follows: when the vehicle is downhill, the flywheel stores energy to reduce the downhill speed and ensure driving safety; Release energy to provide assistance when going uphill.

3. Optimize the shortcomings of the existing small flywheel energy storage technology in application. At present, the existing small flywheel energy storage devices have high gravity instant conversion efficiency, but the wheel is not suitable for uphill conditions due to its general structure, that is, it is difficult to store gravitational potential energy and cannot be used immediately when needed. The application of the technology of converting gravitational potential energy into kinetic energy in vehicles is an important research direction in the future. The purpose of this project is to combine the two technologies and develop a flywheel device that can effectively convert and store gravitational potential energy, so as to achieve the purpose that the flywheel can work normally under various environmental conditions.

The new flywheel is composed of positive and negative wheels, and the springs and gears are both inside the positive and negative flywheels. During normal operation, the gravitational potential energy is stored by the spring energy storage device and acts on the positive wheels of the two wheels for potential energy conversion; When the wheel travels, the spring compresses (from 9 o'clock direction to 12 o'clock position) and decompresses (from 12 o'clock to 9 o'clock position). During the rotation, the influence of the compression and decompression of the spring mechanism on the rim part provides extra power for rotation.

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电废循环—面向新能源汽车电池中有色金属的电磁涡流分选技术

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Summary. *At present, the new energy power battery is about to enter the decommissioning climax, sorting metal is one of the important step, this paper describes our optimization and innovation of the traditional waste power battery process. The research and development of the new vertical eddy current sorter breaks through the bottleneck of the original equipment, and realizes a breakthrough for the problem of not being able to deal with small-sized electronic waste (original eddy current sorting equipment), the problem of only being able to separate non-metals and metals, not being able to separate different metals at the same time (high-voltage electrostatic equipment), and the problem of high-pollution and high-emission (chemical treatment), focusing on the solution of the recovery of the metal with a particle size of less than 5mm. The Recycling Process is a mechanical-physical device that realizes the separation of small-sized non-metals from metals and between different metals. Based on this, on the traditional*

recycling process, we also added two processes of freezing crushing and wind selection, freezing crushing by controlling the temperature, the use of which solid waste at low temperatures in the brittle fracture temperature difference, so that the material becomes brittle, in addition to the crushing effect is better, the advantages of energy saving and noise reduction are also very obvious, the wind selection to a certain extent to make the degree of dissociation of the waste power batteries is higher, so that the separation of metal and non-metallic materials more thoroughly, thus improving the recycling efficiency. It also improves the recycling efficiency.

According to the New Energy Vehicle Industry Development Plan (2021–2035) issued by the General Office of the State Council in November 2020, China will also vigorously develop new energy vehicles in the future, and it is expected that by 2025, China's new energy vehicle sales will reach 5 million units, accounting for 20 % of new vehicle sales and 44 % of the global new energy vehicle market capacity. By then, China will become the world's largest country of new energy vehicles.

The vigorous promotion of new energy vehicles has led to the explosive growth of the power battery industry, the current market is common ternary batteries and lithium iron phosphate batteries, lithium iron phosphate batteries in the phosphorus, iron elements are widely available in the earth's resources; lithium iron phosphate batteries, the mixing of chemical mixtures of the simpler method, so that the cost of lithium iron phosphate batteries to be relatively inexpensive about 10–15 %; lithium iron phosphate battery cycle life can be up to 10 years or so, but ternary battery life is only 6 years. Up to about 10 years, but the service life of lithium ternary batteries is only 6 years. The following table shows that lithium iron phosphate year-on-year growth and year-on-year cumulative growth is the most obvious. Lithium iron phosphate batteries (LFPBs) occupy a large share of the power battery market due to their advantages of high safety, long cycle life and low price. At present, in China has entered the end-of-life power battery, lithium iron phosphate batteries accounted for more than 70 %, the future amount of retired lithium iron phosphate batteries will become increasingly large, so the recycling of used lithium iron phosphate batteries is particularly important.

Table 1 – Power Battery Production by Material Type (Unit: MWh, %)

Material type	October	Cumulative January-October	Chain reactionary growth	Year-on-year increase	Cumulative year-on-year growth
ternary material	9200.2	72038.5	–4.5 %	93.5 %	165.0 %
lithium iron phosphate	15892.1	87520.2	17.6 %	314.0 %	378.2 %
lithium manganate	26.2	142.5	61.7 %	31.0 %	21.3 %
consider	25122.5	159824.4	8.4 %	191.6 %	250.0 %

Power battery is mainly composed of shell, positive pole piece, negative pole piece, electrolyte and diaphragm, positive pole piece is composed of aluminum foil and positive pole material adhered on it, negative pole piece is composed of copper foil and negative pole material adhered on it, and these materials contain a large amount of valuable metals, and the composition of valuable metals contained in different positive pole materials is different, among which the metals with the highest economic value are cobalt, lithium, nickel and so on. For example, the average content of lithium in ternary batteries is 1.9 %, nickel 12.1 %, cobalt 2.3 %; in addition, the proportion of copper and aluminum also reaches 13.3 % and 12.7 %, and their content is even much higher than that in primary ores, which is of great recycling value. In addition, a large number of used power batteries are directly landfilled or stockpiled after decommissioning, which not only occupies land resources but also causes serious pollution of soil and water resources when heavy metals such as cobalt, lithium and nickel penetrate into the soil, seriously threatening the environment and human health, and causing great pressure on the social and ecological environment. Therefore, the recycling of used power batteries to realize the green recycling of cobalt, lithium and other scarce mineral resources has greater economic and social value.

At present, there are four methods for the recovery of copper and aluminum as well as some non-magnetic metals in used lithium iron phosphate batteries: fire method, wet method, biological method and mechanical-physical recovery method. Among them, the chemical method is more damaging to the environment, and the biological method is more difficult to be applied in large-scale industrialization. Therefore, the technological breakthrough of physical methods will be a good development direction for sorting. The optimized recycling process and the new vertical eddy current sorter developed in this project focus on solving a series of problems, such as insufficient dissociation of crushed materials, limited size of sorted particles, and excessive sticky and slimy materials.