Product Introduction

# Development of Hydraulic Compression Stop for Monotube Gas RCU

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## 1 Introduction

Recently, there has been an increase in sales of adventure models in the motorcycle market, as shown in Photo 1. Vehicle manufacturers are actively developing new models. These models are popular for long-distance touring because of their high ground clearance and ability to handle rough road surfaces. This requires the suspension to provide excellent shock absorption and a comfortable ride.

However, when riding on rough roads while carrying a load or passenger, the rear suspension (hereinafter, "RCU") connecting the frame to the rear wheel tends to bottom out[Note 1]. Conventional designs use multi-stage springs and cushion rubber to absorb bottom-out shocks. However, there are limits to how much absorption can be improved (Fig. 1). If absorption fail to meet targets during the development stage, countermeasures are taken by increasing the damping force within the normal operating range. However, this results in a trade-off where ride comfort deteriorates.

In this project, we developed a new product structure for the BMW F450GS that provides both ride comfort and bottom-out absorption within the normal operating range. The following will provide an overview of the product.

Note 1) Reaching full stroke and bottoming out.

**Photo 1** BMW G310GS - An example of adventure models

* G310GS is a trademark of BMW Motorrad.

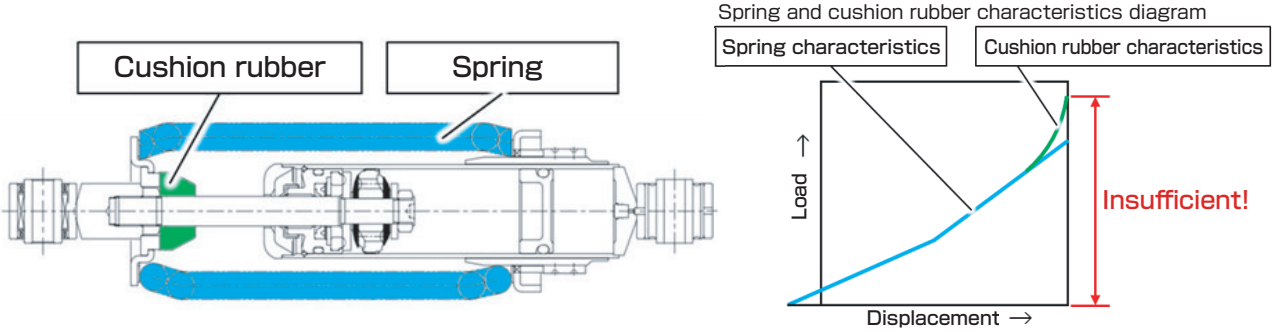



**Fig. 1** Conventional gas RCU

## 2 Development Background

The hydraulic compression stop[Note 2] (hereinafter, the "hydraulic stop") is a mechanism that provides a comfortable ride and absorbs bottom-out shock. It has long been used in the front forks (hereinafter, "FF") of motorcycles. Fig. 2 shows an example of the hydraulic stop.

In the FF hydraulic stop, a piece attached to the piston rod enters the case during the compression stroke, forming a pressure chamber. The area between the Case ID and Piston rod OD is where the pressure is generated. The internal pressure of the pressure chamber generates the hydraulic stop load[1].

KYB has a track record of producing twin-tube gas shock absorbers for automobiles equipped with a hydraulic stop mechanism (Fig. 3). In this design, the piston support and the cylinder form the pressure chamber[2].

The target model of this development project is a monotube gas RCU, a flagship product among motorcycle RCUs. This model does not have a hydraulic stop mechanism.

Note 2) A hydraulic stop that operates during the damper compression stroke.

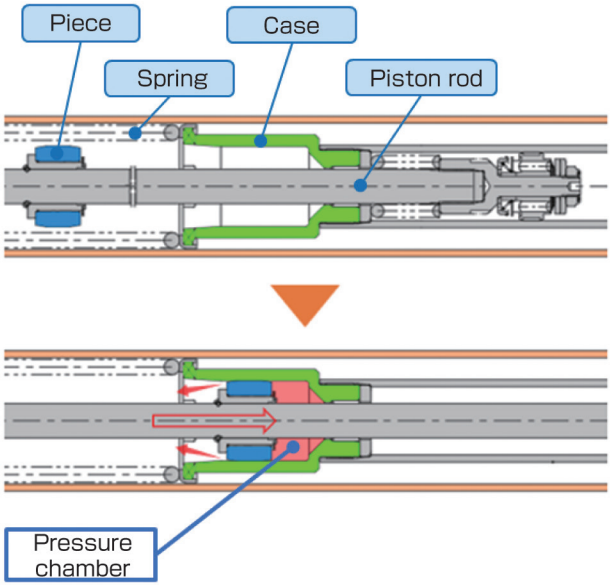



**Fig. 2** Conventional FF hydraulic stop mechanism

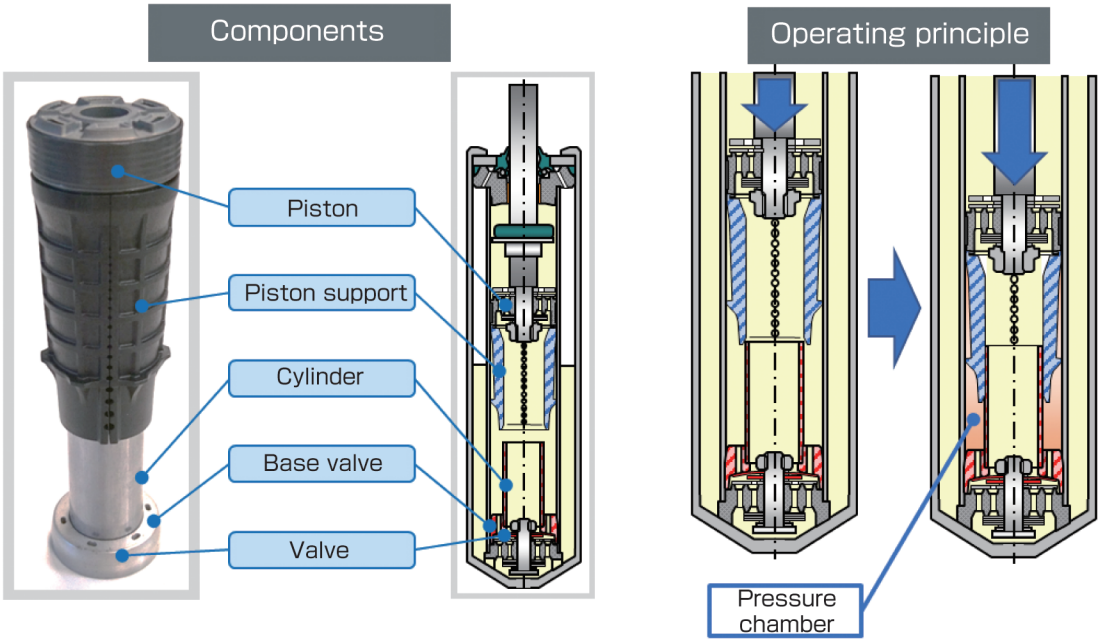



**Fig. 3** Twin-tube gas shock absorber hydraulic stop mechanism

## 3 Market Product Survey

Before developing a hydraulic stop for monotube gas RCUs, we surveyed competitors' products. The results showed that the hydraulic stops generate the required load. We confirmed that they successfully provide both ride comfort and bottom-out shock absorption within the normal operating range.

Next, we examined how the pressure chamber is formed to generate a hydraulic stop load. In this step, we recognized that KYB's existing hydraulic stop structure (Figs. 2 and 3) differs in design concept from competitors' products.

KYB's hydraulic stop structure is designed to form a pressure chamber in a specific part of the damper. This design ensures that the pressure generated during operation of the hydraulic stop does not place a load on the oil seal or other parts.

In contrast, competitors' products use the entire interior space of the damper as a pressure chamber. The pressure generated during operation of the hydraulic stop places a load on the oil seal. To prevent damage to this type of pressure chamber, it is necessary either to use oil seals capable of withstanding the high pressure generated during operation or to ensure that the operating pressure does not exceed the specified level.

## 4 Developed Structure

Based on the survey results, we established a target hydraulic stop load. Additionally, we devised a structure that maximizes the pressure-receiving area while ensuring the operating pressure does not place a load on the oil seal. This allows for higher hydraulic stop loads.

Fig. 4 shows the structure of the developed product.

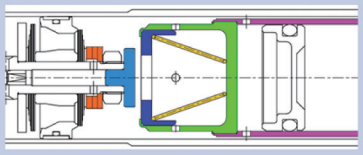
The developed product has an inner cylinder that has been added to the conventional damper and secured to the case by crimping. A piece and spring are placed inside the case. Crimping the case prevents the piece and spring from coming off. Additionally, a stopper is press-fitted and secured to the piston rod.

The product operates by using the stopper to block the hole in the center of the piece, forming a pressure chamber at a predetermined stroke. Changing the clearance between the inner diameter of the case and the outer diameter of the piston adjusts the hydraulic stop load. Thus, the target hydraulic stop load is achieved.

The hydraulic fluid corresponding to the piston rod's retraction volume flows through an orifice in the inner cylinder to the free piston. This mechanism preserves the damping force generated by the main piston.

## 5 Cost

The initial target was to add a hydraulic stop with 10 parts. However, we successfully reduced the number of parts for the developed product to just six. Consequently, we achieved a 32% cost reduction.

| Item | Target value | Developed product |
|---|---|---|
| Structure | |  |
| Number of parts to add a hydraulic stop | 10 | 6 |
| Additional cost to add a hydraulic stop | Target | 32% reduction from the target |

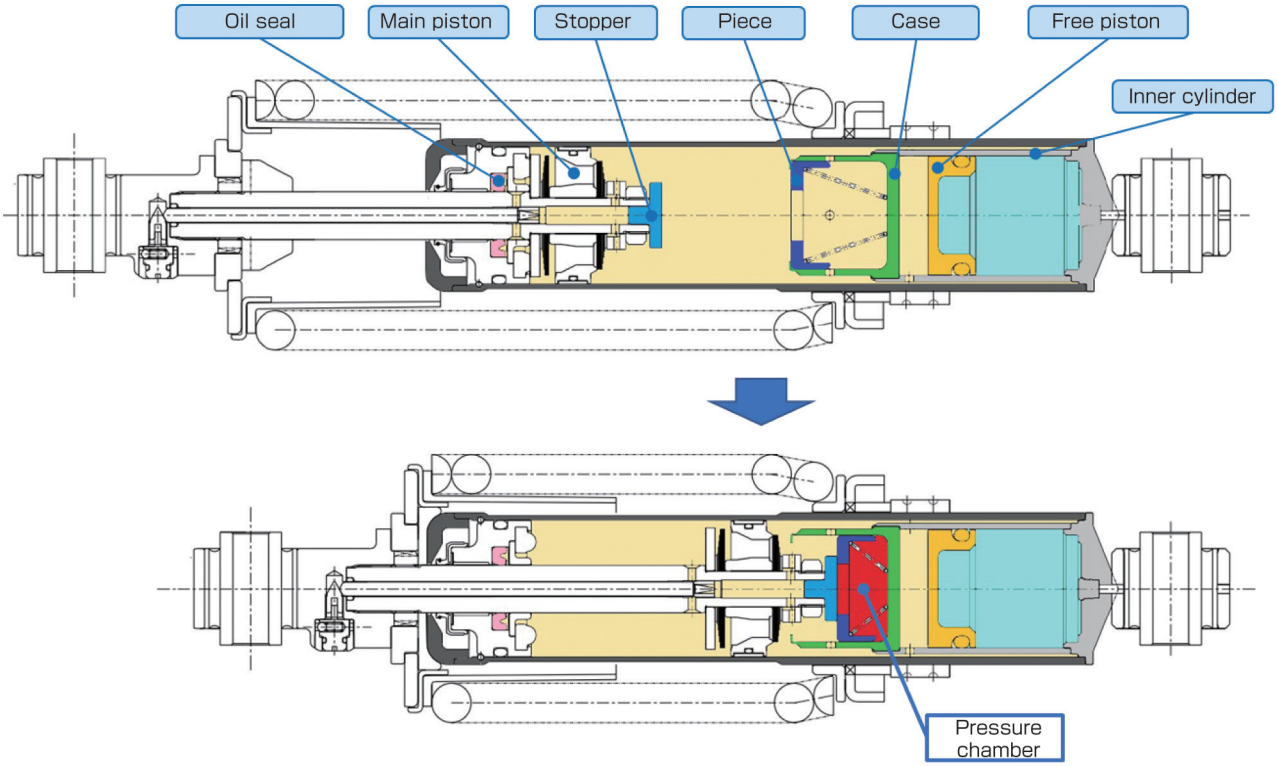



**Fig. 4** Monotube gas RCU hydraulic stop mechanism

## 6 Conclusions

We developed a hydraulic stop structure that can be mounted on the monotube gas RCU.

This product is used in the BMW F450GS (Photo 2) to provide ride comfort and bottom-shock absorption during normal driving. We hope the riders experience and enjoy the excellent performance of this product.

## 7 Applications and Future Outlook

The structure developed in this project has moved to mass production. We plan to expand its use to other models and increase sales. Additionally, since this structure maximized the pressure-receiving area, we plan to apply it to RCUs for compact vehicles. We expect it to find wider applications and higher production.

**Photo 2** BMW F450GS equipped with the developed product

* F450GS is a trademark of BMW Motorrad.

## 8 In Closing

Finally, we would like to take this opportunity to express our sincere gratitude to BMW Motorrad, TVS Motor Company Limited, and the staff of the relevant departments for their support in developing this product.

### References

1) SUZAKI: “Development of a performance and quality improvement structure for $\phi$37-mm upside-down front forks,” KYB Technical Review No.68 (April 2024).
2) Senar: “Double Hydraulic Stop Suspension,” KYB Technical Review No.58 (April 2019).

## Author

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Joined the company in 2008.
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