagnetic fields from the many systems in the environment are collected and used as a free source of energy.

The railway systems, which are spotlighted as future green transportation systems, can be the application of the wireless power transfer technology. Applying wireless power transmission (WPT) technologies to public transportation is one promising effort to reduce the consumption of oil energy. Even if the concept was first introduced in 1970's, it is an undeniable fact that the technology had almost been discarded as an unrealistic one for more than a century.

In this paper, we introduce the concept of wireless power transmission (WPT) for Electric Train and suggest design methodology for high-power wireless Microwave Power Transmission (MPT) with high efficiency. Also, the concerns with a new antenna design, and a full-wave rectifier concept and its effects on human bodies are discussed.

1. History

Wireless energy transfer as an alternative to electric transmission and distribution lines, was first proposed and demonstrated by Nikola Tesla. In 1899 Tesla

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presented a wireless transmission field powered fluorescent lamps located twenty-five miles from the power supply without the use of wires. But at the time it was cheaper to do the wiring of copper wires 25 miles rather than build special generators, which requires experience Tesla. Patent, he had not given out, and the invention of science left in the bins. While Tesla was the first person who was able to demonstrate the feasibility of wireless communication in 1899, today, there is quite a bit of selling devices are wireless headphones brushes, charging for mobile phones and so on.

In the late 1930s, further progress in the WPT occurred with the invention of the klystron tube, the microwave energy into DC using microwave power tube converted one end and DC diode tubes at the other. Advances in microwave - cavity magnetron led to higher efficiency for applications in the WPT World War II. In the 1950s, two improvements by the invention of the intensifier tube, were a major amount of transmit power to drive generates an electromagnetic beam and allows the focusing of the electromagnetic energy in a beam of high efficiencies. In May 1963, Raytheon demonstrated the first microwave - power transmission system, which converted 400 W CW power at the transmitter to 100W DC power to drive a motor. In October 1964 a demonstration of microwave -powered helicopter flight was presented up to 60 meters via a transmitting antenna. In early of 2000, A similar s y s t e m with the concept magnetic field to railway systems was also proposed.

1. Wireless Power Transfer System

Wireless power transmission using microwaves

Resonance Induction Coupling

Is brought electromagnetic wave in a high angle waveguide as the evanescent wave, which called carry no energy , as if a proper resonant waveguide is in the vicinity of the transmitter then a tunnel to the power drawing waveguide in DC can be converted with rectifier circuits are formed.

Fig 1. Resonant Induction Recharging

3.1.2 Electrical Conduction Method

In this method, during the transmission of energy through wires or conductor when the voltage reaches the breakdown voltage, operates the surrounding medium start in this manner can be transmitted energy through the medium of air.

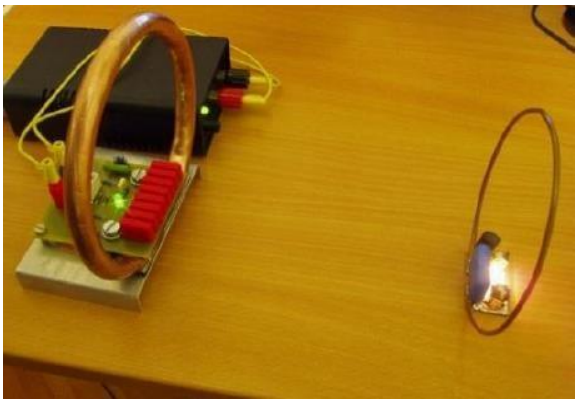

Fig 2, Electrical Conduction Methods

3.1.3. Radio and microwave Energy Transfer

With this method, a long series is possible. In this procedure will be sent to the microwave long distances and can be received again to extract into electrical energy by the rectenna microwave energy. However, the problem with this method is that the diameter of the antenna should be of the order of kilometers

Block Diagram and Implementation:

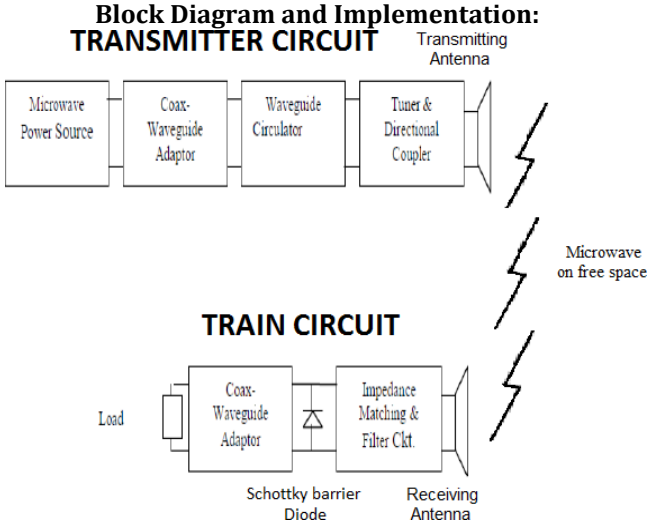

Fig 3. Basic Design of WPT for electric train

Wireless power transmission can be explained by functional diagram of WPT. The block diagram describes that in

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transmitting side, microwave power source generates microwaves. Waveguide circulator prevents the microwave source from

reflected power and it is connected with microwave power source through Coax - waveguide adaptor. The tuner and matches the impedance between microwave source and transmitting antenna. Then antenna spreads the generated microwaves in specific direction with the help of directional coupler. Thus, antenna radiates power in form of microwaves through free space towards rectenna (rectifying antenna).

In Train circuit, rectenna receives the transmitted power and converts it into the output in which electric train works. To match the output impedance of signal source equal to the rectifying circuit, impedance matcher and filter is used. The rectifying circuit consists of schottky barrier diodes which converts microwaves power into DC power.

1. A WPT system for transportation

Even if the principle is already used for many household appliances as well as several industry, the market of wireless power technology is dramatically expanding and application of WPT is indeed a growing trend in recent years. Table 1 clearly demonstrates how the WPT market is growing in a wide range of applications in industry.

No	Watts	Application	Stage	2012 2013 2014 2015 2016
1	5W	Mobile Equip.	R&D	
			Mrch	
2	30W	Tablet PC	R&D	
			Mrch	
3	50W	PC & Laptop	R&D	
			Mrch	
4	100W	TV & Robot	R&D	
			Mrch	
5	150W	Electric Vehicle	R&D	
			Mrch	

Table 1. WPT application roadmap

By applying the WPT system to trains, there are many advantages. At first, unlike conventional operation, overhead wires and power poles can be eliminated and spaces are opened up so that attractiveness of surroundings also increases. The application also ensures continuous energy supply with contactless power transfer between transmitter and rectenna on the train.

When designing a system of any trains, the first element to meet is requirements for its performance. Since trains deal with much higher level of voltage and power output than those of buses, it is important that one meets high power requirements while keeping its safety. Frequency and voltage in the WPT system play an important role in its performance, and should also be taken into main consideration.

2. Merits

i. This concept will remove the need for an capital intensive grid of cables, towers and substations.

ii. It will rid the scenery of wires, cables, and transmitting towers.

iii. The electrical energy can be economically transmitted without wires to any earthly distance, so there will be no transmission and distribution loss.

iv. To conduct wireless power to any distance without limit. It makes no difference what the distance is.

v. Power theft would be not possible at all.

3. Demerits:

i. Capital Cost for practical application of WPT for electric train is very high.

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

iii. Common belief terror, the effect of microwave radioactivity.

iv. But the studies in this domain repeatedly proves that the microwave radiation level would be never higher than dose established while opening the microwave oven door, meaning it is slightly higher than the releases created by cellular telephones.

4. Related Application

Many firms and electric companies are working on making wireless based electrical equipment.

Wireless Charging Electric Vehicles

Qualcomm Incorporated in recent years is working on the implementation of wireless charging - and not only the batteries of mobile gadgets (development Qualcomm own solution for charging smart-phones called Wi-Power), but also the electric battery. Project to create a commercially attractive system of wireless power transmission from the car charger, called Qualcomm Halo, and the technology in the performance was named Qualcomm Wireless Electric Vehicle Charging (WEVC). It involves the use of two induction coils: first installed

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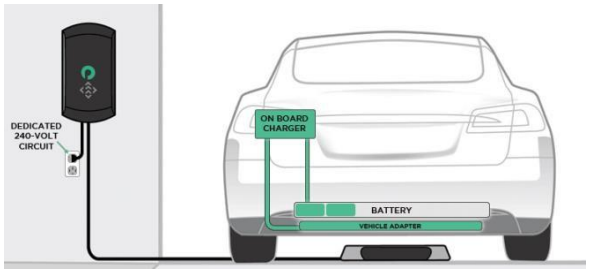
inside the electric vehicle, and the second - under the roadway in places marked as charging pad.



Wireless Charging on the Tesla Model S

5. Conclution

The world that is moving the concept of WPT technologies increases recently therefore, it's worth trying to use WPT technologies to high power systems like electric trains. While WPT trains provide many advantages over conventional electric trains (elimination of overhead wires reduces cost to produce and maintain infrastructures; continuous energy transfer ensures constant stable power supply compared to cables, increase efficiency of current WPT systems. there are many challenging elements to contemplate since there are no practical research on WPT electric trains.

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