Part 04

Making History:
The Large Format Lithium Ion Battery

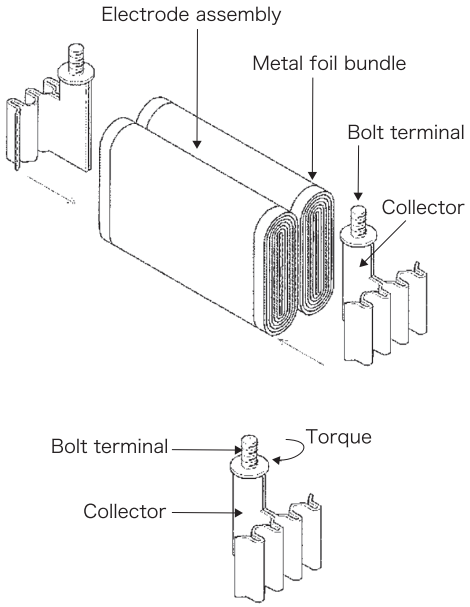
An Innovative Conductive Path Structure and the Gasket Concept

In this series we explore some of GS Yuasa's subtle technological contributions to improving the large format lithium ion battery. The conductive path structure in a battery is another consideration, as this is the route for electricity from the collector inside the battery case to a conductive component outside the battery case. In Parts Two and Three we looked at the various collectors that GS Yuasa developed for the large format lithium ion battery. Here we will introduce the conductive path structure and the gasket adopted for this new conductive path structure.

1. The Typical Conductive Path Structure

GS Yuasa began developing the large format lithium ion battery around 2000. The typical conductive path structure in a battery is a direct connection between the collector inside the battery case and a bolt terminal outside the battery case (upper, ●Fig. 1). The bolt terminal is fastened at the outside of the battery case by a nut. Fastening the nut to the bolt terminal allows the collector inside the battery case to be electrically coupled to a conductive component (such as electrical wiring, or a bus bar) outside the battery case.
When fastening the nut to the bolt terminal (lower, ●Fig. 1), the torque generated acts on the bolt terminal. Thus, in the typical conductive path structure, the torque is transmitted to the collector, which is directly connected to the bolt terminal. This increases the likelihood that the end of the electrode assembly (metal foil bundle) and the collector will separate from each other.

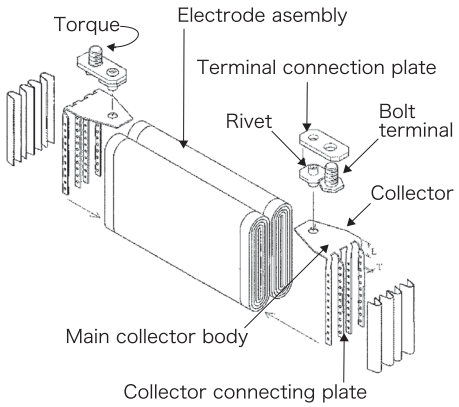
●Fig. 1 Typical Conductive Path Structure



2. An Innovative Conductive Path Structure

GS Yuasa came up with a novel concept for the conductive path structure, namely, separating the bolt terminal and the collector. This novel concept was adopted in the LIM series batteries, which GS Yuasa began to manufacture in 2002.
In this novel conductive path structure, the bolt terminal is electrically coupled to the collector via a terminal connection plate and a rivet (●Fig. 2). The terminal connection plate, which is installed from above, extends horizontally and connects the bolt terminal and the rivet. The rivet is horizontally offset from the bolt terminal and extends vertically from that position; the rivet electrically couples the collector (main collector body) inside the battery case and the terminal connection plate outside the battery case. When the power stored in the battery is supplied to an external component, electricity passes through a conductive path comprised of the electrode assembly, the collector connecting plates, the main collector body, the rivet, and the terminal connection plate.
This conductive path structure, which isolates the bolt terminal from the collector, prevents the torque acting on the bolt terminal when fastening the nut to the bolt terminal from being transmitted to the collector. Therefore, the stability of the bond between the end of the electrode assembly and the collector can be maintained, thereby preventing any increase in electrical resistance along the conductive path that may be caused by a deterioration in the bond.

●Fig. 2 Conductive Path Structure in LIM series battery[1]



3. Providing a Rotation Stopping Gasket

The structure employed to fasten the bolt terminal in GS Yuasa's LIM series batteries is also unique. More specifically, the gasket is an insulating component that is adapted to suit the above described conductive path structure.

The gasket is placed between the bolt terminal and the surface of the battery case receiving the bolt terminal (upper, ●Fig. 3). The gasket extends horizontally and parallel to the terminal connection plate, and is also situated between the surface of the battery case and the rivet. The bolt terminal, the terminal connection plate, and the rivet are therefore insulated from the battery case via the gasket. The gasket also seals the battery case. A recess in the gasket houses the head of the bolt terminal. The shaft of the bolt terminal is inserted through a hole in the terminal connection plate, which connects the bolt terminal and the rivet.

Consider for a moment if a large torque were transmitted to the terminal connection plate. This would cause the terminal connection plate to turn; the bond between the terminal connection plate and the rivet would deteriorate, and is likely to increase the electrical resistance on the conductive path. Similarly, if a large torque were transmitted to the gasket causing the gasket to turn, the gasket could no longer seal the battery case, which would increase the likelihood that the battery case would be less airtight.

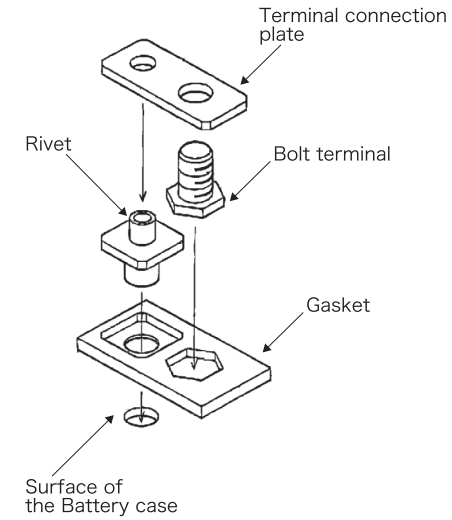
There is some clearance (looseness) between the bolt head and the recess in the gasket with the bolt head housed in the recess, as well as between the bolt shaft and the hole in the terminal connection plate with the bolt shaft inserted through the hole (lower, ●Fig. 3). With clearances between the bolt terminal and the hole in the terminal connection plate and the recess in the gasket, less of the torque acting on the bolt terminal when the nut is fastened to the bolt terminal is transmitted to the terminal connection plate and the gasket. Thus, to some extent, the clearances in the LIM Series battery therefore ensure that neither the terminal connection plate nor the gasket will turn. These clearances allow the fastening structure to absorb and dissipate the torque.

The gasket insulates, seals, and stops rotation, which reduces the number of components required. Thus, it is possible to increase the yield and improve the performance of the battery while keeping manufacturing costs low.

GS Yuasa was able to independently develop a conductive path structure and a bolt terminal fastening structure, through constant improvement and refinement. Both of these structures are still widely used in the large format lithium ion batteries. The above-described fastening structure based on GS Yuasa's novel conductive path concept and GS Yuasa's subsequent continual research and development has contributed to the evolution of the large format lithium ion battery.

Here we discussed the innovative conductive path structure used in the large format lithium ion battery, as well as the development of a gasket specifically suited to this novel conductive path structure. In Part Five, we discuss further development of the gasket, and our improvements to the lid of the battery case.

●Fig. 3 Bolt terminal fastening structure in the LIM Series Battery[2]



1. Japan Patent No. 5545408 (Filed in 2002)
2. Japan Patent Nos. 4843893, 5545400, 5582243 (Filed in 2002)

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