The Partnership between PM and Manufacturers of Shock Absorbers, a Success History

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Abstract

Manufacturers of shock absorbers are continuously innovating for improving safety and enhance comfort in cars. The PM industry, as important supplier of components for shock absorbers, has gone along with this evolution by developing the required technology. This paper presents examples of components and technology to meet demanding market requirements. They have been selected by their representative character but there are many other interesting components that we cannot show because of the limited extension of a paper.

Keywords: shock absorber parts, complicated shape compaction

1. Introduction

Hydraulic shock absorbers are used in automobiles for dampening the reaction of suspension springs to road irregularities. They play a critical role in the comfort of passengers, in the dynamic stability of the vehicle as well as in its steering and stopping ability.

A twin tube shock absorber comprises an inner cylinder which is divided into two chambers by a piston. The inner cylinder is surrounded by an outer cylinder forming an oil reservoir. These two cylinders are communicated by a valve fitted at the bottom of the inner cylinder. A cap or rod guide closes the upper ends of both cylinders and guides the piston rod. The damping force is generated by the flow of oil through holes or ports in the piston and bottom valve. During the extension stage, a disc seating on edges in the piston seals certain ports while oil is free to flow through other ports pushing a disc against the force of a spring on the opposite face. In the compression stage the roles of active and sealed ports interchange.

This basic description applies to the shock absorber shown in Fig. 1 taken from a GM patent of 1936 as well to the one in Fig. 2 showing a modern piston design including a bypass in an electronically controlled monotube shock absorber. One difference between these two examples is that in early times all components were machined or cast while today most of them are produced by Powder Metallurgy (PM). An other difference between the concepts in Figs. 1 and 2 is the huge improvement in function, performance and durability. This improvement is an achievement of the shock absorber manufacturers who have been accompanied by the PM industry providing the corresponding progress in the materials and manufacturing technology [1].

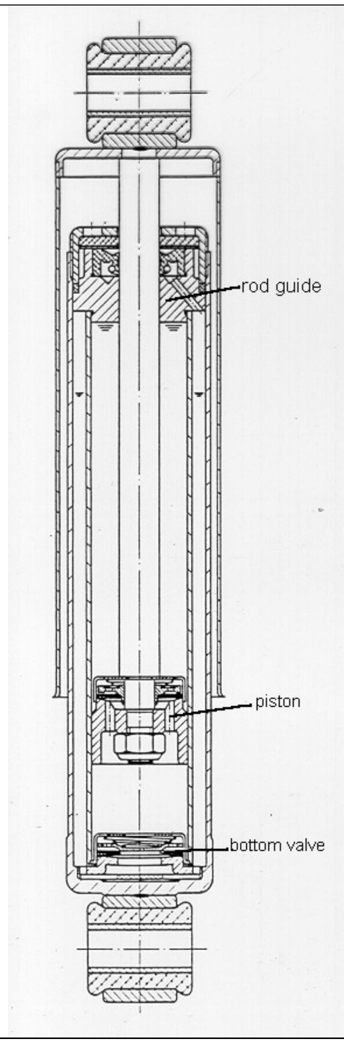

Fig. 1. Twin tube shock absorber, early design of GM

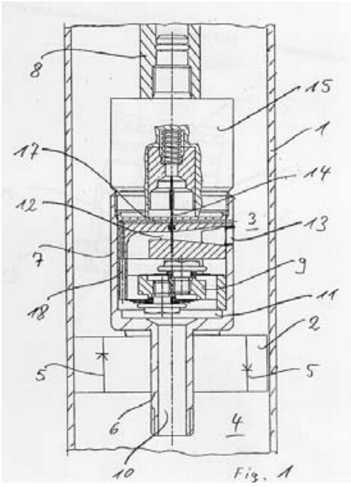

Fig. 2. Bypass for a piston in a Thyssen Krupp Bilstein active suspension [2]

2. Bottom Valve and Piston

The bottom valve withstands the high damping forces between the inner and the outer tubes. Holes in the bottom valve are controlling the high speed damping forces especially at compression. The edges together with the valve discs seal the oil flow.

All these functions require the bottom valve to provide strength, hardness, accuracy, temperature stability as well as complex shape capability. This is achieved by using a Fe-Cu-C alloy sintered in a mesh belt furnace at 1120ºC. These parts are compacted in high speed mechanical presses. Pins on the lower punch penetrate in the upper punch at each press stroke (at a minimum of 20 times per minute) to form the control holes. In order to prevent radial forces during compaction from breaking this very thin pins (2 mm), density is limited to around 6,6 g/cm^3. The required green strength for the valve edge at this density level is only achieved by using a sponge iron powder grade. Final dimensions and tolerances are attained by means of a sizing operation. A typical specification for the tolerance in height of valve edges is 0,01mm. A final steam treatment adjusts hardness, typically 265 HB 2,5/62,5, crush strength as well as wear resistance.

The piston is submitted to compression and rebound forces from both sides. In some cases as in McPherson struts, it must withstand lateral forces against the tube. In the same way as in the case of the bottom valve, holes and edges of different shapes together with valve discs provide the damping function. The outer skirt incorporates sealing means such as piston rings. Low friction between piston and tube is important for quick damping reaction and passenger comfort. Therefore low friction coatings of high wear resistance are common in modern pistons. Alloys and manufacturing technology for pistons are similar as for bottom valves.

3. Bypass for Active Suspension

Modern active suspensions allow the damping characteristic to be adapted to varying road conditions. The driver can manually select a driving style or alternatively, an electronic program tunes the damping characteristic in accordance with speed, steering-wheel state and running dynamics.

For this purpose a bypass, as shown in Fig. 2, communicates the chambers separated by the piston (5). An electronically actuated slider (14) varies the open cross-section (12) of the bypass. In this way, a variable damping characteristic according to an electronic program is achieved.

The bypass has an internal cavity with radial inlet (13) and an axial outlet . This shape seems to be impossible for conventional axial compaction and rather suited for a injection moulding manufacturing technology. Besides that, proper function of the bypass requires tight tolerances in the thin and wide grove for the slider. Therefore limitations in the accuracy and thermal stability of other manufacturing techniques lead to the selection of PM as the optimal manufacturing technology.

The PM solution consists in joining three simple parts: input part, throttle part and output part. Each simple part is pressed with the corresponding opening in the compaction direction. Joining is achieved by resistance projection welding. In this particular case, due to the special requirements of welding, the suitable alloy is a Fe-Cu alloy of low carbon content.

4. Summary and conclusions

Shock absorbers manufacturers are using PM because of the need of cost effective alternatives to cast and machined parts.

As explained by means of examples, the PM industry has developed a consistent manufacturing process for parts of complex shapes, highly accurate and materials of suitable strength, hardness and temperature stability.

Many attempts have been made for the application of other materials or technologies such as metal sheet stampings or moulded plastics but they never achieved the required constellation of properties.

Shock absorber manufacturers and the PM industry have work together in the implementation of modern quality systems. They also have made tremendous gains in productivity by applying techniques such as value analysis. Furthermore the PM industry has always been a partner for product innovation offering their R&D capabilities as an additional service.

5. References

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