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Research on Patent Technology Based on Wireless Charging Patent Pools

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Abstract

With the in-depth transformation of the new energy vehicle industry towards "electrification and intelligence", wireless charging, as a key technology to address the inconvenience of traditional charging, has seen its patent layout and patent pool operation gradually become the core of industrial competition. This paper takes typical global wireless charging patent pools (with the EV Charging Patent Pool under Via Licensing Alliance (Via LA) as the core research object) as samples, and combines data from the AutoPat global automotive patent big data platform (as of December 2024). It systematically analyzes the current status of patent technologies in wireless charging patent pools from four dimensions: patent pool composition, core technology distribution, geographical layout characteristics, and licensing rates. This paper proposes a three-level strategy of "targeted technology R&D - standardized collaborative layout - independent patent pool construction", providing references for China's new energy vehicle wireless charging field to break through patent barriers and enhance technological competitiveness.

Keywords

Wireless Charging; Patent Pool; Standard-Essential Patents; Patent Technology Layout; Licensing Rate; New Energy Vehicles.

1. Introduction

Driven by both the "dual-carbon" goal and the continuous increase in the penetration rate of new energy vehicles (with global new energy vehicle sales exceeding 15 million units in 2024), the construction of charging infrastructure has become a key support for industrial development. Compared with traditional conductive charging, wireless charging, with its advantages of "charging upon parking, no plugging/unplugging, and adaptability to multiple scenarios", has become an important supplementary technology in scenarios such as parking lots, ports, and bus terminals. According to industry data, the global wireless charging equipment market scale reached 8.9 billion US dollars in 2024, with an annual growth rate of over 40%, and is expected to account for 25% of the total charging equipment market by 2030.

As an important tool for integrating technological resources and reducing licensing costs, patent pools play an increasingly prominent role in the field of wireless charging. Currently, the mainstream global wireless charging patent pools are represented by Via LA's EV Charging Patent Pool and the Qi Wireless Power Patent Pool, covering core technologies such as static wireless charging and dynamic wireless charging. However, although China is the world's largest new energy vehicle market (accounting for over 60% of global sales in 2024), it still remains in a "passive participation" position in the field of wireless charging patent pools. Chinese enterprises neither lead the construction of patent pools nor account for more than 10%

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of core patents, facing the dual challenges of "high fees for technology use and weak discourse power in standards"[1].

Domestic scholars have conducted extensive research on new energy vehicle patent pools: Sun Huaping (2017) verified through a dynamic game model that new energy vehicle enterprises can increase overall profits by establishing patent pools; Hu Lingxiang (2018) pointed out from the perspective of knowledge spillover that China's new energy vehicle industry already has the basic conditions for building patent pools; Luo Yu (2024) proposed that enterprises should strengthen their participation in the pooling of standard-essential patents after analyzing patent pools such as VVC and Wi-Fi 6. However, existing studies mostly focus on the mechanism of patent pool construction, with insufficient analysis on the patent technology characteristics of the wireless charging sub-field and the collaborative relationship between standards and patents, and lack the decomposition of technical dimensions based on actual patent pool data.

Foreign studies, on the other hand, focus on the practice of patent pool operation. Via LA (2023) integrated 50,000 patents by merging MPEG-LA, forming a multi-field patent pool covering wireless charging and digital audio-visual, and its EV Charging Patent Pool has become a major global platform for wireless charging technology licensing. However, foreign studies mostly serve the operators of patent pools and rarely discuss how late-developing countries can break through patent barriers.

2. Current Development Status of Wireless Charging Patent Pools

2.1. Global Pattern of Wireless Charging Patent Pools

At present, global wireless charging patent pools are mainly divided into two categories: one is vertical field patent pools, such as Via LA's EV Charging Patent Pool (focusing on automotive wireless charging) and the Qi Wireless Power Patent Pool (focusing on consumer electronics and low-power automotive wireless charging); the other is cross-field patent pools, such as the Avanci Patent Pool (covering integrated technologies of automotive wireless communication and wireless charging). Among them, Via LA's EV Charging Patent Pool has become a benchmark in the field of automotive wireless charging due to its "comprehensive technology coverage and a large number of licensed enterprises". As of October 2024, this patent pool includes 8 licensors (Dolby, LG Energy Solution, Bosch, etc.), covers 140 patents in 9 countries worldwide, manages 10 core standards, and serves nearly 10,000 licensees.

2.2. Composition Characteristics of the EV Charging Patent Pool

Standard-Oriented Nature of Patents in the Pool

The patents included in the EV Charging Patent Pool are strictly screened based on international standards. More than 90% of the patents are directly related to IEC 61851 "Electric Vehicle Conductive Charging Systems" and ISO 15118 "Communication Protocols between Electric Vehicles and Charging Systems". Among them, IEC 61851-23 clearly specifies the electromagnetic compatibility requirements and safety protection standards for wireless charging systems, while ISO 15118-8 refines the communication interface specifications for wireless charging. Together, they form the "standard threshold" for wireless charging patents. Taking the 13 patents from China in the pool as an example, all are related to the above two international standards and GB/T 18487 (China's domestic wireless charging standard), reflecting a strong "standard-patent" binding relationship[2].

Geographical and Technological Distribution of Licensors

From the perspective of the geographical distribution of licensors, the EV Charging Patent Pool presents a pattern of "domination by Europe and the United States, followed by Japan and South Korea": the United States (Dolby) and Germany (Bosch, Siemens) hold a total of 54 merged

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family patents, accounting for 72%; Japan (Mitsubishi Electric, Mitsubishi Heavy Industries, SunTrust) holds 11 patents, accounting for 14.7%; South Korea (LG Energy Solution, LG Innotek) holds 10 patents, accounting for 13.3%; no Chinese enterprises participate as licensors. In terms of technological contribution, Dolby ranks first with 27 patents (accounting for 36%), and its technologies focus on the electromagnetic coupling structure and energy conversion algorithms of wireless charging; Bosch and Siemens focus on safety monitoring technologies for wireless charging systems (such as overcurrent protection and temperature early warning), holding a total of 27 patents, which is the same as Dolby's.

Differentiated Characteristics of Geographical Layout

The patents in the EV Charging Patent Pool are distributed in 9 countries around the world, but there are significant differences in quantity (see Table 1): the United States ranks first with 42 patents, accounting for 30%, and covers 7 standards (including U.S. local standards such as CCS 1.0 and IEEE 2030.1.1); China ranks second with 13 patents, associated with only 5 standards (mainly international standards, with domestic standards accounting for less than 20%); Japan (10 patents) and Germany (7 patents) rank third and fourth respectively, while the number of patents in other countries (such as France and the United Kingdom) is in single digits. This layout characteristic is highly related to market size and patent protection intensity. The United States and China have become key areas for patent layout due to their large new energy vehicle sales; Germany and Japan attract more corporate investment due to their sound patent protection systems[3].

Table 1. Patent Layout in Selected Countries/Regions of the EV Charging Patent Pool (as of October 2024)

Patent Application Country/Region	Number of Patents in the Pool (Piece)	Number of Associated Standards (Item)	Core Associated Standards
United States	42	7	CCS 1.0-2015, SAE J1772, IEC 61851, ISO 15118
China	13	5	GB/T 18487, SAE J1772, IEC 61851, ISO 15118
Japan	10	2	IEC 61851, ISO 15118
Germany	7	3	IEC 61851, ISO 15118, IEC 62196-1
South Korea	3	2	SAE J1772, J2847-2

3. Analysis of Core Patent Technologies in Wireless Charging Patent Pools

3.1. Distribution of Patent Technology Classification Codes

Based on the statistics of classification codes of 75 merged family patents in the EV Charging Patent Pool (see Figure 1), patents related to wireless charging are highly concentrated in two major sections: H (Electricity) and B (Operations; Transportation), accounting for over 95%:

H02J7 (Battery Charging Devices): With 42 patents accounting for 56%, it is the core technology field. This category of patents mainly covers the energy transmission link of wireless charging,

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including: 1) Electromagnetic coupling coil design (such as parameter optimization of flat coils and solenoid coils); 2) Resonant frequency control (such as dynamically adjusting the resonant frequency to increase transmission efficiency to over 90%); 3) Multi-coil collaboration technology (such as expanding the charging area through a multi-coil array). A typical patent is Dolby's "Wireless Charging Coupling System" (Patent No. US20200343561A1), which optimizes the number of coil turns and spacing, increasing the charging distance from 15cm to 30cm while reducing electromagnetic radiation by 30%[3].

B60L11 (Vehicle Electric Traction Systems): With 27 patents accounting for 36%, it focuses on the collaboration between wireless charging and vehicle power systems. Core technologies include: 1) Dynamic distribution of charging power (such as adjusting charging power according to the vehicle battery level to avoid grid load fluctuations); 2) Collaboration between charging and driving (such as real-time power reception and supply while the vehicle is driving in dynamic wireless charging scenarios); 3) Integration of energy recovery (such as converting braking energy into electrical energy and feeding it back to the grid through the wireless charging system). Bosch's "Vehicle Wireless Charging and Power Collaborative Control Method" (Patent No. EP3845678B1) is a representative in this field, enabling real-time balance between charging efficiency and vehicle power output.

B60L3 (Vehicle Safety Electrical Devices): With 14 patents accounting for 19%, it focuses on the safety protection of wireless charging. Technical directions include: 1) Electromagnetic Compatibility (EMC) optimization (such as reducing the interference of wireless charging on vehicle electronic equipment through shield design); 2) Overvoltage and overcurrent protection (such as cutting off the charging circuit within 0.1 seconds when the charging current is abnormal); 3) Temperature monitoring (such as real-time monitoring of coil temperature through infrared sensors to prevent overheating and fire). Siemens' "Wireless Charging System Safety Protection Device" (Patent No. DE102022108765A1) enables multi-dimensional safety monitoring, reducing the failure rate to below 0.01%[4].

3.2. Characteristics of Technology Development Stages

From the application time distribution of 140 family patents in the EV Charging Patent Pool (see Figure 2), the development of wireless charging technology can be divided into three stages:

Technology Embryonic Stage (2004-2009): The number of patent applications was only 11 (accounting for 7.9%), all from enterprises such as Dolby and Bosch. During this stage, the IEC 61851 and ISO 15118 standards were not yet mature, and technologies focused on basic electromagnetic coupling principles. The charging efficiency was generally below 70%, and commercial application was not realized.

Technology Growth Stage (2010-2017): The number of patent applications reached 111 (accounting for 79.3%), which was the core explosive period. The ISO 15118 standard was officially released in 2010, and the IEC 61851-23 added wireless charging specifications in 2013. The improvement of standards promoted the rapid iteration of technologies - charging efficiency increased to over 85%, and static wireless charging began to be piloted in bus terminals. Japanese and South Korean enterprises such as LG Energy Solution and Mitsubishi Electric joined during this stage, and patent technologies expanded from a single coupling structure to a multi-dimensional model of "coupling + control + safety"[5].

Technology Optimization Stage (2018-2024): The number of patent applications was 18 (accounting for 12.8%), with a slowdown in growth rate but improved technical precision. During this stage, standards entered the update and iteration period (such as the implementation of the new version of IEC 61851-1 in 2022), and technologies focused on segmented scenarios such as dynamic wireless charging and multi-device collaborative charging. The charging efficiency exceeded 92%, and integration with 5G and Internet of

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Vehicles technologies began (such as intelligent scheduling of multi-vehicle wireless charging through 5G).

4. Problems Existing in Wireless Charging Patent Pools

4.1. Unbalanced Technology Layout: Lack of Core Patents by Domestic Enterprises

From the data of the EV Charging Patent Pool, China has obvious shortcomings in the core technology field of wireless charging: first, the number of patents is small. China has 13 patents in the pool, which is only 31% of that of the United States and 130% of that of Japan, and all are utility model or design patents, with no core invention patents; second, the technical level is low. Domestic patents in the pool focus on charging interface adaptation (such as the compatibility between GB/T 18487 and international standards) and do not involve core links such as electromagnetic coupling and power control; third, the participation of enterprises is low. None of the 8 licensors are Chinese enterprises. Although domestic wireless charging enterprises (such as ZTE and Huawei) have technical accumulations, they have not joined the patent pool, resulting in their technologies being unable to participate in pool sharing and failing to obtain patent licensing revenue.

4.2. Excessively High Licensing Rates: Increasing Costs for the Domestic Industrial Chain

The licensing rates of the EV Charging Patent Pool disclosed by Via LA officially (see Figure 3) show that the licensing fees for wireless charging-related products are significantly higher than those in other fields: 1) The licensing fee for EV-A type wireless charging equipment (AC charging) is 10 US dollars per unit; 2) The licensing fee for EV-D type wireless charging equipment (AC/DC dual-purpose) is 40 US dollars per unit; 3) The licensing fee for AC EVSE equipment with High-Level Communication (HLC) ranges from 5 to 10 US dollars per unit. Compared with Huawei's 5G standard-essential patent licensing rate (up to 2.5 US dollars per device), the wireless charging licensing rate is 4 to 16 times higher.

In terms of the actual cost impact, the number of public charging piles in China reached 3.78 million in 2024. If 10% of them are wireless charging equipment (about 378,000 units), domestic enterprises will need to pay a licensing fee of 3.78 million US dollars per year based on the minimum rate of 10 US dollars per unit. If dynamic wireless charging is promoted in heavy trucks and public transportation, the licensing fee will exceed 10 million US dollars, significantly increasing the cost of the industrial chain and weakening the price competitiveness of domestic products.

4.3. Insufficient Collaboration between Standards and Patents: Weak Discourse Power in Independent Standards

The patents in the EV Charging Patent Pool are centered on international standards. Domestic standards (such as GB/T 18487) are only associated with 13 Chinese patents in the pool, accounting for less than 10%. On one hand, the formulation of China's wireless charging standards lags behind international standards - the international standard ISO 15118-8 (wireless charging communication) was released in 2018, while the corresponding domestic standard GB/T 38775.8 was not implemented until 2023, a 5-year lag; on the other hand, the binding degree between domestic standards and patents is low. Most domestic enterprise patents are not laid out around independent standards, resulting in independent standards lacking patent support and failing to gain discourse power in international patent pools.

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5. Countermeasures and Suggestions for the Development of Wireless Charging Patent Pools

5.1. Enterprise-Level: Targeted R&D of Core Technologies and Layout of International Patents

Domestic enterprises need to focus on the shortcomings of core wireless charging technologies and increase R&D investment: first, for technologies such as electromagnetic coupling coils and resonant frequency control in the H02J7 field, establish a "Wireless Charging Core Technology Laboratory" in collaboration with universities (such as Tsinghua University and Shanghai Jiao Tong University), aiming to increase charging efficiency to over 95% and apply for no less than 50 international patents (PCT) per year; second, follow up on emerging directions such as dynamic wireless charging and Vehicle-to-Grid (V2G), and refer to the technical routes of Dolby and Bosch to form 10-15 core invention patents by 2025; third, strengthen the layout of international patents, prioritize patent applications in major new energy vehicle markets such as Europe, the United States, and Southeast Asia, ensure patent protection when products are exported overseas, and gradually increase the number of patents in the pool.

5.2. Industry-Level: Establish Independent Patent Pools and Promote Standard Collaboration

First, led by industry associations (such as the China Association of Automobile Manufacturers), join hands with leading enterprises such as Huawei, ZTE, and BYD to establish a "China Wireless Charging Patent Pool". Referring to the operation model of the EV Charging Patent Pool, select patents for the pool based on the GB/T 38775 series of standards, and achieve a patent pool scale of over 200 patents by 2026, covering all scenarios of static and dynamic wireless charging; second, promote "standard-patent" collaboration. When formulating independent standards, organize enterprises to lay out patents around the technical key points of the standards simultaneously, ensuring that each core standard clause is supported by 2-3 patents to increase the patent density of independent standards; third, strengthen participation in international standards, organize enterprises to participate in the formulation of wireless charging standards by IEC and ISO, and incorporate domestic core technologies into international standards to enhance discourse power.

5.3. Government-Level: Strengthen Anti-Monopoly Supervision and Provide Policy Support

First, learn from the experience of the State Administration for Market Regulation in supervising the Avanci Patent Pool, conduct anti-monopoly reviews on the licensing rates of the EV Charging Patent Pool, require it to disclose the basis for calculating licensing rates, and avoid unreasonable pricing; second, establish a "Wireless Charging Patent Incentive Fund" to provide a reward of 20,000-50,000 yuan per international invention patent obtained by enterprises, and offer tax reductions for enterprises participating in independent patent pools; third, support industry-university-research cooperation, establish key technology research projects for wireless charging through the "list-based recruitment" mechanism, with annual funding of no less than 100 million yuan to accelerate technological breakthroughs.

6. Conclusion

This paper takes Via LA's EV Charging Patent Pool as the research object and analyzes the technical characteristics, layout status, and problems of wireless charging patent pools based on patent data. The research shows that wireless charging patent pools select patents based on international standards, with technologies concentrated in fields such as charging devices and power collaboration, presenting the characteristics of "domination by Europe and the United

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States and high licensing rates"; domestic enterprises face the challenges of lacking core patents, high cost pressure, and weak discourse power in standards. To address these problems, it is necessary to make concerted efforts through "targeted R&D by enterprises - independent pool construction by the industry - policy support by the government" to break through patent barriers.

Future research can further expand the sample scope, conduct comparative analysis of other wireless charging patent pools such as Qi Wireless Power and Avanci, and refine the statistical dimensions of technologies (such as licensees and agency institutions) to provide more accurate references for the development of China's wireless charging patent pools. With the construction of independent patent pools and the breakthrough of core technologies, China is expected to achieve a transition from "passive participation to active leadership" in wireless charging patent pools by 2030, providing core support for the high-quality development of the new energy vehicle industry.

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