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Unleashing Ingenuity with Strategic Patent Drafting for Power Lithium-Ion Batteries

Introduction

Lithium-ion batteries with high energy and power capabilities are rechargeable and play a crucial role in powering diverse applications such as electric trains, electric bicycles, electric vehicles, and other electric devices and tools[1]. The power lithium-ion battery industry, situated as a pivotal component within the new energy vehicle industry chain, significantly influences the performance of these batteries across the entire production spectrum, ranging from upstream raw materials to downstream integrated manufacturing processes.

This paper commences with an exploration of the patent drafting strategy for power lithium-ion batteries as the starting point to provide a brief introduction to the power lithium-ion batteries.

[1] Chao Dong, Yuguo Liu, Wei Song, Research on the Development of Power Battery Industry of China Based on the Patent Analysis, Journal of Modern Information.

1. Patent layout strategy for the primary utilization stage of the power lithium-ion batteries

The utilization stage of the power lithium-ion batteries can be divided into a primary utilization stage and a secondary utilization stage. The primary utilization stage refers to the first use of the power lithium-ion battery from the factory. The secondary utilization stage focuses on the reuse of the power lithium-ion batteries after recycling, including the reuse of some components and the reuse of the entire power lithium-ion battery. At present, the patent layout of the power lithium-ion batteries mainly focuses on the primary utilization stage.

As the most commonly used type of the batteries at present, the lithium-ion batteries can be classified into the following types according to different classification standards:

Classification Standards	Types
Positive material	Ternary lithium battery
	Lithium iron phosphate battery
Electrolyte state	Liquid lithium-ion battery
	Semi-solid lithium-ion battery
	Solid lithium-ion battery
Battery shape	Prismatic battery
	Cylindrical battery

1-1. Materials of the lithium-ion batteries

In the lithium-ion battery, the positive material determines the voltage, specific energy and other indexes of the electrical equipment, and the positive materials mainly include lithium cobaltate, lithium manganate, lithium iron phosphate and lithium titanate and so on. The negative material determines the safety performance of the power lithium-ion batteries, and the negative materials mainly include graphite, hard carbon, soft carbon, mesocarbon microbeads, silicon carbon and lithium titanate and so on[2] [3].

Currently, the lithium-ion battery materials have reached a relatively advanced stage of development, and have a continuous emergence of numerous patent

[2] Zhizhong Zhou, Hang Yao, Analysis of Technical Patent Development Status of Lithium-Ion Power Batteries for Electric Vehicles, China Invention & Patent (Journal of Intellectual Property Information Science).

[3] Lei Zhang, Research on the Power Mechanism for the Development of China's New Energy Vehicles Battery Industry, China Academic Journal Electronic Publishing House.

layouts which are primarily focused on different material ratios. With the development of the lithium-ion battery technology, it has become increasingly challenging to achieve breakthroughs in new materials, as a result, there has been a decrease in the creativity of patent applications related to the ratios of material compositions, leading to a decline in the actual effectiveness of this type of patent layout. To enhance the patent grant rate and the stability of the patent rights, many enterprises are increasingly integrating materials with other indicators in their layout of material-related patents. For example, they combined materials with specific structures such as the current collectors used for carrying active materials, the pole assemblies, and battery cases, etc. As an example, an independent claim of a published patent (Publication number is CN110010851B) of a leading enterprise of the power battery is as follows:

A lithium-ion battery comprising a negative pole plate, a positive pole plate, an isolation film and an electrolyte, the positive pole plate comprising a positive current collector and a positive film which is arranged on a surface of the positive current collector and comprises a positive active material, the negative pole plate comprising a negative current collector and a negative film which is arranged on at least one surface of the negative current collector and comprises a negative active material; characterized in that,

the positive active material comprises a lithium nickel cobalt manganese oxide, and the negative active material comprises a graphite;

an OI value of the negative film represented by V_{OI} and a pressing density of the negative film represented by PD satisfy a relationship: $0.75 \leqslant (80/V_{OI}+43/PD) \times PD/V_{OI} \leqslant 4.19$, and a unit of the pressing density of the negative film represented by PD is g/cm^3;

a grain size of the negative active material represented by D50 and an OI value of a powder of the negative active material represented by G_{OI} satisfy a relationship: $3.14 \leqslant 100/(D50+2.8 \times G_{OI}) \leqslant 8.45$, and a unit of the grain size of the negative active material represented by D50 is μm;

the grain size of the negative active material represented by D50 is in a range of 1μm～15μm;

the OI value of the negative film represented by V_{OI} is in a range of 11~60;

the OI value of the negative film represented by $V_{OI}= C_{004}/C_{110}$, C_{004} represents a characteristic diffraction peak area of 004 in X-ray diffraction pattern of the negative film, C_{110} represents a characteristic diffraction peak area of 110 in X-ray diffraction pattern of the negative film;

the OI value of a powder of the negative active material represented by $G_{OI}= C'_{004}/C'_{110}$, C'_{004} represents a characteristic diffraction peak area of 004 in X-ray diffraction pattern of a powder of the

negative active material, C'_{110} represents a characteristic diffraction peak area of 110 in X-ray diffraction pattern of a powder of the negative active material.

The above-mentioned claim not only define the material of the active material but also incorporate various parameter indicators, and combine a variety of parameters and utilize a range of proportional values for different parameters to limit. This approach distinguishes the claim, in terms of their form, from traditional material patent layouts. The layout strategy of this patent can increase the difficulty of patent retrieval, which is beneficial for improving the probability of patent grant. However, this type of patent application requires a comprehensive description of the technical effects in the specification, as well as extensive test data to support the technical effects achieved by the parameter indicators.

By combining the materials in material-related inventions with other indicators, it opens up another avenue of application strategy for material-related inventions. For example, combining materials with structures can produce unexpected technical effects. However, opportunities and risks always go hand in hand. When relevant enterprises engage in patent layout of this type, they need to exercise caution in verifying the related technical effects in the specification. Most of these types of patents require validation through test data, and the accuracy of the test data may determine the validity of the respective patents. In existing public cases, there have been instances where patents have been deemed invalid due to erroneous test data.

1-2. Electrolyte of the lithium-ion battery

The electrolyte plays a role in conducting electrons between the positive and negative poles of the lithium-ion battery. It ensures that the battery can obtain the advantages of high voltage, high specific energy and so on. Additionally, the electrolyte has a great influence on the battery' s charge/discharge performance, lifespan, and operating temperature range.

With the accelerated development of the lithium-ion battery technology, the number of patent applications for the electrolyte has been increasing year by year. This includes patent applications for liquid lithium-ion batteries, semi-solid lithium-ion batteries, and solid lithium-ion batteries.

The liquid lithium-ion batteries are the most mature and widely used at this stage, and they have a relatively large number of patent applications. The semi-solid and solid lithium-ion batteries can reduce or eliminate the potential safety risks associated with electrolyte corrosion and leakage, and are more thermally stable, have excellent machinability as well as a favorable development trend. Therefore, at this stage, there is an increasing number of patent applications for semi-solid and

solid lithium-ion batteries, and many enterprises are now racing to seize the opportunity.

The patent layout strategy for the electrolyte of the lithium-ion battery still revolves primarily around materials, with a focus on combining positive and negative materials. At present, there is no systematic cutting-edge layout strategy, and with the increasing difficulty of patent layout, there has been a combination of the electrolyte and other features of lithium-ion batteries. For example, an independent claim of a patent (Publication number is CN115360438B) of a leading power battery enterprise is as follows:

A battery, characterized in that, the battery comprises a battery case, a cell assembly and an electrolyte, the electrolyte and the cell assembly are arranged in an inner cavity of the battery case, and the electrolyte remaining in the inner cavity is taken as free electrolyte, V0 represents a volume of the inner cavity, V1 represents a volume of the cell assembly, and Vt represents a volume of the free electrolyte, the battery satisfies a relationship: Vt/（V0-V1）=5%~50%.

In the above patent layout, it is fully considered that the battery generates gas during the charging and discharging cycles, and the gas is stored within the battery case; and there is still free electrolyte in the battery case, which occupies a portion of the space of the case. By controlling the electrolyte loading to an appropriate level, the lithium-ion battery can maintain excellent cycling performance while providing sufficient gas storage space for subsequent gas generation. So as to prevent the safety valve from being opened prematurely due to the excessive internal pressure of the inner cavity of the battery case reaching the opening pressure of the explosion-proof valve, thereby ensuring that the battery product possesses both good cycling characteristics and safety.

1-3. Lithium-ion battery shape

The shape of the lithium-ion batteries determines the spatial utilization rate when the batteries are grouped together, which in turn determines the energy density of the battery pack, and also directly affects the grouping efficiency of the batteries and the heat dissipation performance of the battery pack. Currently, the most common lithium-ion batteries are rectangular prism batteries and cylindrical batteries, and there are also a small number of hexagonal prism batteries. In terms of the patent layout, the rectangular prism batteries and the cylindrical batteries are still the mainstream. However, most patents do not specifically mention the shape of the battery. For example, an independent claim of a patent (Publication number is CN205231128U) of a leading power battery enterprise is as follows:

An explosion-proof device, characterized in that, comprises a top cover reinforcement mechanism, an explosion-proof sheet for releasing pressure inside a battery and a battery top cover, the top

cover reinforcement mechanism comprises a reinforcement ring, the battery top cover is provided with a longitudinal through hole, the reinforcement ring is fixed on an outer surface of the battery top cover and is configured to surround the longitudinal through hole, the explosion-proof sheet is configured to cover the longitudinal through hole, and a periphery of the explosion-proof sheet is fixed on an inner surface of the battery top cover.

The above claim primarily highlights the explosion-proof device without further specifying the shape of the battery top cover, that is, there is no restriction on the shape of the battery itself in fact. For the patent layout of the lithium-ion batteries, most patents do not specifically mention the shape of the related structures, especially when it comes to the components of the battery, the majority of these components are applicable to both the rectangular prism batteries and the cylindrical batteries.

However, for certain brand-new battery layouts, most applicants would include the shape of the battery in the patent claims during the initial layout. For example, the independent claim of a published patent application (Publication number is CN114824631A) of a leading power battery enterprise is as follows:

A single battery, characterized in that, the single battery is a square battery, the single battery comprises a battery body, and a volume of the battery body represented by V and an energy of the battery body represented by E satisfy a relationship: $V/E \leqslant 2000mm^3 \cdot Wh^{-1}$.

The above claim specifically defines the shape of the battery, thereby highlighting the inherent characteristics of the battery. At present, in order to increase the probability of authorization and stability of the patents, some applicants also limit the shape of the structure of the lithium-ion batteries in certain patents, so as to achieve better technical effects by combining the shape with related structures. Applicants are becoming more and more knowledgeable about patents, and are not simply pursuing scope blindly.

2. Summary

Given the rapid development of the power lithium-ion batteries, it is particularly important for patent layout strategies to keep pace with the times.

In the patent layout strategy for the power lithium-ion batteries at this stage, the materials or structures layout is still the mainstream, however, in order to fully consider the improvement of the power lithium-ion battery performance, various size and performance parameters have been extensively integrated into the material or structural layout.

Some enterprises, as industry leaders in the power lithium-ion batteries, have a more advanced patent layout strategy and

are actively leveraging their patent advantages to consolidate their industry position. Other power lithium-ion battery enterprises have also realized the increasing importance of patent layout strategies. The requirements for patent agencies have become stricter, as they need to work closely with enterprises to establish a domestic patent network for power lithium-ion batteries in order to protect their territory in this field.

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Email address : ltbj@lungtin.com Website www.lungtin.com

For more information, please contact the author of this article.

LI, Jianzhong

Deputy General Manager of Xi'an Office, Senior Patent Attorney

Mr. Li’ s practice mainly focuses on patent filing, patent portfolio development, etc., and he is very experience in patent cases in technical areas of vehicles, containers, power lithium-ion batteries, medical devices, semiconductors, household appliances, etc., Mr.Li was licensed to practice as a Chinese Patent Attorney in 2018，Since May 2018，Mr.Li has represent over 500 patent filing.