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Non-Contact Electric Vehicle Charging System Under Dynamic Mode

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ABSTRACT

Considering the possibility that an autonomous electric vehicle EV, which has no human intervention, will need to be equipped with a charging system at all times. To this end, charging infrastructure which is completely automatable, fast, secure, cost efficient and dependability is needed in order to provide a viable business model and the rapid adoption of electric transport systems. A Futuristic technology which gives advantages of flexibility, comfort, security and the ability to be completely automated is Wireless Power Transfer WPT. Since resonant inductive wireless charging technology is more efficient and can be easily maintained, it should receive greater attention when using WPT methods. The literature is comprehensive, in addition to an extensive investigation of the wireless EV market with a special emphasis on power transfer charging technology, by examining the state of new inhibitors at this time. The report also includes projections for future growth of the market compared to today's situation. In addition to analyzing the advantages and disadvantages of each method, a brief background is given on wireless charging methods. The present paper compares the technology in use until now with induction pad, rail and compensation. There is also an explanation of how to charge, which differs from Static and Dynamic Methods in terms of their characteristics

Keywords: Automobile charging, transmission of power wirelessly, induction pad technology, Simulation, charging efficiency. .

INTRODUCTION:

Through the use of electromagnetic fields, inductive wireless charging technology facilitates the transmission of electrical power between two coils. Inductive charging, as opposed to conventional cable charging, distributes with the requirement for physical connections and enables devices to charge by just being near a charging pad or other surface. Electronic products like smartphones, wristwatches, and electric cars are frequently charged using this technology. To increase efficiency and increase charging distances, resonant inductive coupling can be used. Interoperability across different devices and charging pads is guaranteed by the Wireless Power association Qi standard. Convenience, less wear on charging ports, and adaptability in surface integration are some of the benefits that make inductive wireless charging so popular in consumer electronics, automotive applications, and other industries. Ongoing developments aim to raise the general performance of the technology and standardize it across many devices and industries, despite obstacles like cost and efficiency concerns.

1. INTRODUCTION TO DYNAMIC WIRELESS CHARGING

It is an innovative technological development, revolutionizing the way electric cars are powered, that allows us to charge them in wireless fashion. The need for effective and flexible charging solutions is becoming increasingly clear in the context of a growing global shift to electrical mobility. Dynamic wireless charging, often referred to as in motion or on the go wireless charging, provides a promising answer to some of the main challenges faced by the EV industry.

Dynamic wireless recharging provides a vehicle the ability to recharge continuously, whether in motion or placed over special charged surfaces, rather than traditional methods where an electrical car is required to plug itself into its own charger. This invention is based on the principle of electromagnetism or inductive coupling, which allows energy to be exchanged from road infrastructure for vehicle battery and does not require a physical connection. This results in a seamless, automated charging experience which not only increases the convenience of owning EV but also addresses range anxieties and infrastructure constraints. This opens up the possibility to explore dynamic wireless charging, a technology that could accelerate adoption of electric cars and lead into a new era of sustainable and efficient transport. To begin with, we will examine the working principles, benefits, challenges and revolutionary effect of dynamic wireless charges on future mobility in this discussion. It is an innovative technological development, revolutionizing the way electric cars are powered, that allows us to charge them in wireless fashion. The need for effective and flexible charging solutions is becoming increasingly clear in the context of a growing global shift to electrical mobility. Dynamic wireless charging, often referred to as in motion or on the go wireless charging, provides a promising answer to some of the main challenges faced by the EV industry. Dynamic wireless recharging provides a vehicle the ability to recharge continuously, whether in motion or placed over special charged surfaces, rather than traditional methods where an electrical car is required to plug itself into its own charger. This invention is based on the principle of electromagnetism or inductive coupling, which allows energy to be exchanged from road infrastructure for vehicle battery and does not require a physical connection. This results in a seamless, automated charging experience which not only increases the convenience of owning EV but also addresses range anxieties and infrastructure constraints. This opens up the possibility to explore dynamic wireless charging, a technology that could accelerate adoption of electric cars and lead into a new era of sustainable and efficient transport. To begin with, we will examine the working principles, benefits, challenges and revolutionary effect of dynamic wireless charges on future mobility in this discussion.

EVs are types of vehicles which make use of electricity as a primary source of power, rather than the conventional Internal Combustion Engines that run on gasoline or diesel. In the past few years, these vehicles have seen significant attention and popularity based on their potential for reducing CO 2 emissions, decreasing reliance on fuels from oil or improving energy efficiency in general. In this short overview, we have an overview of the different types of electrical vehicles: High power cables to charge EVs are one of the main concerns when it comes to electric currents, they're hard to repair. Safeguards may occur as a result of improper handling of standard charger techniques or damaged cables. The method of charging may also be liable to theft and vandalism. Wireless Power Transfer (WPT) is a novel substitute that was first presented by Nikola Tesla in the 1800s. As the WTP develops, it will be capable of providing alternative to conventional wired recharging systems. It is capable of transmitting wireless power using electromagnetic or static waves with the use of transmitters and receivers. That means that, in addition to plugin connections, it provides a competitive alternative. The receiver of a WPT system shall transmit power to the batteries or drive systems by using an electronic converter. The ability to work independently of assistance from humans is one of the most significant characteristics of a wireless charging system.

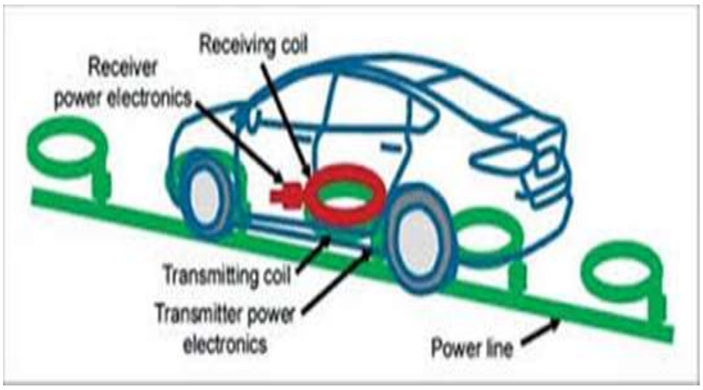

Figure 1: Wireless Charging for Electric Vehicles

2. LITERATURE SURVEY:

Internal Combustion Engine (ICE) widespread use Releases occur from based vehicles in the transportation network. Hazardous gases in the atmosphere are what cause global warming. One major concern facing the world community is climate change. Alternative solutions, including charging electric vehicles, are required to lessen reliance on fossil fuels as a source of energy and to lessen their detrimental effects on the planet. the application of sustainable energy sources. Batteries are expensive because they typically have a low energy density and are heavy. large. Its longevity is also shortened, and charging takes longer. Lithium-ion batteries are used extensively in electric vehicles nowadays. The battery capacity limits the cruise range. [1]-[3]. Electric vehicles and charging systems will play a significant role in the development. The charging of electric vehicles can be carried out through the use of a plug inductively or inductively, or through a wired or wireless method. The categories for plugin's charging are: "Offboard" and "Onboard" The use of high- power cables presents a challenge to the charging system, which poses risks for damages, mishandling, vandalism and theft. Wireless Power Transfer, which Nikola Tesla developed, is a cableless alternative. Enhanced security and flexibility for large scale use are offered by Wi charger systems that don't involve human presence or cables. Constant advancements target issues like electromagnetic radiation and recharge times in an effort to improve wireless charging's effectiveness and safety. [5] As a result of the battery limitations, with electric vehicles, it takes more charging cycles to get long distances. The DWC is able to solve this problem. HevoPower, founded in New York City, is exploring the introduction Regarding both Dynamic Charging Systems and SWCs electric vehicles. They've launched an application that allows customers to charge EVs easily from their mobile phones. [6] Systems for dynamic wireless charging (DWC) present significant capital investment challenges because they use receiving stations mounted on vehicle chassis and transmitting terminals placed on asphalt. For slower-moving or stationary electric vehicles, there is an alternative called Quasi-Dynamic Wireless Charging (QWC), which offers flexible power transmission ranges and lower investment requirements for commercial use.. [7] The key events related to the history and development of WPT are shown in Figure 3. Maxwell and Hertz had a connection to the first period. In 1873, Maxwell devised an equation for the transmission of electric energy from a free space. Hertz, with a series of experiments between 1885 and 1889 confirmed that Maxwell had correctly predicted the presence of electromagnetic radiation In the second era of electricity, Nikola Tesla was a key innovator of polyphase systems and Alternating Current (AC). He imagined using the Earth and its atmosphere as conductors to transfer energy around the world. Tesla achieved successful microwave signal transmission over 48 kilometers in 1896. He studied electromagnetic and electrostatic energy transmission in great detail between August 1, 1891, and 1904. Wireless energy transmission and electrical system advancements were made possible by Tesla's contributions.[10]

3. METHODOLOGY:

3.1 Inductive WPT

The principles of electromagnetic waves underpin the operation of the Inductive Wireless Power Transfer (IWPT) system. When Alternating Current (AC) is applied to the primary side of a conventional transformer, it acts in accordance with Ampere's law and creates a magnetic field around the conductor. A time-varying magnetic field is produced by connecting magnetic couplers on the secondary side to this magnetic field. A voltage is created across the secondary coil by this linked field. that can be used to charge a battery, as per Faraday's law. The system uses a modulation of the supplementary coil to achieve optimum efficiency by aligning it with its operational frequencies. Although the air gap may be widened to 20 cm, this will have a negative effect on efficiency in particular within radio frequency range.

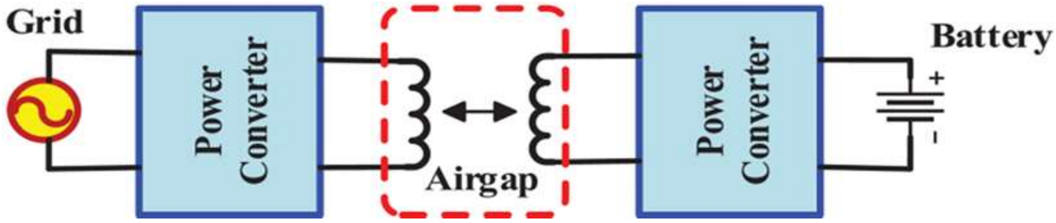

Figure 2: An example of an inductive WPT schematic

3.2 Magnetic Resonance WPT

The Resonant Inductive WPTRIPT is a better IWPT in terms of coupler coils, design, and power transfer capability.. A basic RIPT system model for charging among the batteries is shown in Figure 13. By using power electronics converters, the existing grid voltage is converted into a high frequency ACHFAC1) as compared to another WPT system.After the coupling receives the HFAC signal, electromagnetic field interactions cause the secondary coupling coil to generate voltage. The resultant voltage is transformed into DC using filter and converter circuits in electrical electronics in order to power the battery. The HFAC system, in contrast to the IWPT system, consists of compensation networks, capacitors, inductors, or a combination of these components.

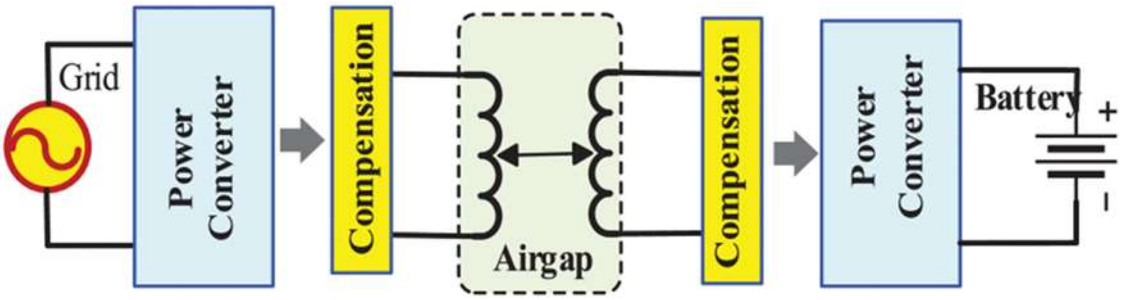

Figure 3: Generic Diagram Of Magnetic Resonance WPT

The focus of this review article is the resonance inductive wireless power system. It addresses topics like Both stationary and dynamic wireless charging use compensation networks, power electronics circuits and structures, shielding techniques, control systems, standards, and communication networks. Additionally, it covers the design of magnetic couplers for both static and dynamic methods. The article also examines a number of other factors that affect these technologies, such as grid integration, batteries, and vehicle-to-grid (V2G). As was already mentioned, Ampere's Law and Faraday's Law form the foundation of resonance inductive Wireless Power Transfer (WPT). According to Ampere's Law, the HFAC signal in this system causes a time-varying magnetic field to be created in the primary winding. The resulting magnetic field is directly proportional to the primary winding's current flow, turn count, and free space permeability. According to Faraday's Law, the secondary winding then experiences an electric current due to this time-varying magnetic flux.

4. MAGNETIC COUPLER:

In the SWPT system, coupling pads are mostly utilized. For the IPT system, conventional transformer structures like E' and U' are initially investigated. Researchers studying nature have suggested a pad-shaped structure that is less voluminous and more compact in order to replace the traditional transformer core structures, which are costly, heavy, brittle, and susceptible to shiftiness. The coupling pads' performance is dependent on the coupling factor (k), quality factor (Q), and misalignment tolerance..

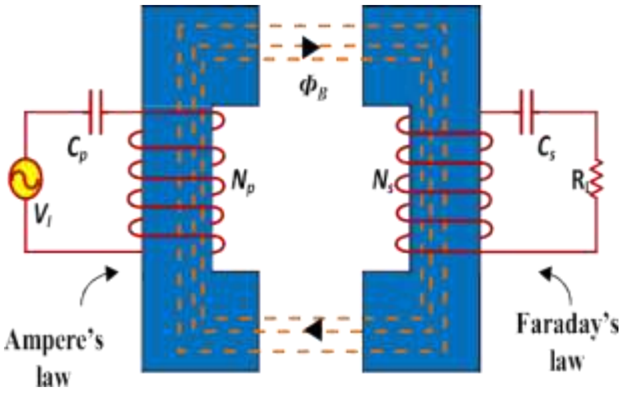

Figure 4: Magnetic Resonance WPT

For this particular coil type, researchers have suggested a variety of coil configurations and designs. In order to reduce losses resulting from the skin effect, Litz wires are frequently used in magnetic couplings. Effective flux guidance, mutual inductance elevation, leakage minimization, and protection are all made possible by ferrite cores. The distance between two proposed Planar pad structures, the coil geometry, the core material, and the kQ factor are important factors. These structures' carefully engineered core, coil, and shield reduce pad volume and weight while allowing for misalignments in all directions—a crucial component of WPT systems. An intermediate coil, also called a coplanar coil, is positioned at the Primary Side Coil within parallel planes to improve load variation management, misalignment tolerances, efficiency, and coupling effectiveness. To increase system effectiveness and tolerance to variations in load resistance, researchers are also investigating the design of multiple additional coil couplings. In order to increase system efficiency and flexibility in response to changes in loading, three lines have been added to both transmitters and receivers. Efficiency may be reduced by keeping the source coil far from the transmitting coil. By adding a coil to the receiving side, the coils' coefficient coupling is improved and transfer range and overall efficiency are increased. This coil might be an addition due to a bifurcation phenomenon, which would require careful attention to detail and a laborious creation process.

Likewise, in order to maximize coupling efficiency and tackle misalignment issues, four-coil structures have been developed. Adjusting the magnetic coil for LCL and LCC elements is necessary to improve its compactness and efficiency. Minimizing leakage losses and improving tolerance to lateral misalignments are the goals of the development of a mixed solenoid coupler. A novel unbalanced coupling structure is another innovation. Furthermore, an improved DC pad that outperforms the DD pad has been introduced.

By using a three-phase system on the pad, power transfer density can be improved. In addition to extending the transmission distance, this method guarantees a uniform flux distribution. Three-phase systems have several advantages over single-phase systems. A three-phase system is used in a trifoliate coil, which was introduced in 1998 to balance electrical factors and inductance while increasing power transfer density. Via an inverter, power is supplied. A 1.2-meter test track with six square coils is powered by a three-phase configuration for the Dynamic Wireless Charging (DWC) system. A longer charging zone is the outcome of this. A tripolar pad with a decoupled coil structure—each coil separately—is described in Article [100]. having its own dedicated inverter—is presented. This structure requires a more extensive power electronic infrastructure, but it offers better performance than a trifoliate coil in terms of flux densities and cross coupling.

5. SIMULATIONS

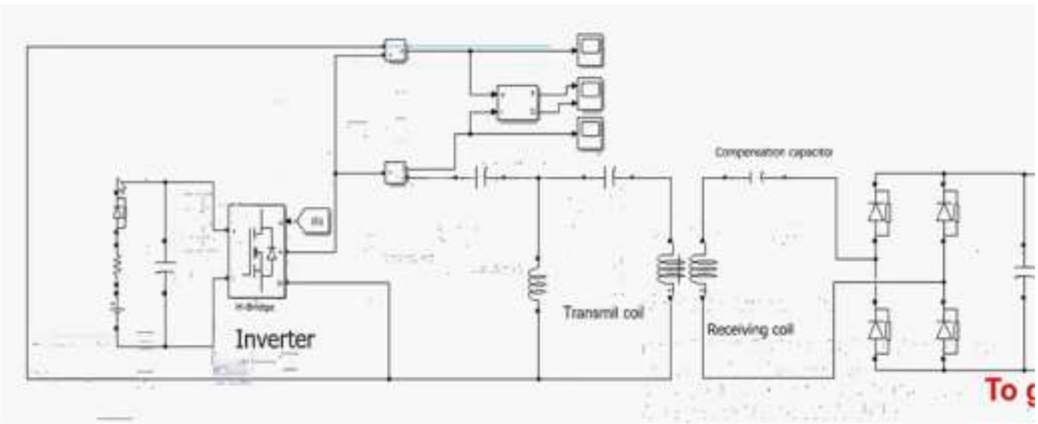

Figure 5 : Simulation Of Inductive Wireless Power Transfer

	Distance between Coils	Self-Inductance of Tx Coil (L_1)	Self-Inductance of Rx Coil (L_2)	Mutual Inductance between Coils (M)
Simulation Results	13.5 cm	203.15 uH	204.30 uH	27.355 uH
Measured Results	13.5 cm	202.70 uH	207.70 uH	27.275 uH

Figure 6: Measurements Of Simulation

Figure 7: Simulation Results

CONCLUSION

Lastly, an innovative approach to the future of electric mobility is provided by inductive wireless charging for electric cars (EVs). It provides unmatched convenience and solves issues with charging port wear and tear by enabling EVs to be charged without physical connectors. While issues like initial costs and charging efficiency still exist, there is hope for the future thanks to resonant inductive coupling, continual advancements, and standardization via platforms like Qi. An important step toward convenient and sustainable transportation solutions is being taken with the seamless integration of inductive wireless charging, which not only improves user experience but also helps to realize autonomous and effective electrified transport systems. Efficiency gain over a charger plugged into an electrical outlet represents one of the primary objectives of WPT charging systems. Dynamic electric vehicle charging has limitless potential to revolutionize road transportation through high performance, safety, and cost effectiveness.

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