Double Eccentric Valve for EGR Systems

1. Overview of the Invention, etc.

The present invention is used in automobile engine exhaust gas recirculation (EGR) valve systems, where it contributes to cleaning the exhaust gas and improving fuel efficiency. EGR refers to a system that returns a portion of the exhaust gas emitted from the engine back to the intake side for re-combustion. Originally, EGR was mainly used for exhaust gas purification (NOx reduction) in diesel vehicles. However, since EGR reduces intake resistance and fuel consumption, it is now widely used in gasoline vehicles as well. (Figure 1)

Compared to conventional EGR valves (Conventional product 1 in Figure 2), the present invention nearly doubles the recirculation flow rate without enlarging the product. This contributes to reducing the weight of automobiles and their environmental impact.

Currently, the present invention is produced domestically at a rate of approximately 600,000 units per year for domestic supply.

Figure 1 Exhaust gas recirculation system and EGR valve

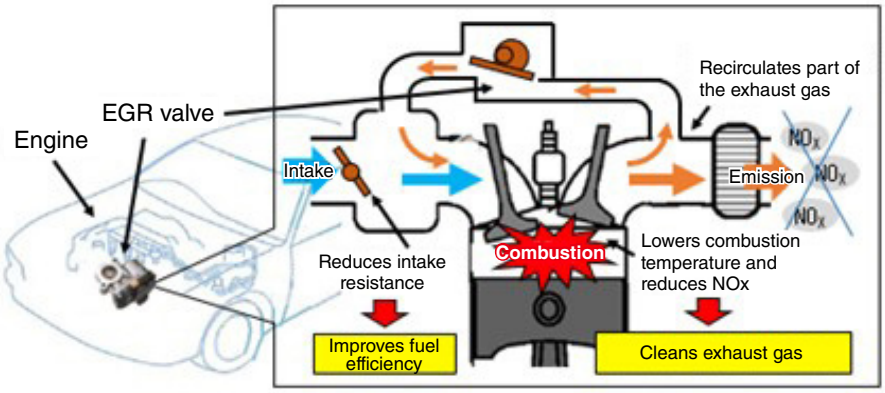
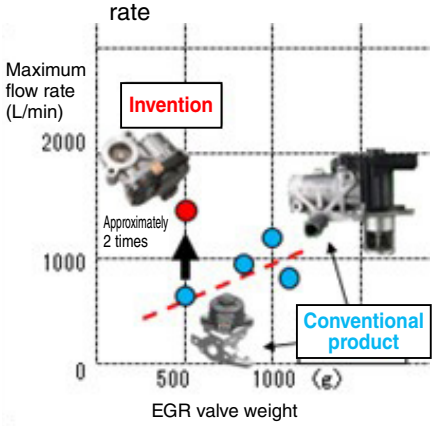


Figure 2 Relationship between product weight and maximum flow rate



2. Issues with Conventional Inventions and Development Needs

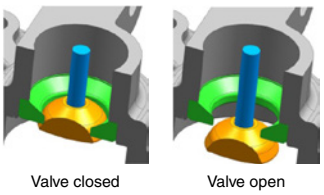
Conventional EGR valves were primarily poppet valves (small size, low flow rate, and high sealing). However, as the amount of recirculated exhaust gas (EGR rate) increases, fuel efficiency and exhaust gas cleanliness improve. Therefore, there has recently been a demand for high flow rates of recirculated exhaust gas. Various companies have proposed the following improvements to achieve high flow rates. (Figure 3)

To meet the development needs for high flow rates, it was difficult to commercialize conventional product 2, and conventional product 1 required enlargement, which would increase its weight.

Figure 3 Conventional technologies and their issues

■ Conventional product 1 (poppet valve)

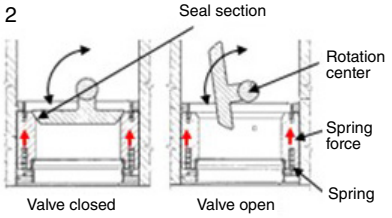
- High sealing and miniaturization are possible for small flow rates
- High sealing is possible for large flow rates, but larger sizes are required



⇒ As flow rate increases, size also increases

■ Conventional product 2 (butterfly valve)

- Miniaturization and large flow rates are possible, but maintaining high sealing is difficult



⇒ The sealing section wears out due to the pressure exerted by the spring force, which makes maintaining the sealing level difficult

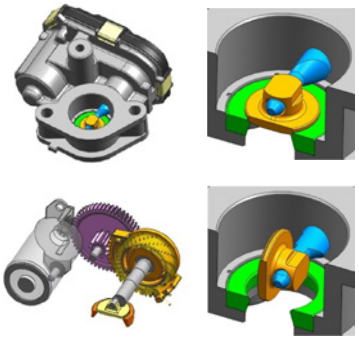
3. Features of the Invention, etc.

The present invention has a structure that achieves high flow rates and sealing performance without enlarging the product. By shifting the center axes of the shaft and valve left and right and up and down (double eccentricity), the product opens like a butterfly valve, which excels at high flow rates, and closes like a poppet valve, which provides excellent sealing performance (Claim 1).

Furthermore, since the present invention relates to fundamental valve technology, it is expected to have various applications.

<Feature 1> Balancing conflicting performance requirements

Figure 4 Structure and performance of the invention (double eccentric valve)

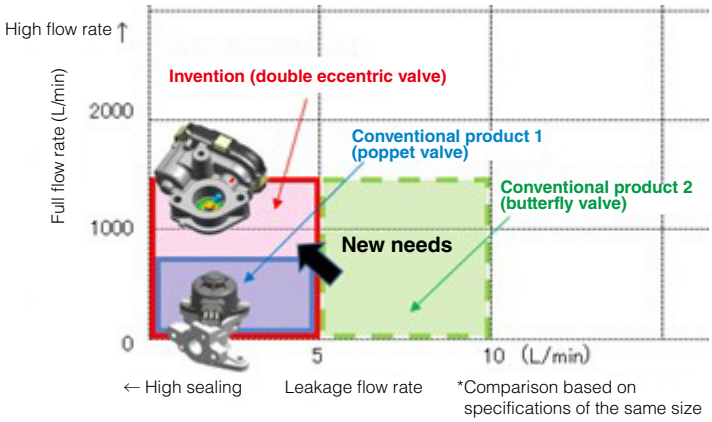


High sealing

Closes like a lid, similar to a poppet valve, providing high sealing performance

High flow rate

Opens like a butterfly valve, despite being a poppet valve, to ensure a wider opening area



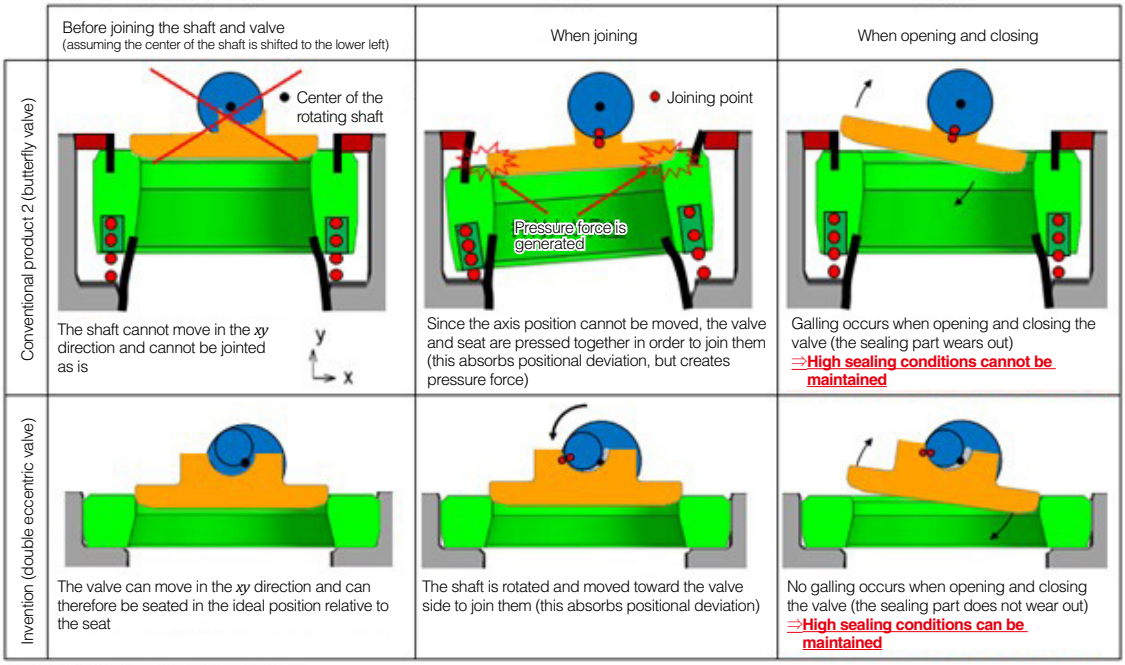
<Feature 2> Excellent durability and a simple structure

In the conventional product 2 butterfly valve (Figure 3, bottom), dimensional variations in each component were attempted to be absorbed by (1) the floating valve seat structure and (2) the pressure applied to the sealing section by the spring. However, with this structure, sealing performance is only ensured when the valve is new. The contact pressure between the valve body and valve seat inevitably increases during opening and closing of the valve, causing localized welding, or "galling," to occur. This results in wear of the sealing section, making it impossible to maintain a high sealing state. (Figure 5, top)

On the other hand, the double eccentric valve of the present invention utilizes (1) the eccentric shaft structure and (2) the gap between the shaft and the valve, absorbing variations in each component during assembly. Consequently, galling does not occur during opening or closing of the valve, and the sealing performance remains at the same level as when the product is new. (Figure 5, bottom)

Furthermore, when comparing the number of components around the valve, there are eight for the conventional product 2 while there are four for the invention, half as many.

Figure 5 Structural comparison between the invention and conventional technologies



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Chubu Region Invention Commendation: Invention Encouragement Award (Japan Institute of Invention and Innovation, a Public Interest Incorporated Association)

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