Microwave Wireless Power Transmission (MWPT)

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Introduction

Electricity energy needs to be transported to the distribution lines through cords. One of the major issues in power transmission is the losses occurring during the transmission and distribution process of electrical power due to the energy dissipation in the conductor and equipment used for transmission. As the demand increases day by day, the power generation and power loss are also increased. In addition, the cost of making electricity is harmful to the environment. Therefore, reducing transmission loss is very crucial because the saved power can be used as an alternative to minimize the cost.

Although the power loss during the transmission process is inevitable, some alternatives can be interpreted to mitigate this problem. In order to minimize power losses in the power distribution network, wireless power transmission has been known for centuries to clean sources of electricity. Battery charging with wireless power transfer is a novel approach.

"Wireless Power Transmission" is a technology revolutionizing the mode of electricity transmission to enable reliable and efficient wireless charging of millions of everyday electronic devices, by integrating a power source to an electrical load without the aid of wires especially in cases where interconnecting wires are precarious. Lessening the transmission loss is very crucial to minimizing the cost.

Wireless Power Transmission has become a highly active research area because of its potential in providing high quality to our daily lives. This emerging technology also benefits the use of portable devices as it limits the use of wired charges. We will be using the techniques for our wireless power transfer.

However, the concept of wireless power transfer even for charging batteries is not a new idea. In the early period, different scientists proved different approaches to transferring power without a physical connection between the source and appliance. Each type of wireless power transfer has its own characteristics and applications. To make this idea familiar for the new researchers we reviewed the background histories, recent technologies, and future advances.

The Technologies we have used include Microwave Power transmission and Alliance for Wireless Technology.

Working

The Microwave Wireless Power Transmission (MWPT) technology transfers high power from the base station to the receiving station or mobile devices with two places being in line of sight. With the help of geosynchronous receiving and transmitting satellites, this technology enables the objects to acquire power from the base station using the magnetron. MWPT provides efficiency in energy conversion but it is slightly difficult to focus the beam in a small region. Besides, this technology could pass through the atmosphere easily. The first step of power transmission is initiated by converting electrical energy to microwave energy and then microwaves energy will be captured using a rectenna. In this technology, Alternating Current (AC) cannot be directly converted to microwaves energy. Therefore, AC needs to be converted to Direct Current (DC) first and then DC is converted to microwaves by using a magnetron. Transmitted waves are received at a rectenna and then rectify microwaves into electricity more efficiently. It will give DC as the output. In the final step, DC will be converted back to AC

The long-distance high-power MWPT system is illustrated, as the schematic view of the experimental setup shown in fig. 4, but it is just at the conceptual stage. All subassemblies include the two main modulated power supplies I and II working for the cathode with a pulse to continuous-wave operation, the 400 kW asymmetrical resonant magnetron, the 10 kW cyclotron-wave rectifier, the transmitting Cassegrain antenna, the receiving Cassegrain antenna, and the output power load are aligned along the propagation direction of the power.

In such a system, the microwave generator is the compact 400 kW asymmetrical resonant magnetron modulated by the power supply I. The novel magnetron with the asymmetrical resonant cavity, the straps, and the novel output loop coupling circuit can effectively enhance the beam–wave interaction, suppress the mode non-desirable modes, and increase the output coupling, which results in a 400 kW output microwave power with a conversion efficiency of 45%.

Next, the power is pumped into the transmitting and receiving antennas, which are used to connect the microwave generator and the rectifier. In order to simplify the system and make it feasible, the transmitting and receiving antennas are designed to be the same Cassegrain antenna with a simple structure, high conversion efficiency, and high power handling capacity. Under the reflection of the optimized two main planes and two secondary planes, the transceiver antenna system can finally reach an integral power transmission efficiency of 2.6% for 10 km distance and 2.45 GHz. The received 10 kW microwave power is equaled to the input of the following cyclotron-wave rectifier.

Then the received microwave signal is channeled into the microwave cyclotron rectifier, under the modulation of the power supply II in the cathode, which can realize the energy conversion from microwave into direct current energy with high efficiency and high power capacity. When the optimized output DC voltage and power loads are 16.23 kV and 32.5 kΩ, the cyclotron-wave rectifier with 2.45 GHz, 10 kW input microwave power can achieve a conversion efficiency of 85%, after suitable signal processing, which can be fed to the power grid afterward.

Finally, the analysis of the long-distance high-power MWPT system based on asymmetrical resonant magnetron and cyclotron-wave rectifier can achieve 8.5 kW DC power for a 10 km distance, but its total DC-DC transmission efficiency of about 1% is relatively low. However, so far this is one of the best-reported cases for long-distance high-power MWPT systems. Of course, the MWPT system will be a source of unwanted exposure to nearby and really may interfere with surrounding electronic equipment, therefore the site selection should need careful consideration.

Components Required

- Asymmetrical Resonant Magnetron (Microwave Generator)
- Semiconductor Amplifier
- Transceiver Cassegrain Antenna System
- Cyclotron Wave Rectifier

Asymmetrical Resonant Magnetron: The magnetron is theoretically and experimentally confirmed to be a viable high efficient and high-power microwave generator. In the long-distance high-power MWPT system proposed in this paper, a transmitting microwave generator based on the novel 400 kW asymmetrical resonant magnetron is developed and used.

Semiconductor Amplifier: Semiconductor devices played a major in the microwave world instead of microwave tubes. The semiconductor device is expected to expand microwave applications, for instance, phased array and Active integrated antenna (AIA), because of its manageability and mass productivity.

Cassegrain Transmitting Antenna: In the ground-based long-distance MWPT system, the receiving and transmitting antennas are equivalent. In order to simplify the system and make it feasible, the receiving and transmitting antennas adopt the same Cassegrain antennas.

Cyclotron Wave Rectifier: In the long-distance high-power MWPT system, the cyclotron-wave rectifier is a special electric vacuum device, which is used to convert microwave power into direct current. Besides its high efficiency and high power capacity, it can also automatically protect itself regardless of input and output power overloading.

Hardware Diagrams

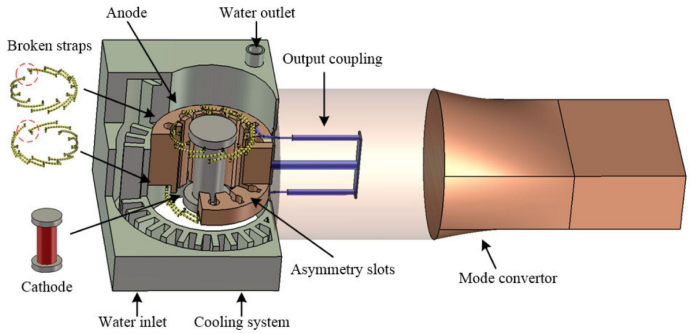


Fig. 1. The structural sketch of the novel high-power asymmetrical resonant magnetron

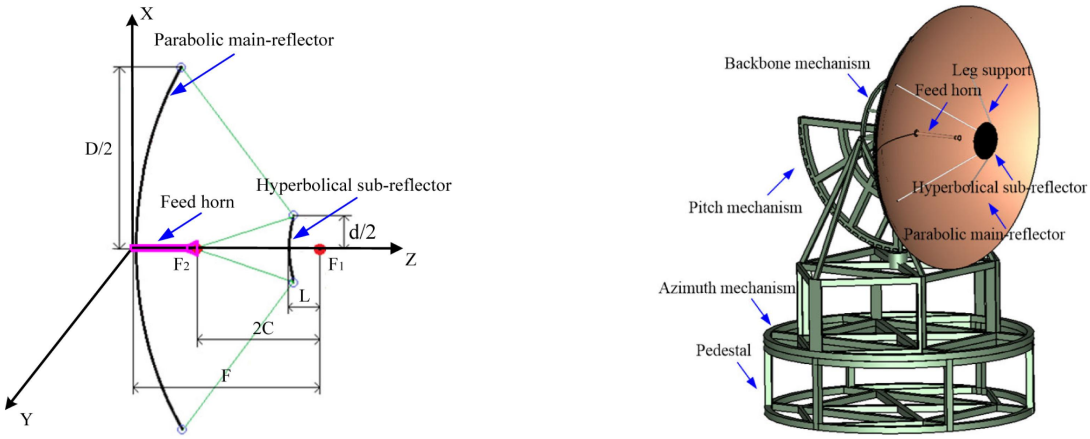


Fig. 2. Geometry configuration and a structural sketch of Cassegrain antenna.

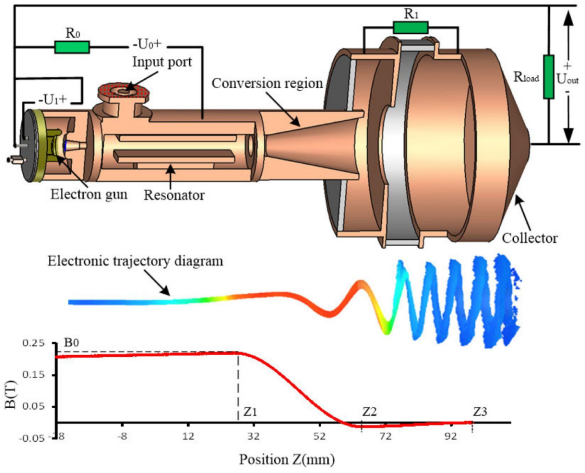


Fig. 3. The structural sketch of the 10 kW cyclotron-wave rectifier

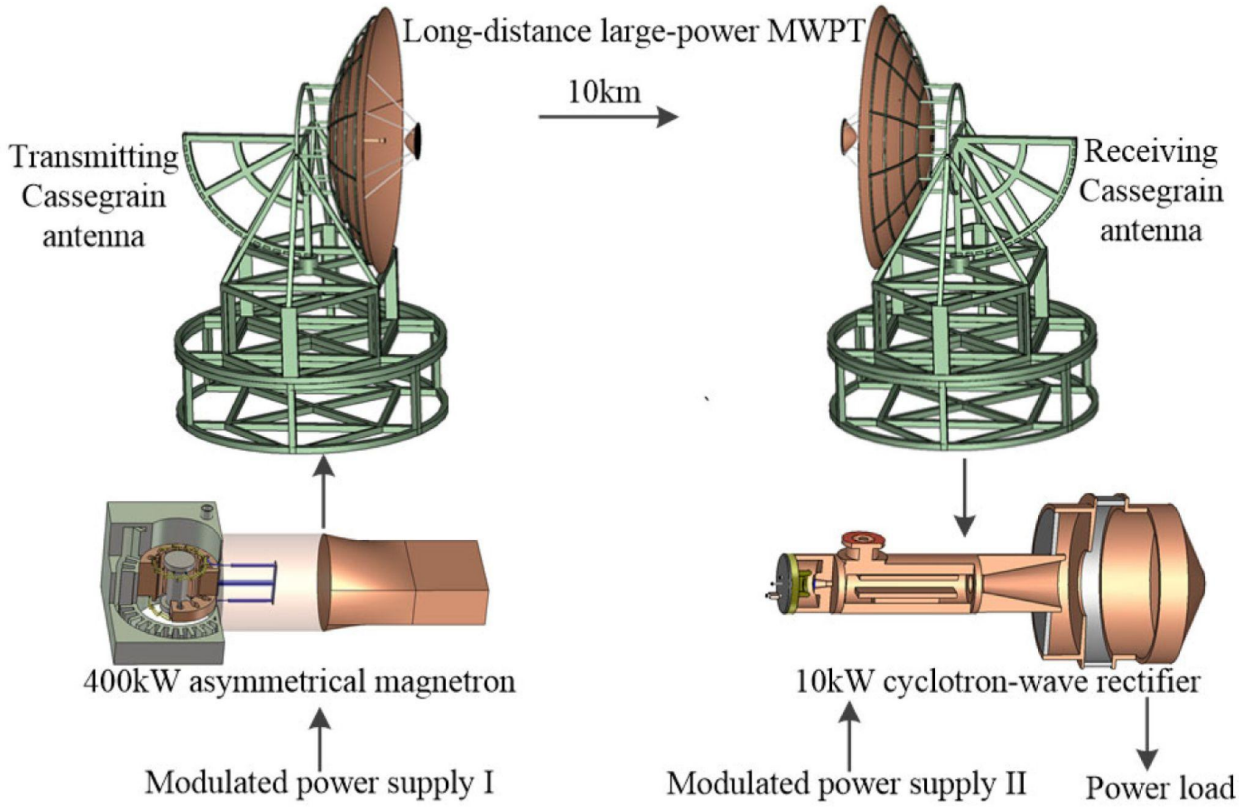
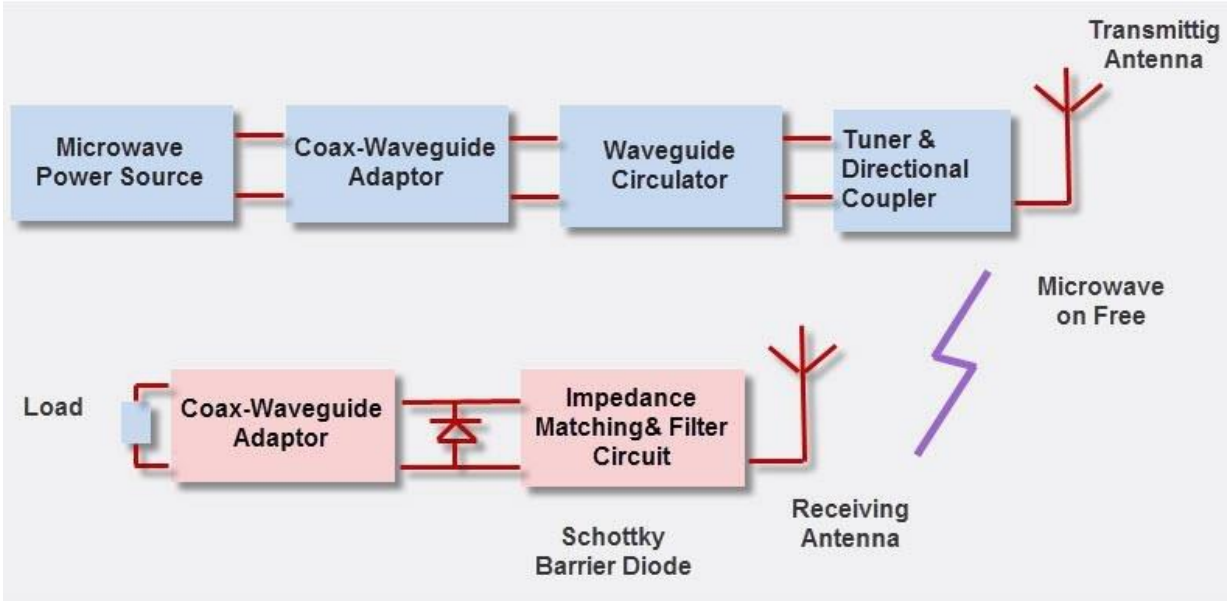


Fig. 4. The schematic view of the long-distance high-power MWPT based on the asymmetrical magnetron & cyclotron-wave rectifier

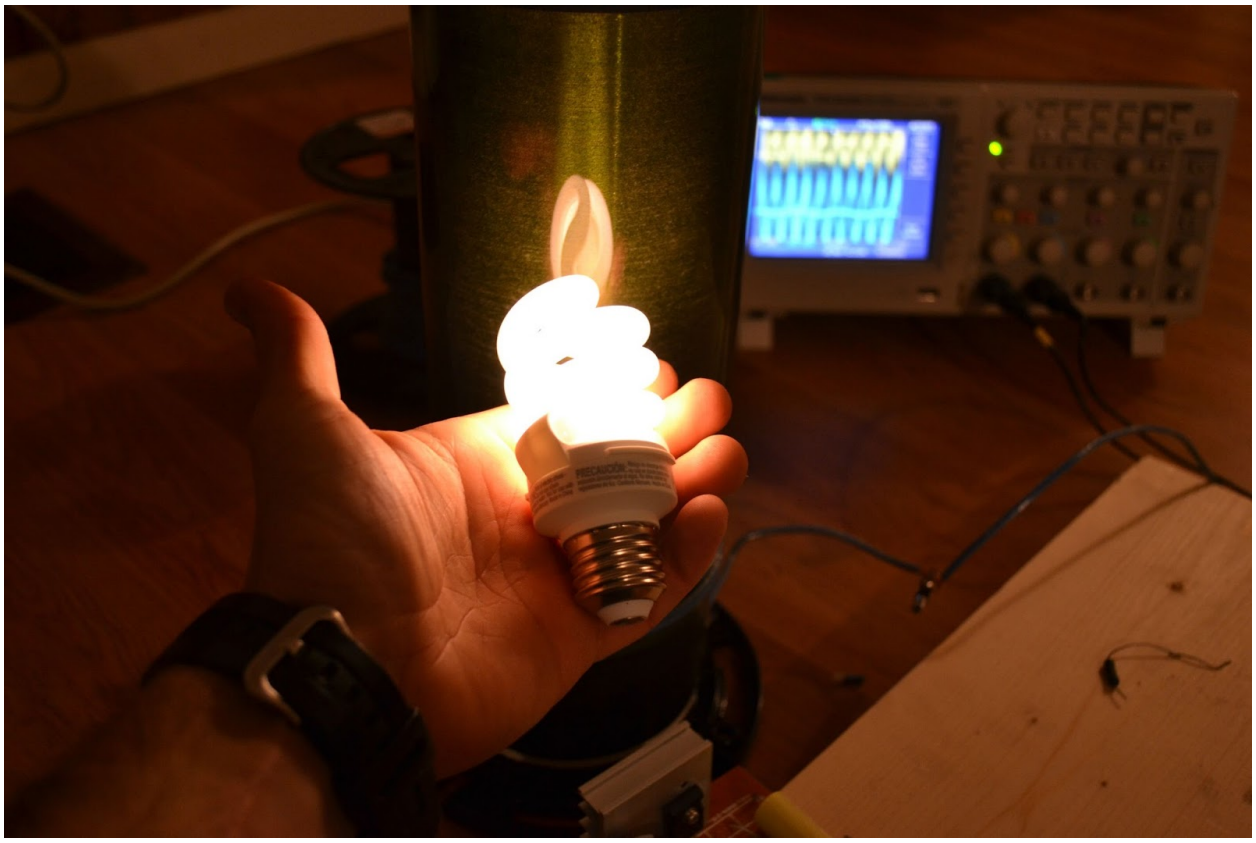
Block Diagram



Practical Implementation & Output

The Wireless Power Transmission system eliminates existing high-tension power transmission line cables, towers, and substations between generating stations and consumers, allowing for global interconnection of electrical generation plants.

The power could be sent to locations where wired transmission is not possible. The loss of transmission in Wireless Power Transmission is low, hence the efficiency of this technology is substantially higher than wired transmission.



Existing Competitors

Only a New Zealand-based startup has implemented Wireless Power Transmission, which created a means of securely and wirelessly distributing electric power over large distances without the necessity of copper cable. The World Resources Institute (WRI) estimates that India's energy infrastructure has the world's largest transmission and distribution losses, at roughly 27%. Various Indian government agencies have issued figures putting the figure at 30 percent, 40 percent, and more than 40 percent. Technical losses (grid inefficiencies) and theft are blamed for this. The magnitude of losses in the Indian electricity and transmission business is frightening. These losses not only eat into the profits of the companies but also make it difficult to fund future initiatives that require a lot of money due to the increased risk. As a result, our initiative is the beginning of a revolution in India's power transmission industry.

Applications of Wireless Power Transfer

There are numerous uses for wireless power transfer. It can be as simple as charging a phone to provide the Earth with all of the energy it requires. Consumers are most likely to see a charging station with a range of one to five meters as one of the first uses. This is a little box-like device that can charge compatible electronics within the system's range. Wireless power transfer charging systems have been shown to exhibit efficiency levels that are comparable to those of traditional charging devices. For example, a family of four would require around one transmitter in each room to make the house totally wireless. This will only act as a convenience to users and will not be used for any other purpose.

Conclusion

Wireless power transfer has the ability to transform the world on many levels. Wireless power transfer has a solution for everything from charging a handheld gadget to reducing the impact of global warming on the planet. WPT via microwave transmission from space is the most commercially viable use emerging to combat the effects of global warming and rising electricity demand. This application will provide Earth with endless electricity while also opening up several new prospects for space exploration. Emerging tech businesses can use WPT to expand the capabilities of most small electronics, such as mobile phones, PDAs, and MP3 players.