



An Analysis of the Causes of Major Faults in Vehicle Suspension Systems and Shock Absorbers

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Annotation

In this article, the elastic part of the car suspension, i.e. the wheels, vibrates the frame and body parts with a variable frequency when moving on uneven roads. Although these vibrations are damped, they last for a long time, which worsens the smoothness of the ride. In automobiles, shock absorbers dampen vibration of the frame and body, and methods to ensure smooth movement are explained.

Keywords: shock absorber, elastic vibrations, frame, body, suspension, wheels, hydro-pneumatic, hydraulic, brake path, diagnostics, engine, car.



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Introduction

As far as we know, there is no industry today that does not use road transport. In particular, cars are used in cities, suburbs, intercity and international transportation of passengers and cargo, as well as performing special tasks. Today, in order to create great comfort for drivers, spare parts that are made with a very high level of precision are used to ensure the safe movement of cars and to increase the smoothness of driving. Vehicles will be able to pass through different road conditions when moving. At the same time, we use devices that are very important in order to dampen shocks from external influences. These spare parts absorb the force coming from the car engine, the impact on the body, and cause the cars to move smoothly [1].

When removing, disassembling and installing the front suspension from the car, it is necessary to follow the safety rules. Before disassembling the front suspension, clean it from mud, dust and all dirt, wash it thoroughly with gasoline and wipe it dry. Compress the spring to prevent it from popping out using the special tools and fixtures shown in disassembly. That is, it is advisable to tighten it from the opposite side as an additional protection. Care must be taken when compressing and releasing the spring. If you notice a change in the spring removal or insertion, i.e. the device tilts or pushes, repeat the compression in the position that ensures the correct direction. [2]

Methods and level of research

In modern cars and buses, a stabilizer is also installed with the suspension. The suspension stabilizer is hinged to the bridge or the arm of the suspension with the help of rubber pads at both ends, reducing the car's lateral deviation and transverse vibrations. Rubber cushion suspensions (elastic construction) are widely used in modern cars and are also called limiters. Limiters are divided into compressible and shock-distributing types. Compressible limiters mainly limit the path of the wheel up and down.

The pneumatic cushion in the suspension acquires elastic properties due to the compression of the air in it. Such cushions are installed vertically in up to two on the front suspension and up to four on the rear suspension [3].

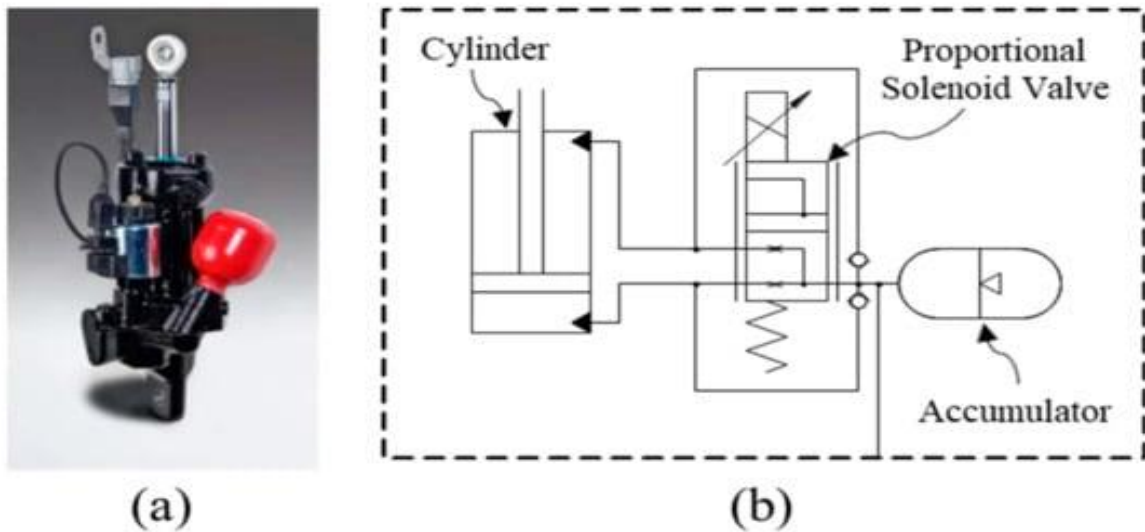


Figure 1. Hydro-pneumatic suspension: (a) and hydraulic circuit.

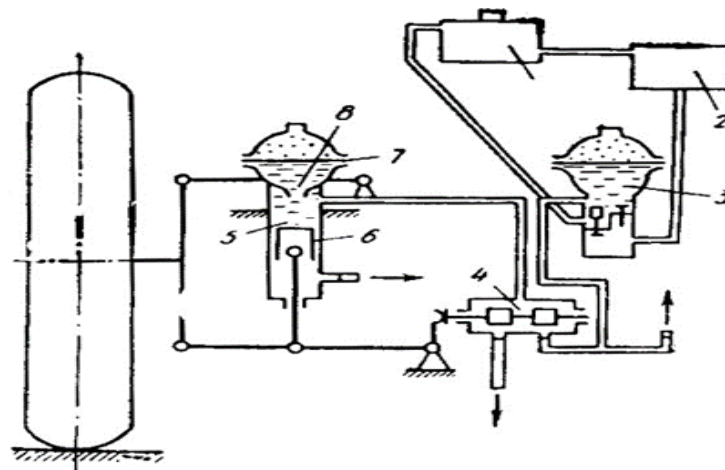


Figure 2. Hydraulic-pneumatic suspension.

Figure 2 shows a drawing of a hydropneumatic suspension. Pump 2 sucks liquid from tank 1 and sends it to pressure accumulator 3. The pressure in the accumulator is always maintained at a certain value. If the pressure increases, the fluid returns to the tank through a return (reduction) valve. The fluid from the accumulator passes to the left and right wheel adjusters 4 (regulators), thereby maintaining the body level in a constant state. From the adjuster 4, the fluid passes to the piston-type pneumatic part 5, which connects the elastic part of the suspension with the damper. In this construction, the space between the piston 6 and the separation membrane 7 is filled with liquid, and the space above the membrane is filled with compressed air. Compressed gas assumes

the elasticity of the suspension, and the liquid assumes vertical loads. As a result of the vibration of the body, when the liquid passes through the valve 8, it meets a series of resistance and overcomes it, due to the friction created, the vibration of the body and wheels is ensured. [4-5]

Research results

Due to the fact that the car travels at different speeds when moving, the influence of the road, that is, the pushing and shearing forces of uneven roads are transmitted to the body or frame through the wheels. In order to eliminate the effects of these forces, various elastically deformable structures are used.

A-suspension of a car: consists of flexible (elastic) guide and damper parts, with the help of which the body, frame, axle or wheels are connected. The suspension supports the car and provides an elastic connection with the body, reduces and dampens negative impact forces, and also ensures smoothness during the movement of the car. The elastic construction includes leaf springs and coil springs. Elastic constructions relieve variable loads caused by the weight of the car. Car suspensions can be mainly divided into two types, namely non-independent and independent.

The elastic part of the car suspension vibrates the frame and body at a variable frequency when the wheel moves on an uneven road. Although these vibrations are damped, they last for a long time, which worsens the smoothness of the ride. The shock absorber dampens the vibrations of the frame and body. There are two types of shock absorbers: lever and telescopic.

The main advantage of the telescopic shock absorber is its compactness and ease of placement on the suspension. This is the reason why telescopic shock absorbers working in both directions are used in modern cars. Therefore, make sure that the car is in perfect condition before going on the road. This is what we are doing now - checking the shock absorbers. Experiments show that shock absorbers do not fail at one time. Maybe it matures as a result of working for a long time. [6-7]

Therefore, drivers cannot always determine in time the reason for the reduction of the car's performance. But there are some signs that report a problem and indicate the need to go to diagnostics:

- ✓ the car shakes from side to side;
- ✓ brake distance is extended. The braking distance of a new shock absorber is 31.70 meters, when worn out - it reaches 35.6 meters;
- ✓ it falls hard into potholes;
- ✓ the body moves forward during a sharp stop, and backward when the speed is increased;
- ✓ the car moves;
- ✓ vibration;
- ✓ rapid wear of the pads.

Results analysis

Any diagnostics begins with a visual inspection. In this way, they determine the condition of the shock absorbers. For example, the presence of oil in the shock absorber housing, traces of rust and other defects in the stocks indicate its malfunction. Random spots on tires, rapid and unjustified wear of tires, suspicious condition of springs and top supports (traces of rust, damage) indicate a problem. As for hanging elements, you should not rely on your eyesight, it is better to contact professionals. Unfortunately, worn shock absorbers can also look better. This is what leads to the delusion that the shock absorber is in working condition. In fact, there may be problems with the internal elements, and in this case, an inspection alone will not be sufficient.

The shock absorber column is the main part of the suspension, on which the elastic elements of the suspension, the spring and the compression buffer are installed. The suspension column acts as a double-acting hydraulic shock absorber and a guide element of the front suspension, that is, it receives and reduces the movement of the wheel relative to the body and the forces and moments acting through the wheel. It provides an angular shift of the column by damping vibrations and shocks when the car moves on an uneven road. [8-9]

A common method for visual, independent diagnostics of shock absorbers is to shake the car. One side of the car should be shaken well and it should be observed how quickly the shaking ends. If the car vibrates several times after shaking, it means that the shock absorber is worn out. During such manipulations, the critical state of the shock absorber is determined. Another unpleasant news is that the hardened shock absorber does not allow the car to shake at all. The golden rule of independent review is not to overdo it. Some people are so eager to make an accurate diagnosis that they shake the car so hard that they damage the body parts.

If the car shows independence during movement - it does not obey the steering control well, if it shakes from side to side, this may be a sign of a shock absorber failure. Moreover, this condition can be observed not only at high speed, but also at an average walk. Damage and wear of the shock absorber lead to an increase in braking distance and the emergence of dangerous situations. In any case, if there are any changes in the handling of the car, it is better to go to the diagnostic specialists. The most effective, easy and inexpensive way to check the condition of the car suspension is to conduct measurements as part of the diagnostics [10].



Figure 3. Failure condition of shock absorbers.

The shock absorber consists of three parts, cylinder and cylinder base, rod and piston, and guide bushings. The piston has two rows of holes arranged in a circle, and the upper row of holes is closed by a valve and its weak spring. The bottom row of holes is closed with a strong spring return valve. At the bottom of the cylinder there are compression and transfer valves. The second diverter valve also closes the holes with a weak spring. The shock absorber is filled with a special liquid, which dampens the vibration of the body due to the resistance created when the liquid is driven from one volume to another. A distinctive feature of the telescopic shock absorber is the presence of a chamber on both sides of the working cylinder that fills the volume of fluid when the rod moves. [11]

When the wheel is gently raised and the suspension spring is compressed, the rod enters the working cylinder. Under the influence of a small pressure of the piston, the liquid passes into the cavity above the piston and into the chamber. Fluid passes through the holes in the top row of the piston, opens the diverter valve, and flows into the space above the piston base. The liquid in the

volume compressed by the shock passes through the calibrated holes of the compression valve to the chamber and increases the pressure in it. In this process, the compression valve is closed by a strong spring. When the wheel slowly descends and the suspension spring stretches, the piston moves up, and the rod comes out of the working cylinder. The diverter valve closes and the pressure on the piston increases. As a result, the liquid on the piston passes through its inner row of holes and passes from the annular space between the valve and the bushing to the volume under the piston. Due to the low pressure, the valve is closed, and the liquid from the pressure in the chamber passes through the holes in the cylinder base, compressing the weak spring of the transfer valve and returns to the cylinder. When the wheel rises quickly, the piston moves faster and the pressure inside the cylinder increases. The high pressure opens the compression valve, as a result of which the increase in shock absorber resistance quickly slows down. Thus, the compression valve protects the shock absorber from the effects of hard shocks. When the wheel descends rapidly, the speed of the piston increases and the pressure on the piston increases. As a result, the valve opens and the liquid falls into the volume under the piston, the resistance of the shock absorber quickly decreases. The valve protects the shock absorber from the complications of hard impulses. [12]

Discussion

The findings indicate that suspension and shock absorber malfunctions are often progressive and may go unnoticed until severe symptoms appear. Many faults originate from inadequate maintenance or delayed replacement of worn components. Environmental factors such as poor road conditions and temperature fluctuations also contribute significantly to early wear.

Preventive measures, including regular inspection, timely replacement of worn parts, and correct load distribution, are critical for prolonging the life of these systems. Diagnostic tools and driver-reported symptoms are both vital for early detection [13].

Conclusion

It should be noted that timely maintenance of car suspensions and shock absorbers guarantees their long-term and high-quality service. In addition, it increases the smoothness of the car, does not have a negative effect on the psyche of drivers, and prevents traffic accidents in cars. Understanding the symptoms and causes of major suspension and shock absorber malfunctions enables technicians and vehicle owners to take proactive steps in maintaining vehicle safety. This study emphasizes the need for routine checks and timely intervention to reduce the risk of component failure and improve overall driving performance [14].

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